GE HITACHI NUCLEAR ENERGY

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TECHNICAL SPECIFICATIONS FOR THE NUCLEAR TEST REACTOR FACILITY LICENSE R-33

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1 INTRODUCTION

1.1 SCOPE AND PURPOSE

This document constitutes the Technical Specifications for the GEH Nuclear Test Reactor as required by 10 CFR 50.36 and supersedes all prior Technical Specifications. This document includes the “basis” to support the selection and significance of the specifications. The Technical Specifications are based on the guidance provided in American National Standards Institute/ American Nuclear Society (ANSI/ANS) 15.1-2007, “The Development of Technical Specifications for Research Reactors” as modified by NUREG-1537, Part 1, Appendix 14.1, “Format and Content of Technical Specifications for Non-Power Reactors.”

These Technical Specifications provide limits within which operation of the reactor will assure the health and safety of the public, the environment, and on-*SITE* personnel. Areas addressed are Definitions, Safety Limits (SL), Limiting Safety System Settings (LSSS), Limiting Conditions for Operation (LCO), Surveillance Requirements, Design Features and Administrative Controls.

1.2 DEFINITIONS

ADMINISTRATIVE CHANGE(S):

An editorial, non-technical change, which does not affect nuclear safety, personnel safety, security, quality, or change the intent of the document being changed.

CHANNEL(S):

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 comparison and/or an adjustment of the *CHANNEL* so 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 test and *SHALL* include the *CHANNEL TEST*.

CHANNEL CHECK:

A qualitative verification of acceptable performance by observation of *CHANNEL* behavior. This verification where possible *SHALL* include comparison of the *CHANNEL* with other independent *CHANNELS* or systems measuring the same parameter.

CHANNEL TEST:

The introduction of a signal into the *CHANNEL* to verify that it is *OPERABLE*.

CONFINEMENT:

The enclosure of the overall *FACILITY* that is designed to limit the release of effluents between the enclosure and its external environment through controlled or defined pathways.

CONTROL ROD(S):

A non-scrammable device having an electric motor drive. The rod contains boron-carbide material used to establish neutron flux changes and to compensate for routine reactivity losses (Refer to Design Feature 5.3.1.).

CORE CONFIGURATION:

The fixed assembly that includes 16 fuel assemblies each containing 40 fuel discs. The assemblies are contained within and evenly distributed around the annular core tank (Refer to Design Feature 5.3.1.). Positioned around the outer edge of the core tank are four *SAFETY RODS*, three *CONTROL RODS*, and installed *MANUAL POISON SHEETS*.

EXPERIMENT(S):

Any operation, hardware or target (excluding devices such as detectors, foils, etc.) which is designed to investigate non-routine reactor characteristics, or which is intended for irradiation in an *EXPERIMENTAL FACILITY,* and which is not rigidly secured to a core or shield structure so as to be a part of their design. *EXPERIMENTS* can include:

1. ***SECURED EXPERIMENT*:** Any *EXPERIMENT* 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, or other forces which are normal to the operating environment of the *EXPERIMENT*, or by forces that can arise as a result of credible malfunctions.
2. ***MOVABLE EXPERIMENT*:** Any *EXPERIMENT* where it is intended all, or part of the *EXPERIMENT* MAY be moved in or near the core or into and out of an *EXPERIMENTAL FACILITY* during *REACTOR OPERATION*.

EXPERIMENTAL FACILITY or EXPERIMENTAL FACILITIES:

Any location for an *EXPERIMENT* which is on or against the external surfaces of the reactor main graphite pack, thermal column, or within any penetration thereof.

EXPLOSIVE MATERIAL:

Any chemical compound or mixture, the primary or common purpose of which is to function by an essentially instantaneous release of gas and heat. *EXPLOSIVE MATERIAL* in the NTR includes:

- Detonating, DOT Type I
- Deflagrating, DOT Type II - IV

FACILITY:

That portion of building 105 composed of the NTR reactor cell, control room, north room, setup room, and south cell.

FLAMMABLE:

A *FLAMMABLE* liquid is any liquid having a flash point under 100°F. A *FLAMMABLE* solid is any solid material, other than one classified as an explosive, which is liable to cause fires through friction or which can be ignited easily and when ignited burns so vigorously and persistently as to create a serious hazard. *FLAMMABLE* solids include spontaneously combustible and water-reactive materials.

LICENSE, LICENSED, or LICENSEE:

The written authorization (LICENSE R-33), by the responsible authority (The NRC), for an individual or organization to carry out the duties and responsibilities associated with a personnel position, material, or *FACILITY* requiring licensing.

LICENSED REACTOR OPERATOR(S) / REACTOR OPERATOR(S) / SENIOR REACTOR OPERATOR(S):

A person who is *LICENSED* as a *REACTOR OPERATOR* (*RO*) or *SENIOR REACTOR OPERATOR* (*SRO*) pursuant to 10 CFR Part 55 to operate the controls of the Nuclear Test Reactor.

MANUAL POISON SHEET(S) (MPS):

Manually positioned devices containing cadmium material used to compensate for fuel burnout and limit the amount of *POTENTIAL EXCESS REACTIVITY* available to the operator (Refer to Design Feature 5.3.1.).

MEASURED VALUE:

The value of a parameter as it appears at the output of a *CHANNEL*.

***OPERABLE / INOPERABLE*:**

A system or component is / is not capable of performing its intended function.

***OPERATING*:**

A component or system is performing its intended function.

***POTENTIAL EXCESS REACTIVITY*:**

That reactivity which can be added by the remote manipulation of *CONTROL RODS* from the point that the reactor is exactly critical plus the maximum credible reactivity addition from primary coolant temperature change plus the *REACTIVITY WORTH* of all installed *EXPERIMENT*s.

***PROTECTIVE ACTION(S)*:**

The initiation of a signal or the operation of equipment within the *REACTOR SAFETY SYSTEM* in response to a parameter or condition of the reactor *FACILITY* having reached a specified limit.

***REACTIVITY WORTH (EXPERIMENT)*:**

The value of the reactivity change that results from the *EXPERIMENT* being inserted into or removed from its intended position.

***REACTOR OPERATING or REACTOR OPERATION(S)*:**

The reactor is *OPERATING* whenever it is not in *REACTOR SECURED* or *REACTOR SHUTDOWN* conditions.

***REACTOR THERMAL POWER*:**

The *REACTOR THERMAL POWER*, as determined by a primary coolant system heat balance.

***REACTOR SAFETY SYSTEM(S)*:**

Those systems, including their associated input *CHANNELS*, which are designed to initiate automatic reactor protection or to provide information for initiation of manual *PROTECTIVE ACTION*.

***REACTOR SECURED*:**

The reactor is considered secured when:

1. EITHER there is insufficient moderator available in the reactor to attain criticality or there is insufficient fissile material present in the reactor to attain criticality under optimum available conditions of moderation and reflection.
2. OR the following conditions exist:

(a) *REACTOR SHUTDOWN*.

(b) The console keylock switch is OFF and the key is removed from the lock.

(c) No work is in progress on core components that can directly affect core reactivity, including core fuel, core structure, installed control or *SAFETY RODS*, or *CONTROL ROD* drives unless they are physically decoupled from the *CONTROL RODS*.

(d) No *EXPERIMENT*s are being moved or serviced that have, on movement, a *REACTIVITY WORTH* exceeding the maximum value allowed for a single *EXPERIMENT*, or one dollar, whichever is smaller.

***REACTOR SHUTDOWN*:**

The reactor is shutdown if it is subcritical by at least one dollar in the *REFERENCE CORE CONDITION* with the *REACTIVITY WORTH* of all installed *EXPERIMENT*s included.

***READILY AVAILABLE SENIOR REACTOR OPERATOR*:**

A *SENIOR REACTOR OPERATOR* is readily available on call when the SRO:

1. has been specifically designated and the designation is known to the *REACTOR OPERATOR* on duty, and
2. can be rapidly contacted by phone by the RO on duty, and
3. once contacted, is capable of arriving at the NTR within a reasonable time (½ hour / 30-mile radius) under normal conditions.

***REFERENCE CORE CONDITION*:**

Condition of the core when it is at ambient temperature and the reactivity worth of xenon is negligible (<0.30 dollar).

***SAFETY ROD(S)*:**

Spring-actuated scrammable devices containing boron-carbide material used to perform the safety function of ensuring the reactor can be placed in *REACTOR SHUTDOWN* from any *OPERATING* condition. (Refer to Design Feature 5.3.1.).

***SCRAM TIME*:**

The elapsed time between the generation of a safety system scram signal and when the *SAFETY ROD* reaches the full-in position.

SHALL, SHOULD, AND MAY:

The word "*SHALL*" is used to denote a requirement; the word "*SHOULD*" is used to denote a recommendation; and the word "*MAY*" is used to denote permission, neither a requirement nor a recommendation.

SHUTDOWN MARGIN:

The 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* condition, although the most reactive *SAFETY ROD* is stuck in its most reactive position, and the three *CONTROL RODS* are in their most reactive positions, and that the reactor will remain subcritical without further operator action.

SITE:

The area within the confines of the Vallecitos Nuclear Center (VNC) controlled by the LICENSEE (Refer to Safety Analysis Report, Figure 2-3.).

SURVEILLANCE INTERVALS:

- Quinquennial – interval not to exceed 70 months.
- Biennial – interval not to exceed 30 months.
- Annual – interval not to exceed 15 months.
- Semi-annual – interval not to exceed 7.5 months.
- Quarterly – interval not to exceed 4 months.
- Monthly – interval not to exceed 6 weeks.
- Weekly – interval not to exceed 10 days.
- Daily - *Must* be done during the calendar day.
- Prior to SU – Prior to the first reactor start-up of the day.

TRUE VALUE:

The *TRUE VALUE* for a parameter is its actual value.

UNSAFE CONDITION:

A condition that can exist related to either nuclear safety or radiological safety. An *UNSAFE CONDITION* relative to nuclear safety exists if the ability to place the reactor in *REACTOR SHUTDOWN* is compromised or the ability to maintain the reactor subcritical is compromised as verified in Chapter 13 analysis. An *UNSAFE CONDITION* relative to radiological safety can only exist if any combination of failures in equipment or administrative radiological work controls results in an individual being assigned an unplanned dose greater-than-or-equal-to 100 mrem. Determination of an *UNSAFE CONDITION SHOULD* consider the single failure of an active component or a single administrative barrier when assessing radiological safety.

***UNSCHEDULED SHUTDOWN(S)*:**

Any unplanned shutdown of the reactor caused by actuation of the scram *CHANNELS*, operator error, equipment malfunction, or a manual shutdown in response to conditions which could adversely affect safe operation excluding shutdowns which occur during planned equipment testing or check-out operations.

2 SAFETY LIMITS AND LIMITING SAFETY SYSTEM SETTINGS

2.1 SAFETY LIMITS

Applicability

This specification applies to *REACTOR THERMAL POWER* level in *REACTOR OPERATING* mode during either forced convection or natural circulation operation.

Objective

The objective is to specify a maximum reactor power limit at which no damage to the reactor fuel or cladding will occur.

Specification

REACTOR THERMAL POWER

The *TRUE VALUE* of the *REACTOR THERMAL POWER SHALL* not exceed 190 kW.

Basis

Safety Limits are limits on important process variables which are found to be necessary to reasonably protect the integrity of the NTR fuel. The only accidents which could possibly cause fuel damage and a release of fission products from the NTR fuel are those resulting from large reactivity insertions. With the $0.76 *POTENTIAL EXCESS REACTIVITY* limit, a large reactivity insertion is not possible. Therefore, there is no mechanistic way of damaging the fuel and Safety Limits should not be required (Refer to Safety Analysis Report [SAR], Chapter 13.).

The Code of Federal Regulations, however, requires a reactor to have Safety Limits. Therefore, a Safety Limit was chosen to restrict the ratio of the actual heat flux to the Departure from Nucleate Boiling (DNB) surface heat flux in the hottest fuel element coolant passage below 1.5 to preclude any subsequent fuel damage due to a rise in surface temperature. Thermal- hydraulic analyses show that the DNB heat flux for the NTR is not significantly affected by the core flow rate or the core inlet temperature. Reactor power is the only significant process variable that needs to be considered (Refer to SAR, Chapter 13.).

The safety limit for the *REACTOR OPERATING* under steady-state or quasi steady-state conditions is 190 kW. A DNB ratio equal to 1.5 was selected as a conservatively safe *OPERATING* condition for the steady- and quasi steady-state. The *REACTOR*

THERMAL POWER level when the DNBR=1.5 is 190 kW (Refer to SAR, Chapter 13.).

Another Safety Limit under Reactor transient conditions is not required. Conservative transient analyses show that with the *POTENTIAL EXCESS REACTIVITY* limit of $0.76, fuel damage does not occur even if all scrams fail to insert the *SAFETY RODS*. Although the power level may safely attain 4000 kW during this transient event (Refer to SAR, Chapters 4 and 13.), the Safety Limit of 190 kW was conservatively selected to apply to the transient condition.

2.2 LIMITING SAFETY SYSTEM SETTINGS

Applicability

This specification applies to the scram set point for the linear neutron *CHANNELS* which monitor reactor power level in *REACTOR OPERATING mode.*

Objective

The objective is to ensure that automatic action will prevent the safety limit from being reached

Specification

Linear Power - *MEASURED VALUE*

The linear neutron power monitor *CHANNEL* set point *SHALL* not exceed the *MEASURED VALUE* of 125 kW.

Basis

Transient analyses presented in Chapter 13 of the SAR were performed assuming greater than $0.76 maximum potential reactivity and an overpower scram set point at 150 kW. None of the anticipated abnormal occurrences or postulated accidents resulted in fuel damage using these values. The LSSS of 125 kW is conservative for the NTR.

3 LIMITING CONDITIONS FOR OPERATION (LCO)

3.1 REACTOR CORE PARAMETERS

Applicability

These specifications apply to the reactivity condition of the reactor and to the reactivity worths of *CONTROL RODS*, *SAFETY RODS*, and the coolant temperature coefficient of reactivity in *REACTOR OPERATING mode*.

Objective

The objective is to ensure the reactor can be safely controlled at all times and maintain the *REACTOR SHUTDOWN* when required.

Specification

3.1.1 POTENTIAL EXCESS REACTIVITY

POTENTIAL EXCESS REACTIVITY SHALL be ≤ \$0.76. If it is determined to be > \$0.76, the reactor *SHALL* be placed in *REACTOR SHUTDOWN* immediately.

3.1.2 SUBCRITICAL ROD POSITION

The reactor *SHALL* be subcritical whenever the four *SAFETY RODS* are withdrawn from the core and the three *CONTROL RODS* are fully inserted. Place reactor in *REACTOR SHUTDOWN* if this condition is not met.

3.1.3 MINIMUM *SHUTDOWN MARGIN*

The minimum *SHUTDOWN MARGIN* with the maximum worth *SAFETY ROD* stuck out *SHALL* be \$1.0.

Basis

Operation in compliance with LCO 3.1.1 ensures that there would not be any mechanism for addition of reactivity greater than \$0.76. Detailed analyses have been made of reactivity insertions in the NTR Safety Analyses Report (SAR) Chapter 13. The analyses show that a reactivity step addition of \$0.76 will not cause significant fuel degradation.

Operation in accordance with LCO 3.1.2 ensures that criticality will not be achieved during *SAFETY ROD* withdrawal and that the full range of available reactor power is controllable by the *CONTROL RODS*. Adherence to the \$0.76 limit also ensures that the reactor will not go critical during *SAFETY ROD* withdrawal.

Operation in accordance with LCO 3.1.3 ensures that the reactor can be placed in *REACTOR SHUTDOWN* without further operator action under any permissible *OPERATING* condition even with the most reactive *SAFETY ROD* stuck in its most reactive position and accounting for the maximum *POTENTIAL EXCESS REACTIVITY* value of LCO 3.1.1.

3.2 REACTOR CONTROL AND SAFETY SYSTEM

3.2.0 GENERAL

The reactor *SHALL* be placed in *REACTOR SHUTDOWN* immediately if any portion of the *REACTOR SAFETY SYSTEM* malfunctions, except as provided for in Tables 3-1 and 3-2.

Applicability

These specifications apply to the reactor *SAFETY RODS*, *CONTROL RODS* and *REACTOR SAFETY SYSTEMS* when in *REACTOR OPERATING mode*.

Objective

The objective is to specify the lowest acceptable level of performance to reasonably ensure proper operation of the reactor *SAFETY ROD*, *CONTROL ROD* and *REACTOR SAFETY SYSTEMS*.

Specification

3.2.1 RODS *OPERABLE*

REACTOR OPERATION SHALL be permitted only when all four *SAFETY RODS* and all three *CONTROL RODS* are *OPERABLE*. The reactor *SHALL* be placed in *REACTOR SHUTDOWN* immediately if it is known that a *SAFETY ROD* or *CONTROL ROD* is NOT *OPERABLE*.

3.2.2 SAFETY ROD WITHDRAWAL

No more than one *SAFETY ROD SHALL* be simultaneously moved in an outward direction.

3.2.3 SAFETY ROD WITHDRAWAL RATE

The rate of withdrawal of each *SAFETY ROD* during *REACTOR OPERATION SHALL* be less than 1 ¼ inches per second.

3.2.4 *CONTROL ROD* WITHDRAWAL RATE

The rate of withdrawal of *CONTROL RODS* during *REACTOR OPERATION SHALL* be less than 1/6 inch per second. The rods can be inserted or withdrawn singly or multiple rods simultaneously.

3.2.5 SCRAM TIME

The average *SCRAM TIME* of the four *SAFETY RODS SHALL* not exceed 300 msec.

3.2.6 *REACTOR SAFETY SYSTEM* AND SAFETY-RELATED ITEMS

REACTOR OPERATION SHALL be permitted only when the *REACTOR SAFETY SYSTEM* is *OPERABLE* in accordance with Table 3-1 and Table 3-2.

- Table 3-1 specifies automatic trip set points, scram system components, and minimum number of *CHANNELS* necessary to ensure *PROTECTIVE ACTIONS* can be taken to place the reactor in *REACTOR SHUTDOWN*. The Trip Points in Table 3-1 reflect the minimum values necessary to avoid approaching the LCOs in Sections 3.1 and 3.2 of these Technical Specifications.
- Table 3-2 specifies alarm set points and rod interlock features that prompt operator actions that ensure the *FACILITY* is maintained within normal *OPERATING* parameters.

Basis

Operation in accordance with LCO 3.2.1 ensures that adequate *SHUTDOWN MARGIN* is provided during normal operation.

Operation during startup in accordance with LCO 3.2.2 and LCO 3.2.3 limits the rate of reactivity addition during *SAFETY ROD* withdrawal to a reasonable rate for manual control (Refer to SAR, Chapter 4.) and that the *CONTROL RODS* have sufficient reactivity to maintain the reactor subcritical with all four *SAFETY RODS* withdrawn.

Operation in accordance with LCO 3.2.4 limits the rate of reactivity addition during *CONTROL ROD* withdrawal. Experience has shown that this is a value which is easily controlled manually by the operator (Refer to SAR, Chapter 4.). This rate is also less than the value analyzed in the rod withdrawal accident in the SAR.

Operation in accordance with LCO 3.2.5 ensures that the *SAFETY ROD* system performs satisfactorily. The specified time is approximately the same as what was originally established for this type of reactor when higher *POTENTIAL EXCESS REACTIVITY* was permitted. With the current limit on *POTENTIAL EXCESS REACTIVITY* (Refer to Technical LCO 3.1.1.), a scram is not required during postulated events to prevent significant fuel degradation (Refer to SAR, Chapter 13.).

Operation in accordance with LCO 3.2.6 ensures that the *REACTOR SAFETY SYSTEM* is adequate to control operation of the *FACILITY*, measure *OPERATING* parameters, warn of abnormal conditions, and scram the reactor automatically if required.

Table 3-1

REACTOR SAFETY SYSTEM - SCRAM

Item No.	System	Condition	Trip Point	Function	Min. Number of Channels
1.	Linear Power	High reactor power	≤ 125 kW	Scram (2-out-of-3 or 1-out-of-2)	2
		Loss of positive high voltage to ion chambers (if used)	No less than 90% of *OPERATING* voltage	Scram (2-out-of-3 or 1-out-of-2)	
2.	Log N	Fast reactor period	No less than +5 sec	Scram	1
		Amplifier Mode switch not in operate	N/A	Scram	
		Loss of positive high voltage to ion chambers (if used)	No less than 90% of *OPERATING* voltage	Scram	
3.	Primary Coolant Temperature (Fenwall)	High core outlet temperature	≤ 222 °F	Scram	1
4.	Primary Coolant Flow	Low Flow	No less than 15 gpm when reactor power > 0.1 kW	Scram	1
5.	Manual	Console button depressed	N/A	Scram	1
6.	Electrical Power	Reactor console key in off position (loss of AC power to console)	N/A	Scram	1

Table 3-2

REACTOR SAFETY-RELATED ITEMS

Item No.	System	Condition	Set Point	Function
1.	Reactor Cell Pressure	Low Differential pressure	> 0.5 in. water ΔP	Visible and audible alarm; audible alarm *MAY* be bypassed after recognition.
2	Fuel Loading Tank Water Level	Low Level	< 3 ft. below the overflow	Visible and audible alarm; audible alarm *MAY* be bypassed after recognition.
3.	Primary Coolant Temperature	High core outlet temperature	<200°F	Visible and audible alarm; audible alarm *MAY* be bypassed after recognition.
4.	Primary Coolant Temperatures	Core Delta temperature	N/A	Provide information for the heat balance determination
5.	Stack Radioactivity	High Level	Complies with TS 3.7.2.1	Visible and audible alarm; audible alarm *MAY* be bypassed after recognition.
6.	Linear Power	Low Power indication	≥2% on any scale	*SAFETY RODS* or *CONTROL RODS* cannot be withdrawn (2-out-of-3 or 1-out-of-2).
7.	*CONTROL ROD* or *SAFETY ROD*	Rods not in	N/A	*SAFETY ROD* magnets cannot be reenergized
8.	*SAFETY ROD*	Rods not out	N/A	*CONTROL RODS* cannot be withdrawn; *SAFETY RODS SHALL* be withdrawn in sequence; *MAY* be bypassed to allow withdrawal of one *CONTROL ROD*, or one *SAFETY ROD* (drive) out of sequence for purposes of inspection, maintenance, and testing

Basis for items listed in Table 3-1

The linear high reactor power scram will be set no higher than the LSSS. Scram action as a result of a predetermined decrease of positive high voltage to ion chambers for the linear *CHANNELS* provides assurance that the high voltage power supply is functioning, and the ion chambers are *OPERATING* in the ionization region of the gas amplification curve.

The fast period scram limits the rate of rise of the reactor power to periods which are manually controllable. The Log N amplifier mode switch scram ensures that the Log N amplifier is in the Operate Mode. Scram action as a result of loss of positive high voltage to the ion chamber for the Log N *CHANNEL* provides assurance that the high voltage power supply is functioning, and the ion chamber is *OPERATING* in the ionization region of the gas amplification curve.

The primary coolant high core outlet temperature scram provides assurance that *REACTOR SHUTDOWN* will result if the primary coolant outlet temperature is high.

The primary coolant low-flow scram provides diversification in the safety system to ensure, when the reactor is at power levels which require forced cooling, that *REACTOR SHUTDOWN* will result if sufficient primary coolant flow is not maintained.

The manual console scram button provides a method for the *REACTOR OPERATOR* to manually place the reactor in *REACTOR SHUTDOWN* if an unsafe or abnormal condition should occur.

The loss of electrical power with the reactor console key in the off position (loss of ac power to the console) means that the reactor cannot be operated because ac power is no longer provided to the *REACTOR SAFETY SYSTEM*.

Basis for items listed in Table 3-2

The reactor cell low differential pressure alarm alerts the operator that reactor power *SHALL* be lowered below 0.1 kW according to LCO 3.5.1. Remedial action *MAY* be taken to correct the condition prior to shutting down the reactor.

The fuel loading tank low water level alarm alerts the operator to verify that the core tank is filled prior to exceeding 0.1 kW according to LCO 3.3.1, or to place the reactor in *REACTOR SHUTDOWN* according to LCO 3.3.2 if *OPERATING* at > 0.1 kW.

The primary coolant high core outlet temperature alarm alerts the operator prior to reaching a high core outlet temperature trip and has no associated LCO.

Core delta temperature is the difference between the core outlet (TC-2) and core inlet (TC-5) thermocouples.

The stack radioactivity high level alarm gives adequate assurance that operation of the reactor will comply with LCO 3.7.4. The alarm alerts the operator that action is necessary to ensure discharges stay within the limits specified in Table 3-3.

The low power level rod block and alarm assures that the operator has a linear power *CHANNEL OPERATING* and indicating neutron flux levels during rod withdrawal.

The *CONTROL RODS* "not-in" interlock ensures that the reactor will be started up by withdrawing the four *SAFETY RODS* prior to withdrawing the *CONTROL RODS* and *SHALL* be functional prior to startup.

The *SAFETY RODS* "not-out" interlock ensures that the method of reactivity control is with the *CONTROL RODS* during *REACTOR OPERATION* and *SHALL* be functional prior to startup.

3.3 REACTOR COOLANT SYSTEM

Applicability

This specification applies to the water in the reactor primary coolant system when in *REACTOR OPERATING mode* except that LCO 3.3.3 is applicable in all modes.

Objective

The objective is to minimize the adverse corrosion effects on reactor components, ensure that adequate primary water exists for shielding and core cooling, and that proper conditions of the coolant system are maintained for *REACTOR OPERATION*.

Specification

3.3.1 FORCED FLOW COOLING

For *REACTOR OPERATION* above 0.1 kW, the reactor *SHALL* be cooled by light water forced coolant flow in *REACTOR OPERATING mode*.

3.3.2 CORE TANK FULL

REACTOR OPERATION SHALL not be permitted unless the fuel loading tank is filled with water which ensures that the core tank is full. If during operation of the reactor it is determined that the fuel loading tank is not filled with water, the reactor *SHALL* be placed in *REACTOR SHUTDOWN* immediately.

3.3.3 PRIMARY COOLANT CONDUCTIVITY

The specific conductivity of the primary coolant water *SHALL* be maintained less than 5 μS/cm when averaged over a one-month period.

Basis

During a complete loss of primary coolant flow without a reactor scram, fuel damage does not occur (SAR, Chapter 13). Natural convection cooling is sufficient. Requiring forced coolant flow above 0.1 kW, then, is extremely conservative. At or below 0.1 kW forced coolant flow is not required.

Operation in accordance with LCO 3.3.2 ensures that there will be no reactivity insertions due to the removal of voids or the sudden addition of water into the core tank during *REACTOR OPERATION*.

The minimum corrosion rate for aluminum in water (< 50°C) occurs at a pH of 6.5. Maintaining water purity below 5 μS/cm will maintain the pH between 5.5 and 7.5. These values are acceptable for NTR operation. (Refer to SAR 5.4.) Operation in accordance with LCO 3.3.3 ensures aluminum corrosion is within acceptable levels and that activation of impurities in the primary water remain below hazardous levels.

3.4 CONFINEMENT

This section left intentionally blank.

3.5 REACTOR CELL, VENTILATION, AND CONFINEMENT SYSTEM

Applicability

This specification applies to the reactor cell ventilation system when in *REACTOR OPERATING* mode or during activities that could release airborne radioactivity into the reactor cell.

Objective

The objective is to limit the release of airborne radioactive materials to the environment.

Specification

3.5.1 REACTOR CELL NEGATIVE PRESSURE

In *REACTOR OPERATING* mode, reactor power *SHALL* not be increased above 0.1 kW unless the reactor cell is maintained at a negative pressure of not less than 0.5 in. of water with respect to the control room.

If during operation of the reactor above 0.1 kW, the negative pressure with respect to the control room is not maintained, then the reactor power *SHALL* be lowered to less than 0.1 kW immediately.

3.5.2 REACTOR CELL ACTIVITY RELEASE

Reactor cell ventilation system *SHALL* be *OPERATING* during performance of activities that could release airborne radioactivity into the reactor cell.

Basis

Operation in accordance with LCOs 3.5.1 and 3.5.2 ensures that potentially contaminated reactor cell air is released and monitored through the ventilation system. The reactor cell also works in conjunction with the ventilation system to limit small radioactive releases during fueled *EXPERIMENTS* (SAR, Chapters 3 and 13) in other areas of the *FACILITY*. However, as demonstrated in Chapter 13 of the NTR Safety Analysis Report, *CONFINEMENT* is not required to ensure radiological doses will not exceed 10 CFR 20 allowable limits.

3.6 EMERGENCY POWER

This section left intentionally blank.

3.7 RADIATION MONITORING SYSTEMS AND EFFLUENTS

Applicability

This specification applies to area radiation monitors, which contribute to the protection of personnel by maintaining exposures ALARA but do not have a reactor safety function. The *SITE* radiation protection program (SAR 11.1.2) is managed by the Regulatory Compliance (RC) Manager. However, the specifications below relate to NTR-specific activities.

This specification also applies to *SITE* monitoring with dosimeters and to the gaseous and particulate activity exiting the ventilation discharge stack in *REACTOR OPERATING* mode or during activities that could release airborne radioactivity into the reactor cell.

Objective

The objective is to specify the radiation monitoring capabilities that SHALL be available to limit occupational radiation exposure and to ensure dose to members of the public due to direct exposure or airborne releases from NTR are below applicable limits.

Specification

3.7.1 MONITORING SYSTEMS DURING *REACTOR OPERATIONS*

Functional area radiation monitors* are required in *EXPERIMENTAL FACILITY* spaces while *EXPERIMENTS* are in progress and the control room during *REACTOR OPERATIONS*.

3.7.2 MONITORING SYSTEMS DURING REACTOR CELL MAINTENANCE

A functional area radiation monitor* is required in the reactor cell during maintenance activities.

*A functional area radiation monitor *SHALL* include:

- Instrument readout that is visible in the control room.
- a gamma-sensitive instrument.
- A local audible alarm.

3.7.3 EFFLUENTS – ENVIRONMENTAL MONITORING

The VNC *SITE* utilizes environmental air sampling stations and TLD badges in locations specified by the VNC Environmental Monitoring Manual.

3.7.4 EFFLUENTS – STACK RELEASE ACTIVITY

The stack discharge rates of gaseous and particulate activity *SHALL* not exceed the limits in Table 3-3, ensuring compliance with the 10 CFR 20.1101(d) limit of 10 mrem/year.

Table 3-3

STACK RELEASE ACTION LEVELS

	Gaseous Activity (Ar-41)	Particulate Activity (Beta)
Weekly release	9 Ci/wk	1.7E+03 µCi/wk
Alarm setpoint	9.5E-05 µCi/cc	1.9E-08 µCi/cc

1. If the alarm setpoint is exceeded, then the operator SHALL determine the weekly release rate and take actions to ensure the weekly release rate action level is not exceeded.

2. If the weekly release rate is determined to have been exceeded, then the reactor SHALL be placed in SHUTDOWN until the condition can be evaluated and the release rates determined to be below action levels.

3.7.5 EFFLUENTS – STACK MONITOR OPERABILITY

The stack gaseous and particulate activity monitors *SHALL* be *OPERATING* when the reactor is operated above 0.1 kW or when any activity is performed in the facility that could release airborne radioactivity in the reactor cell. If either monitor is not functional:

1. Reduce power to below 0.1 kW
2. All evolutions that could precipitate airborne releases *SHOULD* be discontinued within the *FACILITY*.
3. The failed monitor *SHOULD* be restored to functionality by the end of the run or at the discretion of management.
4. If these actions cannot be completed, the reactor *SHALL* be placed in *REACTOR SHUTDOWN* and not returned to operation above 0.1 kW until both monitors are functional.

Basis

The radiation monitoring systems provide information to operations personnel regarding impending or existing danger from excess radiation during operation, irradiated *EXPERIMENT* handling, and maintenance activities.

Permanently installed radiation monitoring equipment is located at the:

- North Room (adjacent to the CHRIS)
- South Cell
- Reactor Cell
- Control Room
- North Room (MSM)

The stack release action levels are based on the annual average dilution factor from the NTR stack to the SITE boundary. A nominal stack flow rate of 1800 ft^3/min and 30 hours per week NTR operation time are assumed. This information, along with other conservative assumptions, ensures that effluent concentrations at the site boundary will not exceed those listed in 10 CFR 20, Appendix B, Table 2, Column 1, nor will the dose from air emissions exceed the 10 mrem/yr constraint from 10 CFR 20.1101(d). A detailed description of the weekly release and alarm setpoints can be found in SAR sections 11.2.4 and 11.2.5.

3.8 EXPERIMENTS

Applicability

This specification applies to reactor *EXPERIMENT*S.

Objective

The objective is to prevent an *EXPERIMENT* from resulting in a hazard to staff or the general public or damage to the reactor.

Specification

3.8.1 *EXPERIMENT REACTIVITY WORTH* LIMIT

The sum of the *REACTIVITY WORTH* of all *EXPERIMENT*S performed at any one time *SHALL* be limited to comply with the specification on *POTENTIAL EXCESS REACTIVITY* (Refer to LCO 3.1.1.).

3.8.2 EXPERIMENTAL OBJECT MOVEMENT

No experimental object *SHALL* be moved during *REACTOR OPERATION* unless its potential *REACTIVITY WORTH* is known to be less than $0.50

3.8.3 EXPLOSIVES LIMITS FOR THE NTR

The amounts of explosives (detonating and deflagrating, DOT Hazard Class/Divisions 1.1, 1.2, 1.3 and 1.4) permitted in the NTR facilities are as follows:

i. South Cell, $W \le (D/2)^2$ with $W \le 9$ lbs and $D \ge 3$ ft.

ii. North room (without Modular Stone Monument), $W \le D^2$ with $W \le 16$ lbs and $D \ge 1$ft.

iii. Setup Room, $W \le 25$ lbs.

3.8.4 EXPLOSIVES LIMITS FOR THE NORTH ROOM

The amounts of explosives allowed in the North room MSM (inclusive in the limit of 3.8.3. ii. above) are as follows:

i. for DOT Hazard Class Divisions 1.1, 1.2, and 1.3 (detonating): $W \le 2$ pounds

ii. for DOT Hazard Class Division 1.4 (deflagrating): $W \le 4$ pounds

where: W = Total weight of explosives in pounds of equivalent TNT.

D = Distance in feet from the South Cell blast shield or the North

Room wall.

3.8.5 EXPERIMENTAL OBJECTS IN THE CORE TANK

Experimental objects *SHALL* not be allowed inside the core tank when the reactor is at a power greater than 0.1 kW.

3.8.6 EXPERIMENTAL OBJECTS IN THE FUEL LOADING CHUTE

Experimental objects located in the fuel loading chute *SHALL* be secured to prevent their entry into the core region during *REACTOR OPERATION*.

3.8.7 RADIOACTIVE MATERIAL NEAR EXPLOSIVES

A maximum of 10 Ci of radioactive material and up to 50 g of uranium *SHALL* be in storage in a neutron radiography area where explosive devices are present (i.e., in the South Cell or North Room). The storage locations *SHALL* be at least 1.5 m (5 ft) from any explosive device.

Radioactive materials, other than byproduct irradiated explosive devices and imaging systems, are not permitted in the Setup Room if *EXPLOSIVE MATERIAL* is present.

<u>Exception.</u> Devices containing not more than 10 grams TNT equivalent of explosives with up to 200 mCi of tritium in the form of tritiated metal (hydride) are permitted. However, no more than one device *SHALL* be in a neutron radiography area or the setup room at any one time, and no other *EXPLOSIVE MATERIAL SHALL* be in the same area at that time.

3.8.8 EXPLOSIVES IN RADIATION FIELDS

No explosive device *SHALL* be placed in a radiation field greater than 1×10^4 roentgens or consisting of greater than 3×10^{12} n/cm^2 thermal neutrons.

3.8.9 ELECTROMAGNETIC WAVE NEAR EXPLOSIVES RESTRICTION

With the exception of communication equipment utilizing low-energy electromagnetic waves in radiofrequencies, such as mobile phones and two-way hand-held radios, unshielded high-frequency generating equipment *SHALL* not be operated within 50 feet of any explosive device.

3.8.10 EXPERIMENTAL CAPSULE DESIGN

Experimental capsules to be utilized in the *EXPERIMENTAL FACILITIES SHALL* be designed or tested to ensure that any pressure transient produced by chemical reaction of their contents and/or leakage of corrosion or *FLAMMABLE* materials will not damage the reactor.

3.8.11 FISSILE MATERIAL EXPERIMENTAL LIMITATIONS

EXPERIMENTS containing fissile material *SHALL* be encapsulated and limited to a U-235 inventory of 50 mg.

3.8.12 CHEMICAL ENERGY FROM *FLAMMABLE* MATERIALS

The potential *REACTIVITY WORTH* of any component which could be ejected from the reactor by a chemical reaction *SHALL* be less than $0.50.

The maximum possible chemical energy release from the combustion of *FLAMMABLE* materials contained in any *EXPERIMENTAL FACILITY SHALL* not exceed 1000 kW-sec. The total possible energy release from chemical combination or decomposition of substances contained in any experimental capsule *SHALL* be limited to 5 kW-sec, if the rate of the reaction in the capsule could exceed 1 W. *EXPERIMENTAL FACILITIES* containing *FLAMMABLE* materials *SHALL* be vented external to the reactor graphite pack.

3.8.13 *EXPERIMENT* APPROVAL

A written description and analysis of the possible hazards involved for each type of *EXPERIMENT SHALL* be evaluated and approved by the area manager, or his designated alternate, before the *EXPERIMENT* is conducted.

3.8.14 *EXPERIMENT* INTERFERENCE IN *REACTOR SHUTDOWN*

No irradiation *SHALL* be performed which could credibly interfere with the scram action of the *SAFETY RODS* at any time during *REACTOR OPERATION*.

3.8.15 *EXPERIMENT* RADIATION LIMITS

The radioactive material content, including fission products, of any singly encapsulated *EXPERIMENT* to be utilized in the *EXPERIMENTAL FACILITIES SHALL* be limited, so that the complete release of all gaseous, particulate, or volatile components from the encapsulation could not result in doses in excess of 10% of the equivalent annual doses stated in 10 CFR Part 20. This dose limit applies to persons occupying unrestricted areas continuously for 2 hours starting at time of release or restricted areas during the length of time required to evacuate the restricted area.

Basis

Operation in accordance with LCO 3.8.1 ensures that there would not be any mechanism for addition of reactivity greater than \$0.76, including *EXPERIMENT*S. See the basis for LCO 3.1.1.

LCOs 3.8.1 through 3.8.14 are intended to reduce the likelihood of damage to the reactor components and/or radioactivity releases resulting from *EXPERIMENT* failure and serve as a guide for the review and approval of new and untried *EXPERIMENT*S by the *FACILITY* personnel. (Refer to SAR Chapter 13.2 for *EXPERIMENT* Design Basis Accident analysis.)

LCOs 3.8.3 and 3.8.4 detailed bases are included in SAR Chapter 13.6.4 *EXPERIMENT* Limitations.

LCO 3.8.7 assures that any radiological effects in storage areas will not pose hazards to the public.

LCO 3.8.15 ensures the radiological effects of *EXPERIMENT* failures do not pose a hazard to the general public or to staff.

4 SURVEILLANCE REQUIREMENTS

4.0 GENERAL SURVEILLANCE INTERVALS

Surveillances *SHALL* not exceed their defined *SURVEILLANCE INTERVALS* (Refer to Definitions, 1.2.) unless deferred according to Surveillance Requirements 4.0.1 or 4.0.2.

4.0.1 DEFERRED *OPERATING* SURVEILLANCES

Surveillances (except those required for safety while in *REACTOR SHUTDOWN*) *MAY* be deferred during a period which the reactor is shutdown, except, for Table 4-2 Items 2, 4, and 5 (Test and Calibration), and Surveillance Requirement 4.7.1 (Test and Calibration). Deferred surveillances *SHALL* be completed prior to reactor startup unless *REACTOR OPERATION* is required for performance of the surveillance. These surveillances *SHALL* be performed as soon as practical after startup.

4.0.2 DEFERRED SHUTDOWN SURVEILLANCES

Scheduled surveillances which cannot be performed with the *REACTOR OPERATING*, *MAY* be deferred until the subsequent scheduled *REACTOR SHUTDOWN*.

4.1 REACTOR CORE PARAMETERS

Applicability

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

Objective

The objective is to verify the reactor does not exceed the authorized limits for *POTENTIAL EXCESS REACTIVITY* and *SHUTDOWN MARGIN*, and that criticality and all authorized power levels are controllable by the *CONTROL RODS*.

Specification

4.1.1 *POTENTIAL EXCESS REACTIVITY*

POTENTIAL EXCESS REACTIVITY SHALL be calculated before each startup. Actual critical rod position *SHALL* then be used to verify that the *MEASURED VALUE* is ≤ $0.76.

4.1.2 SUBCRITICAL ROD POSITION

The reactor *SHALL* be placed in *REACTOR SHUTDOWN* if it is not in a subcritical condition with all four *SAFETY RODS* withdrawn and all *CONTROL RODS* inserted during every reactor startup. *SAFETY ROD* withdrawal *SHALL* be stopped if it appears criticality will be reached before all *SAFETY RODS* are withdrawn.

4.1.3 MINIMUM SHUTDOWN MARGIN

The minimum *SHUTDOWN MARGIN SHALL* be determined by calculation or measurement biennially or whenever a decrease in the reactivity worth of a *SAFETY ROD* is suspected.

Basis

Operation in accordance with Surveillance Requirement 4.1.1 will ensure that the reactor is not operated with a *POTENTIAL EXCESS REACTIVITY* of >$0.76.

Operation in accordance with Surveillance Requirement 4.1.2 will ensure that the reactor will be subcritical when all the *SAFETY RODS* are in the full-out position with *CONTROL RODS* inserted.

Minimum *SHUTDOWN MARGIN* is assured when the *POTENTIAL EXCESS REACTIVITY* is limited to 76¢ and *SAFETY ROD* reactivity worth are unchanged. The *SHUTDOWN MARGIN*, then, *SHOULD* be determined as specified in Surveillance Requirement 4.1.3 when changes to the reactor are made which could decrease the reactivity worth of a *SAFETY ROD*. Composition and configuration of *CONTROL ROD* and *SAFETY ROD* poisons have been unchanged for the lifetime of the reactor.

4.2 REACTOR CONTROL AND SAFETY SYSTEM

Applicability

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

Objective

The objective is to verify performance and operability of the instruments directly associated with reactor safety and safety-related systems.

Specification

4.2.1 *RODS OPERABLE*

Each *SAFETY ROD* and *CONTROL ROD* drive *SHALL* be tested for operability annually.

4.2.2 SAFETY ROD WITHDRAWAL

The interlock which restricts *SAFETY ROD* withdrawal to one rod at a time, in the pre-determined sequence, *SHALL* be tested annually.

4.2.3 SAFETY ROD WITHDRAWAL RATE

The rate of withdrawal of each *SAFETY ROD SHALL* be measured annually.

4.2.4 CONTROL ROD WITHDRAWAL RATE

The rate of withdrawal of each *CONTROL ROD SHALL* be measured annually.

4.2.5 SCRAM TIME

The *SAFETY ROD SCRAM TIME SHALL* be measured semi-annually. The *SCRAM TIME SHALL* also be measured after any work is performed which could affect it.

4.2.6 REACTOR SAFETY SYSTEM AND SAFETY-RELATED ITEMS

Checks, tests and calibrations of the *REACTOR SAFETY SYSTEM* and safety-related items *SHALL* be performed as specified in Tables 4-1 and 4-2 of these Technical Specifications.

Table 4-1

SURVEILLANCE REQUIREMENTS OF REACTOR

SAFETY SYSTEM SCRAM INSTRUMENTS

Item No.	System	Surveillance	Frequency*
1.	Linear Power	*CHANNEL CHECK* (neutron source check)	Prior to SU
		CHANNEL TEST (high level trip test)	Prior to SU
		CHANNEL TEST (lack of high voltage)	Monthly
		CHANNEL CHECK (comparison against a heat balance)	Monthly
		CHANNEL CALIBRATION	Annual
2.	Log N	*CHANNEL CHECK*	Prior to SU
		CHANNEL TEST	Monthly
		CHANNEL CALIBRATION	Annually
3.	Primary Coolant Temperature (Fenwall)	*CHANNEL TEST*	Prior
		CHANNEL CALIBRATION	Annually
4.	Primary Coolant Flow	*CHANNEL CHECK*	Prior to SU
		CHANNEL TEST	Prior to SU
		CHANNEL CALIBRATION	Annually
5.	Manual	*CHANNEL TEST*	Prior to SU
6.	Electrical Power	*CHANNEL TEST*	Prior to SU

*Prior to placing into service an instrument which has been repaired or declared *INOPERABLE*, the instrument check, or test or calibration, as appropriate will be performed to demonstrate operability.

Table 4-2

SURVEILLANCE REQUIREMENTS OF REACTOR SAFETY-RELATED ITEMS (INFORMATION INSTRUMENTS)

Item No.	System	Surveillance	Frequency*
1.	Reactor Cell Pressure	*CHANNEL CHECK*	Prior to SU
		CHANNEL TEST	Quarterly
		CHANNEL CALIBRATION	Annually
2.	Fuel Loading Tank Water Level	*CHANNEL TEST*	Quarterly
3.	Primary Coolant Temperature (TC-7)	*CHANNEL TEST*	Quarterly
		CHANNEL CALIBRATION	Annually
4.	Primary Coolant Temperatures (TC2 & TC5)	*CHANNEL CHECK*	Monthly
		CHANNEL CALIBRATION	Annually
5.	Stack Radioactivity (Gas and particulate *CHANNELS*)	*CHANNEL CHECK*	Prior to SU
		CHANNEL TEST	Monthly
		CHANNEL CALIBRATION	Annually
6.	Linear Power – Low Power Rod Block Setpoint	*CHANNEL TEST*	Monthly
7.	*CONTROL ROD* or *SAFETY ROD* not IN	*CHANNEL TEST*	Annually
8.	*SAFETY ROD* Sequence	*CHANNEL TEST*	Annually
9.	Primary Coolant Conductivity	*CHANNEL CHECK*	Quarterly
		CHANNEL CALIBRATION	Biennially

*Prior to placing into service an instrument which has been repaired or declared *INOPERABLE*, the instrument check, or test, or calibration, as appropriate will be performed to demonstrate operability.

Basis

Surveillance Requirement 4.2.1 ensures that each *SAFETY ROD* and *CONTROL ROD* is maintained *OPERABLE*.

Surveillance Requirement 4.2.2 ensures that the *SAFETY ROD* interlock preventing the simultaneous withdrawal of more than one *SAFETY ROD* functions properly.

Surveillance Requirements 4.2.3 and 4.2.4 ensure that the *SAFETY ROD* and *CONTROL ROD* withdrawal rates are within limits.

Surveillance Requirement 4.2.5 provides for the periodic measurement of *SAFETY ROD* insertion times to ensure they are within limits.

Surveillance Requirement 4.2.6 ensures that the safety system is periodically tested and checked to maintain all instruments *OPERABLE*.

4.3 REACTOR COOLANT SYSTEM

Specifications regarding surveillance requirements of the reactor coolant system for flow, fuel loading tank level, and conductivity are included in the *REACTOR SAFETY SYSTEM*, Surveillance Requirements Section 4.2, Tables 4-1 and 4-2.

4.4 CONFINEMENT

This section left intentionally blank.

4.5 REACTOR CELL VENTILATION AND CONFINEMENT SYSTEM

Applicability

This specification applies to surveillance requirements of the reactor cell ventilation system.

Objective

The objective is to verify proper operation of the ventilation system to ensure contaminated air associated with *REACTOR OPERATIONS* is controlled and exhausted out the NTR discharge stack.

Specifications

4.5.1 REACTOR CELL NEGATIVE PRESSURE

Surveillance requirements for the instrumentation and equipment required to comply with LCO 3.5.1 *SHALL* be tested as listed in Surveillance Requirements Section 4.2,

Table 4-2, Item No. 1 & 5.

4.5.2 REACTOR CELL ACTIVITY RELEASE

A *CHANNEL CHECK SHALL* be performed *DAILY* during activities that could release airborne radioactivity into the reactor cell.

Basis

Operation in accordance with Surveillance Requirement 4.5.1 ensures that contaminated reactor cell air is exhausted through the ventilation system. This minimizes the possibility of airborne contamination release to surrounding areas.

Operation in accordance with Surveillance Requirement 4.5.2 ensures that all required *CHANNELS* are *OPERABLE*, and that proper notification and surveillance will occur.

4.6 EMERGENCY POWER

This section left intentionally blank.

4.7 RADIATION MONITORING SYSTEMS AND EFFLUENTS

Applicability

This specification applies to the surveillance requirements of radiation and effluent monitoring systems.

Objective

The objective is to ensure that radiation and effluent monitoring systems are *OPERATING* properly and to verify appropriate alarm set points.

Specification

4.7.1 MONITORING SYSTEMS DURING *REACTOR OPERATIONS*

Surveillances for the Area Radiation Monitors during *REACTOR OPERATIONS* include a *PRIOR to SU CHANNEL CHECK*, a *MONTHLY CHANNEL TEST*, and an *ANNUAL CHANNEL CALIBRATION*. Prior to placing into service an Area Radiation Monitor which has been repaired or declared *INOPERABLE*, the applicable surveillance will be performed to demonstrate it is *OPERABLE*.

4.7.2 MONITORING SYSTEMS DURING REACTOR CELL MAINTENANCE

A *CHANNEL CHECK SHALL* be performed *DAILY* during reactor cell maintenance.

4.7.3 EFFLUENTS – ENVIRONMENTAL MONITORING

a. Monitoring of dose on *SITE* using thermoluminescent dosimeters or other equivalent devices *SHALL* be performed and documented annually.

b. Environmental monitoring (e.g., sampling of soil and vegetation) *SHALL* be performed and documented annually.

4.7.4 EFFLUENTS – STACK RELEASE ACTIVITY

The stack alarm SHALL be verified *MONTHLY*.

4.7.5 EFFLUENTS – STACK MONITOR OPERABILITY

Stack activity monitors *SHALL* be performed according to Table 4-2, Item No. 5.

4.8 EXPERIMENTS

Specific surveillance activities *SHALL* be established during the review and approval process as specified in Administrative Control 6.2.3 "Review Function" and are not part of the Technical Specifications.

5 <u>DESIGN FEATURES</u>

5.1 SITE AND FACILITY DESCRIPTION

5.1.1 *FACILITY* LOCATION

The Nuclear Test Reactor (NTR) *FACILITY SHALL* be located on the *SITE* of the Vallecitos Nuclear Center (VNC).

5.1.2 CONTROLLED AREA AND RESTRICTED AREA TERMINOLOGY

The controlled area, as defined in 10 CFR Part 20 of the Commission's regulations, is the area within the VNC *SITE* boundary. The restricted area, as defined in 10 CFR Part 20 of the Commission's Regulations, is the NTR *FACILITY*.

5.1.3 EFFLUENT DISCHARGE

The discharge of all gaseous radioactive effluents *SHALL* be from the effluent stack at a minimum height of 45 feet (14 meters) above the grade level of Building 105.

5.2 REACTOR PRIMARY COOLANT SYSTEM

5.2.1 PRIMARY SYSTEM PRESSURE

The reactor coolant system is maintained at atmospheric pressure by a vent line to the holdup tank and the top of the fuel tank being open to the reactor cell.

5.3 REACTOR CORE AND FUEL

5.3.1 CONTROL SYSTEM

The control system *SHALL* consist of four scrammable, spring-actuated *SAFETY RODS*, three nonscrammable *CONTROL RODS*, and *MANUAL POISON SHEETS*. Up to three *MANUAL POISON SHEETS* MAY be added or removed as needed to limit positive excess reactivity and compensate for reactivity loss from fuel burnup.

(1) The *SAFETY RODS* and *CONTROL RODS SHALL* be boron carbide clad in stainless steel.

(2) The *MANUAL POISON SHEETS SHALL* contain metallic cadmium.

(3) Each installed *MANUAL POISON SHEET SHALL* be restrained in its respective graphite reflector slot in a manner which will prevent movement by more than ½ inch relative to the reactor core.

(4) When the *CONTROL RODS*, *SAFETY RODS*, and *MANUAL POISON*

SHEETS are inserted, they *SHALL* be located in the graphite reflector at the outer periphery of the core tank.

5.3.2 REACTOR FUEL

The core *SHALL* consist of 16 fuel element assemblies. Each fuel element assembly *SHALL* consist of 40 disks separated by spacers of varying widths on an aluminum support shaft. Other nominal specifications of the assemblies *SHALL* include the following:

Fuel	23.5% (by weight uranium) / 76.5% aluminum (by weight aluminum)
Enrichment	Approximately 93% U-235 (unburned)
Cladding	Aluminum, 0.027-inch thickness
Fuel disk active diameter	2.75 inch (OD)
Fuel disk spacing on shaft	0.24 to 0.27-inch, face-to-face

5.3.3 CORE REEL ASSEMBLY

The fuel assemblies *SHALL* be positioned in a reel assembly inside the core tank. The core reel assembly *SHALL* be rotated only when in *REACTOR SHUTDOWN* and by manual operation of a crank inside the NTR cell.

5.3.4 TEMPERATURE COEFFICIENT OF REACTIVITY

The core is designed to exhibit a negative temperature coefficient of reactivity above 124°F, which is approximately the reactor steady-state operating temperature.

5.4 FISSIONABLE MATERIAL STORAGE

5.4.1 FUEL STORAGE

Fuel including fueled *EXPERIMENT*S and fuel devices not in the reactor *SHALL* be stored in a geometrical array where k_{eff} is no greater than 0.9 for all conditions of moderation and reflection using light water.

Basis

The basis for the items in Design Features Sections 5.1 to 5.4 are as follows:

The effluent stack is of sufficient height to disperse the exhaust upward.

Ensuring the reactor primary coolant system is vented to atmosphere protects the system from overpressure damage.

The fixed NTR *CORE CONFIGURATION* ensures a temperature coefficient turnover from positive to negative above the operational coolant temperature of 124°F and yields a negative void coefficient above that temperature. This ensures there is no significant positive reactivity feedback from coolant temperature change during reactor power transients.

Loss of coolant will not result in damage to the fuel system comprised of this proven clad, metallic fuel plates. Neglecting natural convection air cooling of the fuel plates, the loss-of coolant inventory from the reactor results in a worst-case fuel temperature peak at about 800°F about 20 minutes after coolant loss at which time it begins to decline. At this peak, the commensurate power is 1.5 kW, which can be tolerated indefinitely without increasing graphite temperatures to over 150°F. Limiting *POTENTIAL EXCESS REACTIVITY* to $0.76 (Refer to SAR, Chapter 13.) ensures a step reactivity insertion also will not cause fuel damage; even with a failure to scram, operation of the reactor will not pose a threat to the health and safety of the public.

Limits imposed in Design Feature 5.3.3 on the fueled *EXPERIMENTS* and fuel devices not in the reactor are conservative and ensures safe storage.

6 ADMINISTRATIVE CONTROLS

6.1 ORGANIZATION

The NTR *SHALL* be owned and operated by the *LICENSEE* with management and operations organization as shown in Figure 6-1.

6.1.1 STRUCTURE

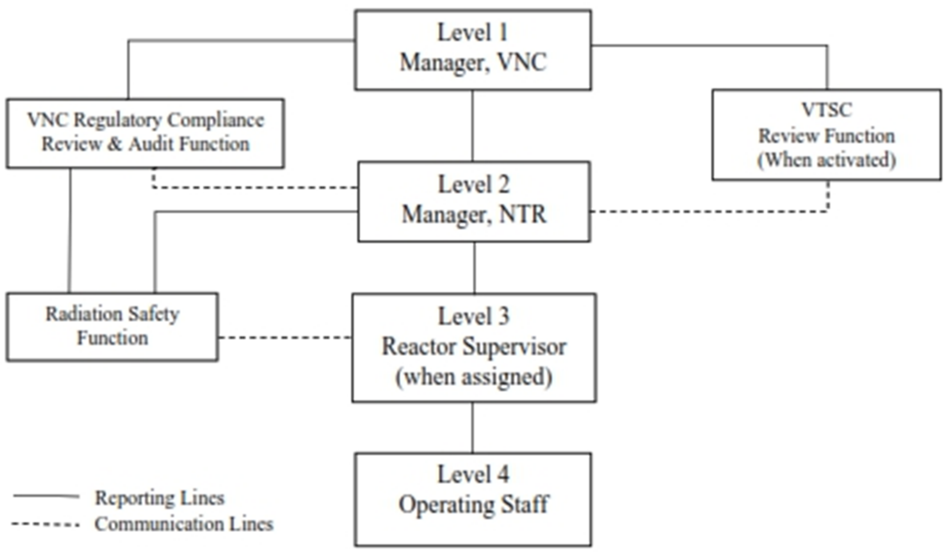

Figure 6-1 *FACILITY* Organization

6.1.2 RESPONSIBILITIES

(1) The Level 1 manager *SHALL* be responsible for the NTR *FACILITY LICENSE*.

(2) The Level 2 manager is designated the area manager for the NTR and *SHALL* be responsible for the overall safe operation and maintenance of the *FACILITY*.

(3) The Level 3 Reactor supervisor (if utilized) is the individual responsible for supervising daily operations. In the absence of this position, the Level 2 manager is responsible for supervising daily operations.

(4) The Level 4 Operations staff includes *SENIOR REACTOR OPERATORS*, *REACTOR OPERATORS*, and trainees.

(5) Responsibilities of one level *MAY* be assumed by alternates when designated in writing.

(6) Functions performed by one level *MAY* be performed by a higher level, provided the

minimum qualifications are met (e.g., *SENIOR REACTOR OPERATOR LICENSE*).

6.1.3 STAFFING

(1) The minimum staffing when the REACTOR IS NOT SECURED (Refer to *REACTOR SECURED.*) *SHALL* be composed of:

- A *LICENSED REACTOR OPERATOR* in the control room.
- A second person present at the *SITE* who is familiar with the VNC Radiological Emergency Plan and Emergency Procedures relevant to the NTR and is capable of carrying out *FACILITY* written procedures.
- A *LICENSED SENIOR REACTOR OPERATOR SHALL* be present at the NTR *FACILITY,* or a *READILY AVAILABLE SENIOR REACTOR OPERATOR* designated.

(2) A list of reactor *FACILITY* personnel by name and telephone number *SHALL* be available in the control room for use by the operator and includes:

- Management personnel
- Radiation safety personnel
- Other operations personnel

(3) A *LICENSED SENIOR REACTOR OPERATOR SHALL* be present at the NTR *FACILITY* during the following events:

- first daily startup and approach to power
- recovery from an *UNSCHEDULED SHUTDOWN*
- all reactor fuel, *SAFETY ROD*, and *CONTROL ROD* relocations within the reactor core region
- *MANUAL POISON SHEET* changes
- relocation of any *EXPERIMENT* or *FACILITY* changes with a *REACTIVITY WORTH* greater than one dollar.

6.1.4 SELECTION AND TRAINING OF PERSONNEL

The selection, training and requalification of operations personnel *SHALL* meet or exceed the requirements of American National Standard for Selection and Training of Personnel for Research Reactors, ANSI/ANS 15.4-2016, and the latest revision of the *FACILITY* Operator Requalification Program.

6.2 *REVIEW AND AUDIT*

6.2.1 COMPOSITION AND QUALIFICATIONS

(1) The RC organization *SHALL* conduct routine audits and perform periodic reviews of the implementation of these Technical Specifications.

(2) The Vallecitos Technological Safety Council (VTSC), at the direction of the Level 1 manager, *SHALL* perform independent reviews to ensure proper ongoing operation of the NTR.

(3) The VTSC *SHALL* not have more than half of its members from either Operations or RC Organizations.

(4) The VTSC *SHALL* be composed of a minimum of three members.

(5) VTSC members and alternates *SHALL* be appointed by the Level 1 manager.

(6) VTSC members *SHALL* collectively represent a broad spectrum of expertise in the appropriate reactor technology.

(7) Qualified and approved alternates *MAY* serve in the absence of regular members.

6.2.2 CHARTER AND RULES

The VTSC functions *SHALL* be conducted under a written charter including provision for:

(1) A meeting frequency of not less than once per calendar year.

(2) Allowing only one vote for each member or alternate for each issue reviewed.

(3) Quorum rules whereby a quorum is at least one-half of the voting members, and the NTR operations staff doesn't constitute a majority of the quorum.

(4) The use of support organizations.

(5) Maintenance of records; including the dissemination, review, and approval of minutes.

6.2.3 REVIEW FUNCTION

Activities requiring review *SHALL* include the following:

(1) Determinations that proposed changes in equipment, systems, tests, *EXPERIMENTS*, or procedures are allowed without prior NRC approval as

determined by 50.59 evaluation.

(2) Determinations that new *EXPERIMENT*s or classes of *EXPERIMENT*s that could affect reactivity or result in the release of radioactivity do not require prior NRC approval as determined by 50.59 evaluation.

(3) Determinations that proposed changes to the Fire Protection program as described in the Safety Analysis Report that do not require prior NRC approval, would not adversely affect the ability to achieve and maintain safe *REACTOR SHUTDOWN* of the NTR in the event of a fire as determined by 50.59 evaluation.

(4) All new procedures and major revisions of existing procedures having safety significance that are required by the administrative control specifications in Administrative Controls Section 6.4.

(5) Proposed changes to the Technical Specifications or the *FACILITY* operating *LICENSE*.

(6) Violations of Technical Specifications, and *FACILITY LICENSE* requirements.

(7) Unusual or abnormal occurrences which are reportable to the NRC under provisions of the Federal Regulations or Administrative Control 6.7.2.

(8) Significant operating abnormalities or deviations from normal and expected performance of *FACILITY* equipment that affect, or could affect, nuclear safety.

(9) Audit Reports.

6.2.4 AUDIT FUNCTION

Audits *SHALL* include examination of operations records, logs, and documents as well as discussions with staff and observations as appropriate. Deficiencies *SHALL* be reported to the Level 1 manager as soon as identified and a written report of the findings of the audit submitted to the Level 1 manager within 3 months after the audit has been completed. The following *SHALL* be audited:

(1) *FACILITY* operation for conformance to these Technical Specifications and applicable *LICENSE* conditions: at least once per calendar year not to exceed 15 months between audits.

(2) Retraining and requalification program for the *LICENSED* operations staff: at least once every other calendar year not to exceed 30 months between audits.

(3) The results of condition reports initiated relative to the NTR and operation of the NTR: once per calendar year not to exceed 15 months between audits.

(4) The VNC Radiological Emergency Plan and implementing procedures: once every other year not to exceed 30 months between audits.

6.3 RADIATION SAFETY

The Level 2 manager (or the Level 3 supervisor when assigned), in coordination with the VNC Radiation Safety Officer (RSO), *SHALL* be responsible for implementing the NTR radiation safety function. The RSO *SHALL* report relevant findings to the Level 2 manager, but SHALL report organizationally to the Manager, RC, thereby maintaining independence from the reactor operations organization. The radiation safety function is informed by the guidelines of the ANSI/ANS 15.11-2016, "Radiation Protection at Research Reactor Facilities."

6.4 PROCEDURES

Written procedures *SHALL* be prepared, reviewed, and authorized prior to initiating any of the activities listed in this section. Because the VNC is a multi-license *FACILITY*, procedures implementing elements of *SITE*-wide programs (i.e., radiation protection, emergency planning, security) are authorized by the *SITE* Manager, RC. NTR-specific implementing procedures as components of those larger programs *SHALL* be authorized by the Level 2 manager according to Administrative Control 6.4.2. Procedures exclusive to the implementation of administrative and operational requirements of the NTR Licensing basis and their revisions *SHALL* be authorized by the Level 2 manager or his designated alternate(s) according to this section. Several of the activities in Administrative Control 6.4.1 *MAY* be included in a single manual or set of procedures or divided among various manuals or procedures.

6.4.1 WRITTEN PROCEDURES

Written procedures *SHALL* be prepared for the following activities as required:

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

(2) Defueling, refueling, and fuel transfer operations, when required.

(3) Preventive or corrective maintenance which could have an effect on the safety of the reactor, including the replacement of components.

(4) Surveillance checks, tests, calibrations, and inspections required by the Technical Specifications.

(5) NTR-specific radiation protection program implementing procedures for personnel safety consistent with applicable regulations or guidelines. Management commitment and programs to maintain exposures and releases as low as reasonably achievable *SHALL* be a component of the *SITE*-wide radiation protection program.

(6) Administrative controls for operation and maintenance and the conduct of *EXPERIMENTS* that could affect reactor safety or core reactivity.

(7) NTR-specific implementing procedures for the *SITE*-wide emergency and security plans.

(8) NTR-specific radiation protection program implementing procedures for the use, receipt, and on-*SITE* transfer of by-product material for such activities performed under the R-33 *LICENSE*.

6.4.2 LEVEL 2 APPROVAL

(1) The Level 2 manager *SHALL* authorize all new procedures required by Administrative Control 6.4.1 before implementation.

(2) The Level 2 manager *SHALL* authorize all non-*ADMINISTRATIVE CHANGES* to procedures required according to Administrative Control 6.4.1.

6.4.3 *ADMINISTRATIVE CHANGES* TO PROCEDURES

(1) *ADMINISTRATIVE CHANGES* to procedures required by Administrative Control 6.4.1 *MAY* be made by the Level 3 reactor supervisor or Level 2 manager before implementation.

(2) *ADMINISTRATIVE CHANGES* made by authorization of the Level 3 reactor supervisor *SHALL* be subsequently approved by the Level 2 manager.

6.4.4 TEMPORARY DEVIATIONS

Temporary deviations from established procedures *MAY* be made by a *LICENSED SENIOR REACTOR OPERATOR* in order to deal with special or unusual circumstances. These deviations *SHALL* be documented and reported to the Level 2 manager by the end of the next working day.

6.5 EXPERIMENTS REVIEW AND APPROVAL

6.5.1 NEW *EXPERIMENT* APPROVAL

All new *EXPERIMENT*s or class of *EXPERIMENT*s *SHALL* undergo review according to Administrative Control 6.2.3 and be approved in writing by the Level 2 manager or designee.

6.5.2 CHANGES TO *EXPERIMENT*S

Changes, except for *ADMINISTRATIVE CHANGES,* to *EXPERIMENT* implementing documents or to previously approved *EXPERIMENTS SHALL* undergo review according to Administrative Control 6.2.3 and be approved in writing by the Level 2 manager or designee.

6.5.3 *ADMINISTRATIVE CHANGES* TO *EXPERIMENT*S

ADMINISTRATIVE CHANGES made to previously approved *EXPERIMENT* implementing procedures (e.g., ERs and EAFs) do not require independent review and *MAY* be approved by an *SRO*.

6.6 REQUIRED ACTIONS

6.6.1 Actions to be Taken in Case of Safety Limit Violation

(1) The reactor *SHALL* be placed in *REACTOR SHUTDOWN*, and *REACTOR OPERATION*s *SHALL* not be resumed until authorized by Level 1 management and the NRC.

(2) The safety limit violation *SHALL* be promptly reported to the Level 2 manager or designated alternates.

(3) The safety limit violation *SHALL* be reported to the NRC.

(4) A safety limit violation report *SHALL* be prepared. The report *SHALL* describe the following:

   (a) Applicable circumstances leading to the violation including, when known, the cause and contributing factors.

   (b) Effect of the violation upon reactor *FACILITY* components, systems, or structures and on the health and safety of personnel and the public.

   (c) Corrective action to be taken to prevent recurrence.

(5) The report *SHALL* be reviewed by the Manager, Regulatory Compliance (RC) or designee and any follow-up report *SHALL* be submitted to the NRC when authorization is sought to resume operation of the reactor.

6.6.2 Action to be taken in the event of an occurrence of the type Identified in Section 6.7.2(1)b and 6.7.2(1)c

(1) Reactor conditions *SHALL* be returned to normal or the reactor *SHALL* be placed in *REACTOR SHUTDOWN*. If *REACTOR SHUTDOWN* is necessary to correct the occurrence, operations *SHALL* not be resumed unless authorized by the Level 2 manager or the Level 1 manager.

(2) Occurrence *SHALL* be reported to the area manager and to the NRC addressed in accordance with 10 CFR 50.4.

(3) Occurrence *SHALL* be reviewed by the Manager, RC, or designee, or the VTSC at its next scheduled meeting.

6.7 REPORTS

6.7.1 Operating Reports

Annual operating report(s) *SHALL* be submitted to the NRC Document Control Desk. The report(s) *SHALL* include the following:

(1) A narrative summary of reactor operating experience including the hours the reactor was critical and total energy produced.

(2) The *UNSCHEDULED SHUTDOWNS* including, where applicable, corrective action taken to preclude recurrence.

(3) Tabulation of major preventive and corrective maintenance operations having safety significance.

(4) A summary report in accordance with 10 CFR 50.59(d)(2).

(5) 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 <25% of the concentration allowed or recommended, a statement to this effect is sufficient.

(6) Summarized results of environmental surveys performed outside the *FACILITY*.

(7) A summary of exposures received by *FACILITY* personnel and visitors where such exposures are greater than 25% of that allowed or recommended.

6.7.2 Special Reports

Special reports are used to report unplanned events as well as planned major *FACILITY* and administrative changes. The following special reports *SHALL* be forwarded to the NRC addressed in accordance with 10 CFR 50.4:

(1) There *SHALL* be a report not later than the following working day by telephone and confirmed in writing by telegraph or similar conveyance to the NRC, to be followed by a written report within 14 days, that describes the circumstances of any of the following events:

a. Violation of safety limit

b. Release of radioactivity from the *SITE* above allowed limits.

c. Any of the following:

i. Operation with actual safety-system settings for required systems less conservative than the limiting safety-system settings specified in the Technical Specifications.

ii. Operation in violation of limiting conditions for operation established in the Technical Specifications unless prompt remedial action is taken.

iii. 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 *REACTOR SHUTDOWN* periods.

NOTE: Where components or systems are provided in addition to those required by the Technical Specifications, the failure of the extra components or systems are not considered reportable provided that the minimum numbers of components or systems specified or required perform their intended reactor safety function.

iv. An unanticipated or uncontrolled change in reactivity greater than $0.50.

v. Abnormal and significant degradation in reactor fuel, cladding, or coolant boundary, which could result in exceeding prescribed radiation limits for personnel or the environment.

vi. An observed inadequacy in the implementation of administrative or procedural controls such that the inadequacy causes or could have caused the existence or development of an *UNSAFE CONDITION* with regard to *REACTOR OPERATION*s.

(2) There *SHALL* be a written report within 30 days to the NRC for:

a. Permanent changes in the *FACILITY* organization involving Level 1 or Level 2 management.

b. Significant changes in the transient or accident analysis as described in the Safety Analysis Report.

6.8 RECORDS

Records *MAY* be in the form of logs, data sheets, or other suitable forms. The required information *MAY* be contained in single, or multiple records, or a combination thereof.

6.8.1 Records to be retained for a period of at least five years or for the life of the component, whichever is less:

(1) Normal reactor *FACILITY* operation (supporting documents such as checklists, log sheets, etc., *SHALL* be maintained for a period of at least one year).

(2) Principal maintenance operations.

(3) Reportable occurrences.

(4) Surveillance activities required by the Technical Specifications.

(5) Reactor *FACILITY* radiation and contamination surveys where required by applicable regulations.

(6) *EXPERIMENTS* performed with the reactor.

(7) Fuel inventories, receipts, and shipments.

(8) Approved changes in operating procedures.

(9) Records of meeting and audit reports of the review and audit groups.

6.8.2 Records of the requalification programs

Records of the requalification programs *SHALL* be maintained in accordance with 10 CFR 55.59(c)(5).

6.8.3 Records to be Retained for the Lifetime of the Reactor *FACILITY*

Note: Applicable annual reports, if they contain all the required information, *MAY* be used as records in this section.

(1) Gaseous and liquid radioactive effluents released to the environs.

(2) Off-*SITE* environmental-monitoring surveys required by the Technical Specifications.

(3) Radiation exposure for all personnel monitored.

(4) Drawings of the reactor *FACILITY*.