U.S. GEOLOGICAL SURVEY
RESEARCH REACTOR
LICENSE NO. R-113
DOCKET NO. 50-274

RESPONSE TO NRC STAFF REQUEST FOR ADDITIONAL INFORMATION FOR LICENSE RENEWAL REVIEW

APRIL 1, 2016

REDACTED VERSION*

SECURITY-RELATED INFORMATION REMOVED

*REDACTED TEXT AND FIGURES BLACKED OUR OR DENOTED BY BRACKETS

Department of the Interior
US Geological Survey
PO Box 25046 MS 974
Denver, CO 80225-0046

April 1, 2016

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Reference: U.S. Geological Survey TRIGA Reactor (GSTR), Docket 50-274, License R-113, Request for Additional Information (RAI) dated February 8, 2016

Subject: Responses to RAI questions

Mr. Wertz:

Responses to RAI questions are provided in the enclosed pages. Please contact me if further details, or corrections, are needed.

In addition, per our phone conversation of 3/28/16, I have attached (as Attachment 6) a copy of our Interagency Agreement with the Department of Energy for the possession and use of TRIGA reactor fuel.

Sincerely,

Tim DeBey

Tim DeBey

USGS Reactor Supervisor

I declare under penalty of perjury that the foregoing is true and correct. Executed on 4/1/2016

Attachment

Copy to:
Vito Nuccio, Reactor Administrator, MS 911
USGS Reactor Operations Committee

A020
NRR

RAI dated 2/8/2016

Technical Review Question 1:

The USGS SAR, Section 7.3.2, "Servo System," provides general information about the servo control system, but does not describe any specific details associated with the potential failure of the servo system. NUREG-1537, Part 1, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Format and Content," Section 7.3, "Reactor Control System," provides guidance that the license should analyze the operation and performance of the system, including the bases for any technical specifications (TSs) and surveillance requirements, and provide a description of the evaluation of any accident scenarios that may be created by a malfunction of the system (e.g., a malfunction of the servo bounded by another reactivity insertion event.).

a. Provide details of the servo system operation including the normal reactivity control range, regulating rod position, interlocks, and any other significant design information, or justify why no additional information is necessary.

b. Explain if additional TSs are needed for the servo system, or justify why no changes are necessary.

Response:

(a.) The servo system at the GSTR works by monitoring three signals (reactor power, reactor period, and demand power) as described in the SAR Section 7.3.2. This system is typical of the "hybrid digital" GA control consoles that were installed in 6 TRIGA reactors in the U.S. and several foreign facilities. We have been using this system for 25 years (since 1991) and are not aware of any failures that have occurred in any of these servo systems. When used to increase power, the AUTO (servo) control system will adjust the regulating rod position to maintain a reactor period of +10 seconds until the demand power is reached. It will then maintain a stable power at the demand power setting. The demand power cannot be set above the full power limit of 1.0 MW. The AUTO control system can be used from 1 W to full power (1.0 MW). All interlocks that apply to standard rod drives also apply to the regulating rod drive, whether it is in the AUTO mode or the MANUAL mode. The speed of the regulating rod motion is controlled by a direct current (DC) voltage that is generated in the control system, either by the AUTO algorithm or by the MANUAL pushbutton switches. If a rapid change occurs in the power indication during use of the AUTO system, the control system will switch out of the AUTO mode and transfer to the MANUAL mode. An absolute reactor period of 2.5 s or less would be sufficient to cause the switch from AUTO to MANUAL.

(b.) No additional TSs are needed for the servo system. The existing rod control system interlocks are sufficient to ensure that an unreviewed safety question does not exist.

Technical Review Question 2:

The USGS SAR does not indicate if chemicals are used in the conduct of experiments, or in the control of contamination for radiation protection of the workers and visitors. NUREG-1537, Part 1, Chapter 10, "Experimental Facilities and Utilization," and Chapter 11, "Radiation Protection Program and Waste Management," provide guidance that chemical hazards should be considered. Provide a description of the chemicals used at the facility that may be considered hazardous to the facility staff, or the environment or public if released, the quantities used, and the controls that mitigate the risks associated with their use, and method of disposal or justify why no additional information is needed.

Response:

This question first requires interpretation of the word "chemicals" and the term "chemical hazards". The NRC does not define "chemicals", but 10 CFR 70 does provide a definition of:

"*Hazardous chemicals produced from licensed materials* means substances having licensed material as precursor compound(s) or substances that physically or chemically interact with licensed materials; and that are toxic, explosive, flammable, corrosive, or reactive to the extent that they can endanger life or health if not adequately controlled. These include substances commingled with licensed material, and include substances such as hydrogen fluoride that is produced by the reaction of uranium hexafluoride and water, but do not include substances prior to process addition to licensed material or after process separation from licensed material."

The GSTR does not have any hazardous chemicals produced from licensed materials.

According to OSHA 29 CFR 1910.1200(c), "chemical" means any substance, or mixture of substances. This definition is not helpful in answering the RAI question and it begs the question of why OSHA doesn't just use the word "substance" instead of "chemical".

In an attempt to meet the assumed intent of the RAI Question 2, we offer the following information:

1. The GSTR does not perform any chemistry control (other than filtration and ion exchange purification) in either the primary or secondary water system. No strong acids or bases are used in the reactor operation or in the experiments performed at the reactor. No highly hazardous chemicals, toxics, or reactives (as defined in OSHA's standard 29 CFR 1910.119 Appendix A) are present at the facility.

2. The only chemicals used on reactor equipment are low quantities of lubricants and cleaners that are typical of those used in a normal home or home workshop.

3. The only maintenance fluids that could leak in the reactor bay are minimal amounts (max ~ 1 liter) of low toxicity materials such as lubricating oils for the primary pump and continuous air monitor pump. Although these lubricating oils are flammable, their

flammability is relatively low and the limited quantities of these materials does limit the fire potential from them. In addition, there is no leakage path for these materials that could result in them getting into the reactor tank. There is no explosion or detonation potential.

4. Chemicals used as neutron target materials are low quantity (typically < 50 ml or <50 g) and of low toxicity, reactivity, and corrosivity. These target materials are evaluated as part of the Experiment Authorization process. These materials become radioactive and are transferred as licensed byproduct material to facility users for their projects.

5. Radioactive wastes are not chemically treated prior to disposal. It is USGS policy that no liquid waste discharges are made from the facility, so any liquid waste is dewatered prior to disposal.

6. The only routine disposal of chemicals is the disposal of used oil from the mechanical equipment that uses oil for lubrication. This used oil is recycled at a local recycling center. If disposal of other hazard chemicals is found necessary, the USGS hazardous chemical procedures would be followed to ensure they are properly handled. The facility has a Collateral Duty Environmental Protection Coordinator who would be consulted in these matters.

Technical Review Question 3:

The USGS SAR, Section 9.2.1, "Fuel Storage Racks," provided information concerning the storage of the USGS TRIGA fuel, including a statement that the keff was measured to be below the limit of 0.9. However, it is not clear if this applies to racks located in both the in-tank and the fuel pit locations. NUREG-1537, Part 1, Section 9.2, "Handling and Storage of Reactor Fuel," provides guidance that the licensee should provide an analysis that shows that the keff for fuel storage, under all conditions, is less than 0.9. Provide an analysis or discussion that demonstrates that the fuel storage keff is less than 0.9 under all conditions, or justify why no explanation is needed.

Response:

The limiting configuration for fuel storage Keff is water-moderated hexagonal fuel racks that hold up to 19 fuel elements. At optimum spacing and water moderation, a TRIGA reactor needs approximately 54 fuel elements to achieve criticality. A criticality analysis performed by General Atomics (see attachment 1) that shows that the Keff in this 19-element rack is well below 0.8 in a worst case, water-moderated condition.

Technical Review Question 4:

By letter dated September 8, 2015 (ADAMS Accession No. ML15261A042), USGS staff provided proposed TSs.

a. Proposed TS Table 3.2, "Minimum Reactor Safety Channels," provided safety channels for (1) High Voltage; and (2) Watchdog SCRAMS. However, it does not appear to list the setpoints. NUREG-1537, Part 1, Section 14, Appendix 14.1, Chapter 3.2, "Reactor Control and Safety Systems," item (4), "Scram Channels," provides guidance that scrams and their associated setpoints should be provided. Provide setpoints for the scrams associated with the High Voltage and Watchdog SCRAMS, or justify why no changes are needed.

b. The proposed TSs do not appear to contain a limit or specification on reactivity insertion rate. NUREG-1537, Part 1, Section 14, Appendix 14.1, Chapter 3.2, "Reactor Control and Safety Systems," item (2), "Reactivity Insertion Rate," provides guidance that a reactivity insertion rate should be included in the TSs. Provide a reactivity insertion rate, or justify why no change is needed.

c. The TSs provided by letter dated September 8, 2015, contained numerous annotations or markups which were useful to the staff to understand the proposed changes. However, in order to help ensure that the NRC staff understands the final format and content, provide a final, clean version of the USGS proposed TSs, or justify why additional information is needed.

Response:

(a.) The setpoint for the High Voltage scrams is "loss of high voltage". This is consistent with the High Voltage scram setpoints for other NRC-licensed TRIGA reactors, including the recently approved licenses for the DOW Chemical Company and the Texas A & M University. We propose that the setpoint for the Watchdog scram be a loss of computer communication that is > 8 seconds.

(b.) We propose a reactivity insertion rate limit, from normal control rod motion (not pulsing operation) of $0.29 cents per second. This is consistent with the historical limit and it is consistent with the safety analysis performed for the relicensing.

(c.) We have included a final, clean version of the proposed TSs, including revisions proposed in this RAI response, as attachment 2.

Financial Review Question 1:

Pursuant to 10 CFR 50.33, "Contents of applications; general information," certain information is required by the applicant, USGS. The application indicates that USGS is a Federal bureau within the U.S. Department of the Interior. To comply with 10 CFR 50.33(d), the staff requests that the applicant state whether USGS is owned, controlled, or dominated by an alien, foreign corporation, or foreign government, and if so, give details.

Response:

The USGS is a federal bureau within the U.S. Department of Interior and it is not owned, controlled, or dominated by an alien, foreign corporation, or foreign government. The Geological Survey was established by U.S. Congress through the Organic Act of March 3, 1879 (20 Stat. 394; 43 U.S.C. 31).

Financial Review Question 2:

The NRC staff will analyze USGS' annual financial statements for the current year, which are required by 10 CFR 50.71(b), to determine if USGS is financially qualified to operate the GSTR. Since USGS' financial statements are not included in the application, please provide a copy of the latest annual financial statements for the staff's review.

Response:

The latest annual financial statement of the USGS is provided as attachment 3. (Financial statements for a number of USGS budgets, by fiscal year, may be found at the web site: http://www.usgs.gov/budget/fiscal_year.asp)

Financial Review Question 3:

Pursuant to 10 CFR 50.33(f)(2), "[t]he applicant shall submit estimates for total annual operating costs for each of the first five years of operation of the facility." For the NRC staff to complete its review, the following additional information must be submitted:

a. The estimated operating costs for the GSTR for each of the fiscal years (FYs) 2016 through FY2020 (the first five years after projected license renewal).

b. USGS' source(s) of funds to cover the operating costs for the above FYs.

Response:

(a.) The estimated annual operating costs for the GSTR fiscal years 2016 through 2020 are:

FY2016	$454,300
FY2017	$461,100
FY2018	$468,000
FY2019	$475,000
FY2020	$482,100

(b.) The sources of funds to cover the operating costs of the GSTR are funds allocated through the federal government budget process for USGS programs, user fees from USGS reactor users, and user fees from non-USGS reactor users.

Financial Review Question 4:

NUREG-1537, Part 1, Section 15.3, "Financial Ability to Decommission the Facility," states that the cost to decommission the GSTR was $3.7 million in 2006 dollars. In order for the NRC staff to complete its review of the decommissioning cost estimate, please provide the following additional information:

a. A current cost estimate in 2016 dollars to meet the NRC's radiological release criteria for decommissioning the facility for unrestricted use, the basis for the decommissioning cost estimate, and show costs specifically broken down into the categories of labor, waste disposal, other items (such as energy, equipment, supplies), and a contingency factor of at least 25 percent.

b. A description of the means of adjusting the cost estimate and associated funding level periodically over the life of the facility to comply with 10 CFR 50.75(d)(2)(iii). Also, provide a detailed numerical example showing how the 2016 cost estimate will be updated periodically in the future.

Response:

(a.) The current cost estimate for decommissioning the facility for unrestricted use is $4.9 million in 2015 dollars. Inflation data are not available for 2016, so a cost estimate in 2016 dollars is not possible at this time.

(b.) The means for adjusting the decommissioning cost estimate, along with the example for determining the 2015 dollar cost estimate, is provided as attachment 4.

Financial Review Question 5:

The USGS SAR, Section 15.3, "Financial Ability to Decommission the Facility," states that "...the funds needed for decommissioning will be requested through appropriate federal funding channels and will be obtained sufficiently in advance of decommissioning to prevent delay of required activities." Where the applicant intends to use a statement of intent (SOI) as the method to provide decommissioning funding assurance, as provided for by 10 CFR 50.75(e)(1)(iv), the staff must find that the applicant "...is a Federal, State, or local government licensee..."

To make this finding, the applicant must state that it is a Federal government organization and that the decommissioning funding obligations of the applicant are backed by the Federal government, and also provide corroborating documentation. Further, the applicant must provide documentation verifying that the signator of the statement of intent is authorized to execute said document that binds the applicant. This document may be a governing body resolution, management directives, or other form that provides an equivalent level of assurance. As the application does not include all of the above information, please submit the following:

a. The current (2016 dollars) cost estimate for decommissioning (for which decommissioning funding assurance is being provided) and the signator's oath or affirmation attesting to the information.

b. Documentation that corroborates the statement in the application that USGS is a Federal institution and a Federal government licensee under 10 CFR 50.75(e)(2)(iv).

c. A statement as to whether the decommissioning funding obligations for the GSTR are backed by the Federal government. The application must also present information that corroborates this statement. For example, the documentation may be a copy of or complete citation to a Federal statute that expressly provides that the obligations, or at least the decommissioning funding obligations, of the applicant are obligations backed or supported by the full faith and credit of the Federal government, or an opinion of the applicant's General Counsel with citations to statutes, regulations, and/or case law that the obligations, or at least with respect to the decommissioning funding obligations, of the applicant are obligations backed or supported by the full faith and credit of the Federal government.

d. Documentation verifying that the signator of the SOI is authorized to execute such a document that binds the applicant financially. For example, provide a copy of an official USGS delegation of authority showing that the signator of the SOI is authorized to bind USGS financially, at least with respect to funding the decommissioning of the GSTR.

Response:

(a.) The cost estimate for decommissioning, in 2015 dollars, is $4.9 million. The estimate could not be provided in 2016 dollars because inflation data for 2016 are not available.

(b.) Documentation that the USGS is a Federal institution and a Federal government licensee. The Geological Survey is a U.S. federal agency that was established by U.S. Congress through the Organic Act of March 3, 1879 (20 Stat. 394; 43 U.S.C. 31), which provided for "the classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain." The Act of September 5, 1962 (76 Stat. 427; 43 U.S.C. 31(b)), expanded this authorization to include such examinations outside the national domain. Topographic mapping and chemical and physical research were recognized as an essential part of the investigations and studies authorized by the Organic Act, and specific provision was made for them by Congress in the Act of October 2, 1888 (25 Stat. 505, 526).

License R-113 states the following, which corroborates that the USGS is a Federal government licensee:

"The Atomic Energy Commission ("the Commission") having found with respect to the application for license of the U. S. Geological Survey, Department of the Interior (hereinafter "the USGS" or "the licensee"), that:
1. The application for license complies with the requirements of the Atomic Energy Act of 1954, as amended (hereinafter "the Act"), and the Commission's regulations set forth in Title 10, Chapter 1, CFR;
2. The reactor has been constructed in conformity with Construction Permit No. CPRR-102 and will operate in conformity with the application and in conformity with the Act and the rules and regulations of the Commission;
3. There is reasonable assurance that the reactor can be operated at the designated location without endangering the health and safety of the public;
4. The USGS is technically and financially qualified to engage in the proposed activities in accordance with the Commission's regulations;
The issuance of this license will not be inimical to the common defense and security or to the health and safety of the public; and
The USGS is a federal agency and need not furnish proof of financial protection as would otherwise be required by Subsection 170a of the Act."

(c.) Decommissioning funding obligations for the GSTR (license R-113) are backed by the Federal government. A statement documenting this fact, from the Director of the USGS, is included in Attachment 5.

(d.) Attachment 5, a statement from the Director of the USGS, describes the financial authority of the Director.

Attachment 1: Criticality analysis of hexagonal fuel storage racks performed by General Atomics

October 6, 1987

SAFETY ANALYSIS FOR TRIGA FUEL RACKS FOR USGS STORAGE WELLS

Description

The fuel storage racks are made of aluminum. There is a top and bottom grid plate with holes drilled to contain and space up to 19 fuel rods on a hexagonal pitch of 1.75 inches. The fuel rods have a nominal diameter of 1.475 inches. This yields a water volume fraction of 0.356 in a flooded storage well, just slightly greater than the 0.33 water volume fraction in a TRIGA core. The racks fit inside a 10-inch I.D. steel pipe with a 0.365-inch wall. The storage wells are 12-feet deep and the racks are 27-3/8 inches tall.

Analysis

The critical approach loading curves for the USGS reactor can be used to demonstrate that the effective neutron multiplication factor (K effective) is less than 0.8 when the storage racks are full of TRIGA fuel containing 8.5 wt-% U (20% enriched), the storage wells are full of water and there is either a single storage rack or two storage racks stacked vertically in the storage well.

Figures 1 and 2 show two of the three inverse multiplication curves for the loading of the USGS core. The one not shown gives a sizably lower multiplication until the last few loading steps.

Using Figures 1 and 2 and the relationship

$$\frac{1}{M} = 1 - K$$

or

$$K = 1 - \frac{1}{M}$$

where K = effective multiplication factor
M = neutron source multiplication

it is shown that approximately 42 to 47 fuel elements are necessary to give a K = 0.8. Checking the loading curves for a more recent, similar reactor produced similar results. Thus a flooded storage well with a fully loaded single storage rack, containing 19 fuel elements, clearly has a K less than 0.8. A flooded storage well with two fully loaded storage racks stacked vertically also clearly has a K less than 0.8, especially when the following items are considered:

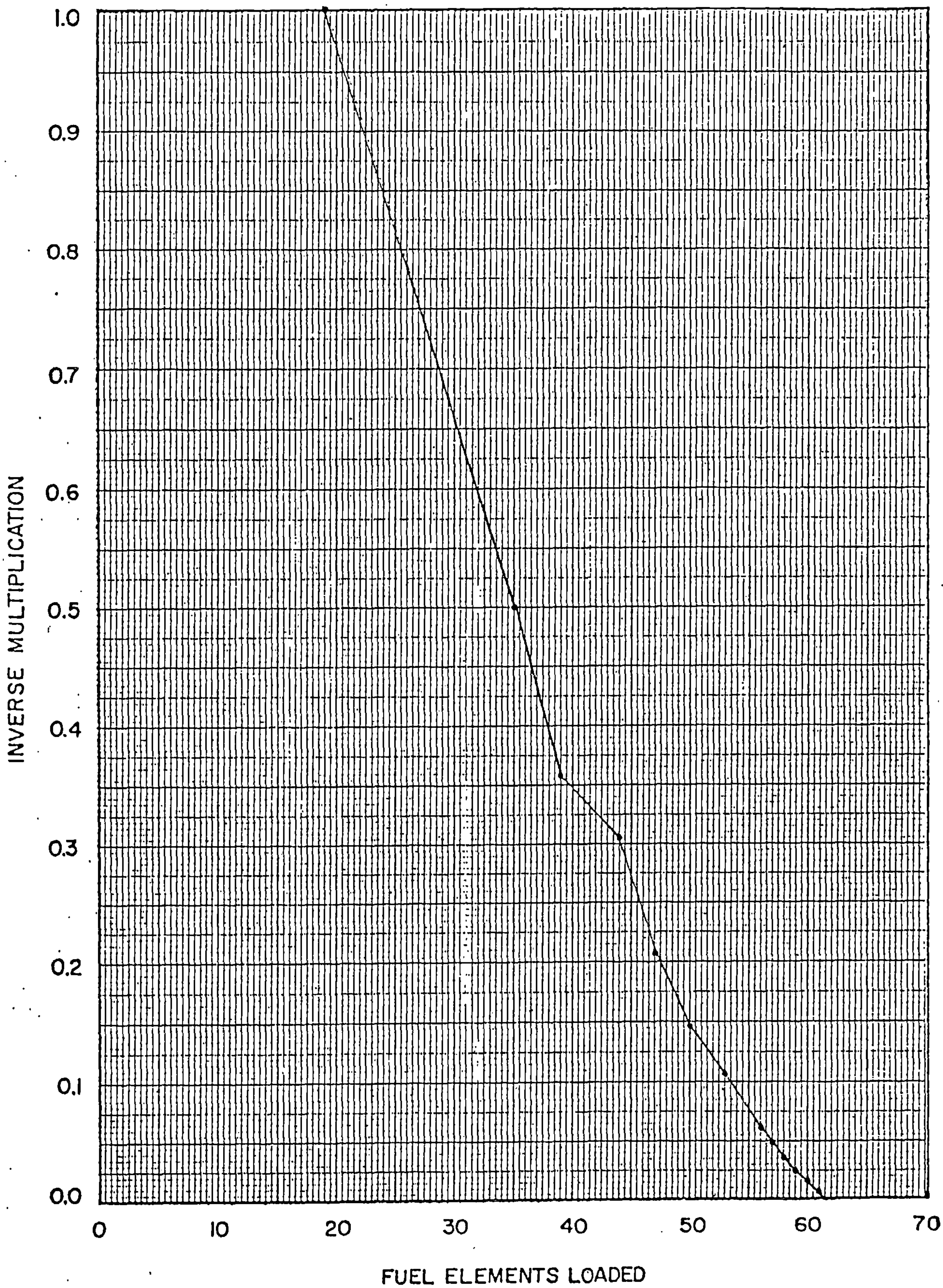
1. 38 fuel elements, contained 19 each in two storage racks stacked vertically are in a much less reactive configuration than 38 fuel elements contained in a single array between the same grid plates. For the stacked configuration there is approximately a one foot separation between the two fuel regions. Contained in this separation distance are graphite end reflectors, stainless steel clad and end fittings and water. This separation produces a strong decoupling between the two fuel regions.

2. Either configuration is closely surrounded by the thick-walled steel pipe of the storage well, which is surrounded by either earth or concrete. These materials are not nearly as effective as a radial reflector as is water, which was the main radial reflector for the configuration pertinent to the loading curves.

3. The small difference in volume fractions between the core and the storage racks produces a very small difference in K. The TRIGA fuel with 8.5 wt-% U (20% enriched) is slightly undermoderated in the core configuration but the curve of K vs water volume fraction for a given number of fuel elements is relatively flat in the range of 30 to 40% water.

4. The reactor core doesn't have a fuel element in the central position whereas the storage rack does. This would produce a reactivity difference of only about 0.25% - the difference between the worth of a fuel element in the A-ring and the C-ring.

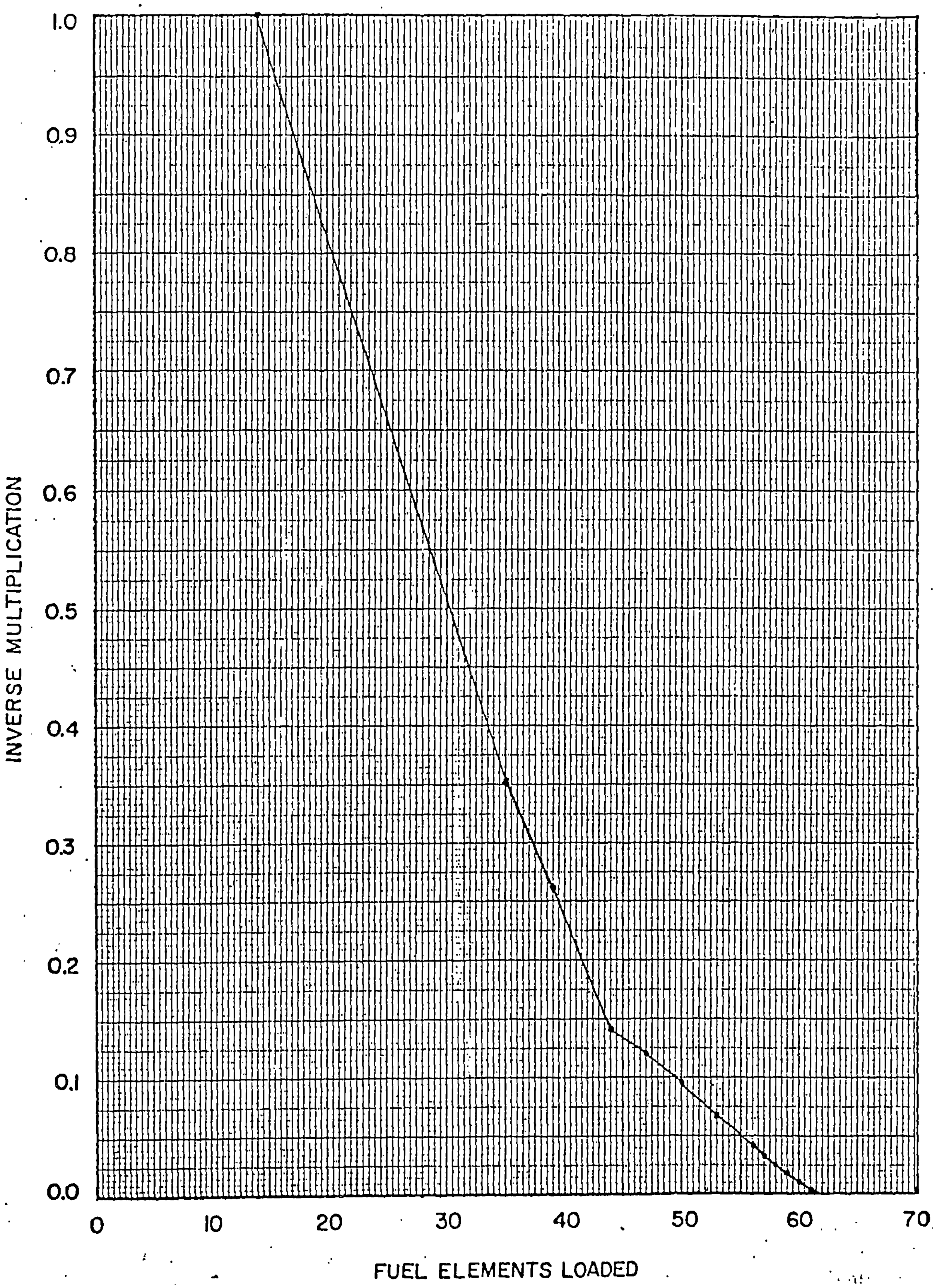
SCALER DATA



Criticality approach curve

USGS TRIGA

KEITHLEY DATA



Criticality approach curve
USGS TRIGA

Attachment 2: Clean copy of proposed Technical Specifications

APPENDIX A

To

FACILITY LICENSE NO. R-113

DOCKET NO. 50-294

TECHNICAL SPECIFICATIONS AND BASES

FOR

THE UNITED STATES GEOLOGICAL SURVEY TRIGA RESEARCH REACTOR

MARCH 2016

TECHNICAL SPECIFICATIONS AND BASES FOR THE USGS TRIGA RESEARCH REACTOR

1. Introduction

1.1 Scope

This document constitutes the Technical Specifications for the Facility License No. 113 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. Each basis is 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, except where they reference the USGS SAR or a specific Technical Specification. These specifications are formatted in a manner consistent with ANSI/ANS 15.1-2007.

1.2 Definitions

Audit: A quantitative examination of records, procedures or other documents.

Channel: A channel is the combination of sensing, signal processing, and outputting 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 include a Channel Test.

Channel Check: A channel check is 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 variable.

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

Confinement: Confinement means an enclosure of the reactor bay which is designed to limit the release of effluents from the enclosure to the external environment through controlled or defined pathways.

Control Rod: A control rod is a device fabricated from neutron absorbing material and/or fuel which is used to establish neutron flux changes and to compensate for routine reactivity losses. A control rod may be coupled to its drive unit allowing it to perform a safety function when the coupling is disengaged. Types of control rods shall include:

> 1. Regulating Rod (Reg Rod): The regulating rod is a control rod having an electric motor drive and scram capabilities. It may have a fueled-follower section. Its position may be varied manually or by the servo-controller.

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

3. Transient Rod: The transient rod is a control rod having an electric motor and pneumatic cylinder drive with scram capabilities that can be rapidly ejected from the reactor core to produce a pulse. It may have an air-filled follower.

Excess Reactivity: Excess reactivity is that amount of reactivity that would exist if all control rods were moved to the maximum reactive condition from the point where the reactor is exactly critical (k_{eff}=1) at reference core conditions.

Experiment: Any operation, hardware, or target (excluding devices such as detectors) which is designed to investigate non-routine reactor characteristics or which is intended for irradiation within an irradiation facility. Hardware rigidly secured to a core or shield structure so as to be a part of their design to carry out experiments is not normally considered an experiment. Specific experiments shall include:

1. Secured Experiment: A secured experiment is any experiment or component of an experiment that is held in a stationary position relative to the reactor core 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.

2. Movable Experiment: A movable experiment is one that is not secured and intended to be moved while near or inside the core during reactor operation.

Instrumented Fuel Element: An instrumented fuel element is a special fuel element in which one or more thermocouples have been embedded for the purpose of measuring the fuel temperatures during reactor operation.

Irradiation Facilities: Irradiation facilities shall mean vertical tubes, rotating specimen rack, pneumatic transfer system irradiation tubes, sample-holding dummy fuel elements and any other in-tank device intended to hold an experiment.

Licensed Area: Rooms 149-152, 154, 157, 158, B10, B10B and B11 of Building 15, the area inside the wrought iron fence and south cooling tower wall that is near the SW corner of Building 15; and Room 2 of Building 10.

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

Operable: A system or component shall be considered operable when it is capable of performing its intended function.

Operating: Operating means a component or system is performing its intended function.

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

Reactivity Worth of an Experiment: The reactivity worth of an experiment is the value of the reactivity change that results from the experiment being inserted into or removed from its intended position.

Reactor Operating: The reactor is operating whenever it is not secured or shut down.

Reactor Operator: An individual who is licensed to manipulate the controls of a reactor.

Reactor Safety Systems: Reactor safety systems are those systems, including their associated input channels, which are designed to initiate, automatically or manually, a reactor scram for the primary purpose of protecting the reactor.

Reactor Secured: The reactor is 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* all the following conditions exist:

    a. All neutron-absorbing control devices are fully inserted or other safety devices are in their shutdown position, as required by technical specifications;

    b. The console key switch is in the off position, and the key is removed from the key switch;

    c. No work is in progress involving; core fuel, in-tank core structure, installed control rods, or control rod drives unless they are physically decoupled from the control rods; and

    d. No experiments are being moved or serviced that have, on movement, a reactivity worth exceeding one dollar.

Reactor Shutdown: The reactor is shut down if it is subcritical by at least one dollar in the reference core condition with the reactivity worth of all installed experiments included.

Reference core condition: The condition of the core when it is at ambient temperature (cold, 18-25 °C) and the reactivity worth of xenon is negligible.

Review: A qualitative examination of records, procedures or other documents.

Safety Channel: A safety channel is a measuring channel in the reactor safety system.

Scram time: Scram time is the elapsed time between the initiation of a scram and the instant that the control rod reaches its fully-inserted position.

Senior Reactor Operator: An individual who is licensed to direct the activities of reactor operators. Such an individual is also a reactor operator.

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

Shutdown Margin: Shutdown margin shall mean the minimum shutdown reactivity necessary to provide confidence that the reactor can be made subcritical by means of the control and safety systems and will remain subcritical without further operator action, starting from any permissible operating condition with the most reactive rod is in its most reactive position.

Shutdown Reactivity: Shutdown reactivity is the measured reactivity with all control rods inserted. The value of shutdown reactivity includes the reactivity value of all installed experiments and is determined with the reactor at ambient conditions.

Square-Wave Mode (S.W. Mode): The square-wave mode shall mean any operation of the reactor with the mode selector in the square-wave position.

Steady-State Mode (S.S. Mode): Steady-state mode shall mean operation of the reactor with the mode selector in the manual or auto position.

Surveillance Intervals: Allowable surveillance intervals shall not exceed the following:

1. Quinquennial - interval not to exceed 70 months.
2. Biennial - interval not to exceed 30 months.
3. Annual - interval not to exceed 15 months.
4. Semi-annual - interval not to exceed 7.5 months.
5. Quarterly - interval not to exceed 4 months.
6. Monthly - interval not to exceed 6 weeks.
7. Weekly - interval not to exceed 10 days.

Unscheduled Shutdown: An unscheduled shutdown is defined as any unplanned shutdown of the reactor caused by actuation of the reactor safety system, operator error, equipment malfunction, or a manual shutdown in response to conditions that could adversely affect safe operation, not including shutdowns that occur during testing or checkout operations.

2. Safety Limits and Limiting Safety System Setting

2.1 Safety Limit-Fuel Element Temperature

Applicability. This specification applies to the reactor fuel.

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

Specifications.

1. The temperature in an aluminum-clad TRIGA fuel element shall not exceed 500 °C under any mode of operation.
2. The temperature in a stainless-steel clad TRIGA fuel element shall not exceed 1,150 °C.

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

The safety limit for the aluminum-clad TRIGA fuel element is based on data which indicate that the zirconium hydride will undergo a phase change at 535 °C. This phase change can cause severe distortion in the fuel element and possible cladding failure. Maintaining the fuel temperature below this level will prevent this potential mechanism for cladding failure (SAR 4.5).

The safety limit for the stainless-steel clad TRIGA fuel is based on data including the large mass of experimental evidence obtained during high performance reactor tests on this fuel. These data indicate that the stress in the cladding due to hydrogen pressure from the dissociation of zirconium hydride will remain below the ultimate stress provided that the temperature of the fuel does not exceed 1,150 °C (SAR 4.5.4.1).

2.2 Limiting Safety System Setting (LSSS)

Applicability. This specification applies to thermal reactor power.

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

Specifications. The limiting safety system setting shall be a steady state thermal power of 1.1 MW.

Basis. The limiting safety system setting is a total core thermal power, which, if exceeded shall cause the reactor safety system to initiate a reactor scram. This setting applies to all modes of operation. In steady-state operation up to 1.1 MW, ample margins exist between this setting and the safety limits of peak fuel temperature as specified in SAR 14.2.1, as long as the aluminum-clad fuel is restricted to the F and G rings of the core assembly (SAR 4.5.4.1).

Thermal and hydraulic calculations indicate that stainless-steel clad TRIGA fuel may be safely operated up to power levels of at least 1.9 MW with natural convection cooling (SAR 4.5.4.5).

3. Limiting Conditions of Operation

3.1 Reactor Core Parameters

3.1.1 Steady-state Operation

3.1.1.1 Shutdown Margin

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

Objective. The objective is to assure that the reactor can be shutdown at all times and to assure that the fuel temperature safety limit shall not be exceeded.

Specifications. The reactor shall not be operated unless the following conditions exist: The shutdown margin provided by control rods shall be at least $0.30 with:

a. Irradiation facilities and experiments in place and all, non-secured experiment in their most reactive state;

b. The most reactive control rod fully-withdrawn; and

c. The reactor in the reference core condition where there is no ^{135}Xe poison present and the core is at ambient temperature. Calculations may be performed to determine a "no ^{135}Xe poison" reactivity condition.

Basis. The value of the shutdown margin assures that the reactor can be shut down from any operating condition even if the most reactive control rod should remain in the fully-withdrawn position. Since the reactor is seldom in a "no ^{135}Xe poison" condition, it is acceptable to perform calculations to determine the "no ^{135}Xe poison" reactivity condition.

3.1.1.2 Core Excess Reactivity

Applicability. This specification applies to the reactivity condition of the reactor and the reactivity worths of control rods and experiments. It applies for all modes of operation.

Objective. The objectives that must be simultaneously met are to assure that the reactor has sufficient reactivity to meet its mission requirements, be able to be shut down at any time, and not exceed its fuel temperature safety limit.

Specifications. The maximum available excess reactivity shall not exceed $7.00 at reference core conditions.

Basis. This amount of excess reactivity will provide the capability to operate the reactor at full power with experiments in place and ^{135}Xe built up in the core.

3.1.2 Pulse Mode Operation

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

Objective. The objective is to ensure that the fuel temperature shall not be exceed 830°C.

Specifications. The reactivity to be inserted for pulse operation shall be determined and limited by a mechanical stop on the transient rod, such that the reactivity insertion shall not exceed $3.00.

Basis. The fuel temperature rise during a pulse transient has been estimated conservatively to not exceed any fuel temperature limits with a $3.00 pulse insertion.

3.1.3 Core Configuration Limitations

Applicability. This specification applies to mixed cores of aluminum-clad and stainless-steel clad types of fuel.

Objective. The objective is to ensure that the fuel temperature safety limit shall not be exceeded due to power peaking effects in a mixed core.

Specifications. Aluminum-clad fuel shall only be loaded in the F and G rings of the core and there shall be at least 110 fuel elements in the core (not including fuel-followed control rods). There shall not be a fuel element in the central thimble.

Basis. The limitation of power peaking effects ensures that the fuel temperature safety limit shall not be exceeded in an operational core. Keeping aluminum-clad fuel in the F and G rings limits those fuel temperatures to safe values for aluminum-clad fuel (SAR 4.5.1.2). Keeping at least 110 fuel elements in the core helps reduce the power peaking in the core.

3.1.4 Fuel Parameters

Applicability. This specification applies to all fuel elements.

Objective. The objective is to maintain integrity of the fuel element cladding.

Specifications. The reactor shall not operate with damaged fuel elements, except for the purpose of locating damaged fuel elements. A fuel element shall be considered damaged and must be removed from the core if:

a. The transverse bend exceeds 0.0625 inches over the length of the cladding;

b. Its length exceeds its original length by 0.10 inch for stainless-steel clad fuel or 0.50 inch for aluminum-clad fuel;

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

d. Visual inspection identifies significant bulges, pitting, or corrosion; and

e. ^{235}U burnup is calculated to be greater than 50% of initial content.

Basis. Gross failure or obvious, significant visual deterioration of the fuel is sufficient to warrant declaration of the fuel as damaged. The elongation and bend limits are the values found acceptable to the USNRC (NUREG-1537).

3.2 Reactor Control and Safety System

3.2.1 Control Rods

Applicability. This specification applies to the function of the control rods.

Objective. The objective is to determine that the control rods are operable.

Specifications. The reactor shall not be operated unless all control rods are operable.

Control rods shall not be considered operable if:

a. Physical damage is apparent to the rod or rod drive assembly and it does not respond normally to control rod motion signals; or

b. The scram time exceeds 1 second for the shim and regulating rods or 2 seconds for the transient rod; or

b. The maximum reactivity insertion rate of a standard control rod exceeds $0.29 per second.

Basis. This specification ensures that the reactor shall be promptly shut down when a scram signal is initiated. Experience and analysis have indicated that for the range of transients anticipated for a TRIGA reactor, the specified scram time is adequate to ensure the safety of the reactor (SAR 13.2.2.2.1).

3.2.2 Reactor Measuring Channels

Applicability. This specification applies to the information which shall be available to the Reactor Operator during reactor operation.

Objective. The objective is to specify the minimum number of power measuring channels that shall be available to the operator to ensure safe operation of the reactor.

Specifications. The reactor shall not be operated in the specified mode unless the minimum number of power measuring channels listed in Table 3.1 is operable.

Table 3.1 Minimum Measuring Channels

Measuring Channel	Effective Mode		
	S.S.	Pulse	S.W.
Power level (NP1000 and NPP1000)	2	-	2
Pulse power level (NPP1000)	-	1	-
Power level (NM1000)	1	-	1
Water temperature	1	1	1

Basis. The power level monitors ensure that the reactor power level is adequately monitored for steady-state, square wave and pulse modes of operation (SAR 7.2.3.1). The specifications on reactor power level indication are included in this section since the power level is directly related to the fuel temperature. The water temperature monitor ensures that water temperature will be kept within the specified limit.

3.2.3 Reactor Safety System

Applicability. This specification applies to the reactor safety system channels.

Objective. The objective is to specify the minimum number of reactor safety system channels that shall be available to the operator to ensure safe operation of the reactor.

Specifications. The reactor shall not be operated unless the minimum number of safety channels described in Table 3.2 and interlocks described in Table 3.3 are operable.

Table 3.2 Minimum Reactor Safety Channels

Safety Channel	Function	Effective Mode		
		S.S.	Pulse	S.W.
Power level	SCRAM @ 1.1. MW(t) or less	2	-	2
Preset timer	SCRAM ($\leq$15 sec)	-	1	-
Console SCRAM button	SCRAM	1	1	1
High voltage	SCRAM on loss of nominal operating voltage to required power channels	2	1	2
Watchdog SCRAMs	Scram within 8 seconds upon lack of response in DAC or CSC computer (one scram circuit per computer)	2	2	2

Table 3.3 Minimum Interlocks

Interlock	Function	Effective Mode		
		S.S.	Pulse	S.W.
NM1000 Power level	Prevents control rod withdrawal at <10^{-7}% power	1	-	-
Transient Rod Cylinder	Prevents application of air unless fully inserted	1	-	-
1kW Pulse interlock	Prevents entering pulse mode above 1 kW	1	-	-
Shim and Regulating rod drive circuits	Prevents simultaneous manual withdrawal of two rods	1	-	1
Shim and Regulating rod drive circuits	Prevents withdrawal of any rod except Transient Rod	-	1	-

Basis. The power level scrams provide protection to ensure that the reactor can be shut down before the safety limit on the fuel element temperature will be exceeded. The manual scram allows the operator to shut down the system if an unsafe or abnormal condition occurs. The high voltage scram ensures that the required power measuring channels have sufficient high voltage as required for proper functioning of their power level scrams. The interlock to prevent startup of the reactor at count rates less than 10^{-7}% power ensures that the startup is not initiated unless a reliable indication of the neutron flux level in the reactor core is available. The interlock to prevent entering pulse mode above 1 kW is to ensure that the magnitude of the pulse will not cause the fuel element temperature safety limits to be exceeded. The interlock to prevent application of air to the transient rod unless the cylinder is fully inserted is to prevent pulsing the reactor in the steady-state mode. The interlock to prevent withdrawal of the shim, safety or regulating rod in the pulse mode is to prevent the reactor from being pulsed while on a positive period. The interlock to prevent simultaneous withdrawal of two control rods is to limit reactivity insertion rate from the standard control rods.

3.3 Reactor Primary Tank Water

Applicability. This specification applies to the primary water of the reactor tank.

Objective. The objective is to ensure that there is an adequate amount of high quality water in the reactor tank for fuel cooling and shielding purposes, and that the bulk temperature of the reactor tank water remains sufficiently low to guarantee ion exchanger resin integrity.

Specifications. The reactor primary water shall exhibit the following parameters:

a. The bulk tank water temperature shall not exceed 60 °C;

b. The conductivity of the tank water shall be less than 5 µmhos/cm when averaged over a one month period; and

c. The reactor shall not be operated if the tank water level is more than 24 inches below the top lip of the reactor tank.

NOTE: These specifications are not required to be met if the reactor fuel has been removed from the tank.

Basis. The bulk water temperature limit is necessary to ensure that the ion exchange resin does not undergo severe thermal degradation. Experience at many research reactor facilities has shown that maintaining the conductivity within the specified limit provides acceptable control of corrosion (NUREG-1537). The minimum water level of no more than 24 inches below the top lip of the reactor tank ensures sufficient cooling water both for normal operation and during the design reactor tank leak of 350 gpm for any aluminum clad fuel to cool to safe levels after a reactor shutdown. This water level (no more than 24 inches below the top lip of the tank) gives approximately 18 feet-4 inches of water above the top grid plate of the core.

3.4 This section intentionally left blank.

3.5 Ventilation and Confinement System

Applicability. This specification applies to the operation of the facility ventilation and confinement system.

Objective. The objective is to ensure that the ventilation and confinement system shall be in operation to mitigate the consequences of possible releases of radioactive materials resulting from reactor operation.

Specifications.

1. The reactor shall not be operated unless a facility ventilation system is operating and the reactor bay pressure is maintained negative with respect to surrounding areas by at least 0.1" water pressure except for short periods of time (not to exceed 2 hours) for system troubleshooting, maintenance and movement of personnel or equipment through open doors, provided the CAM is operating. The normal mode ventilation system is considered operable if:

    a. The normal exhaust fan is operating; and

    b. The reactor bay is sufficiently confined to allow a minimum differential pressure of 0.1" water column to be maintained by the normal exhaust fan.

2. The reactor bay ventilation system shall operate in the emergency mode, with all exhaust air passing through a HEPA filter, whenever a high level continuous air monitor (CAM) alarm is present due to airborne particulate radionuclides emitted from the reactor or samples in the reactor bay. The emergency mode ventilation system is considered operable if:

    a. The emergency exhaust fan is operating; and

    b. The reactor bay is sufficiently confined to allow a minimum differential pressure of 0.1"water column to be maintained by the emergency exhaust fan

Basis. The worst-case maximum total effective dose equivalent is well below the 10 CFR 20 limit for individual members of the public. This has been shown to be true for scenarios where the ventilation system continues to operate during the MHA and where the ventilation system does not operate during the MHA (SAR 13.2.1). Therefore, operation of the reactor for short periods while the reactor bay underpressure is not maintained because of testing or reactor bay open doors, does not compromise the control over the release of radioactive material to the unrestricted area nor should it cause occupational doses that exceed those limits given in 10 CFR 20.

3.6 This section intentionally left blank.

3.7 Radiation Monitoring Systems and Effluents

3.7.1 Radiation Monitoring Systems

Applicability. This specification applies to the radiation monitoring systems.

Objective. The objective is to specify the minimum radiation monitoring channels that shall be available to the operator to assure safe operation of the reactor.

Specifications. The reactor shall not be operated unless the minimum number of radiation monitoring channels listed in Table 3.4 are operating. Each channel shall have a readout in the control room and be capable of sounding an audible alarm.

Table 3.4: Minimum Radiation Monitoring Channels*	
Radiation Monitoring Channel	**Number**
Continuous Air Monitor	1
Radiation Area Monitor	1
Environmental Dosimeter	3

*Monitors may be out-of-service for up to 2 hours for calibration, maintenance, troubleshooting, or repair. During this out-of-service time, no experiments or maintenance activities shall be conducted which could directly result in alarm conditions (e.g., airborne releases or high radiation levels), and the ventilation system shall be operating. A portable, gamma-sensitive ion chamber, visible from the control room, may be utilized as a temporary substitute for the required Area Radiation Monitor for a period up to 60 days.

Basis. The radiation monitors provide information to operating personnel regarding routine releases of radioactivity and any impending or existing danger from radiation. The alarm setpoints are chosen to be at levels higher than those normally encountered during routine reactor operations. Their operation will provide sufficient time to evacuate the facility or take the necessary steps to prevent the spread of radioactivity to the surroundings (SAR 11.1.6).

3.7.2 Effluents

Applicability. This specification applies to the release rate of ^{41}Ar.

Objective. The objective is to ensure that the concentration of the ^{41}Ar in the unrestricted areas shall be below the applicable effluent concentration value in 10 CFR 20.

Specifications. The annual average concentration of ^{41}Ar discharged into the unrestricted area shall not exceed 4.8×10^{-6} µCi/ml at the point of discharge.

Basis. If ^{41}Ar is continuously discharged at 4.8 x 10^{-6} μCi/ml, measurements and calculations show that ^{41}Ar released to the publicly accessible areas under the worst-case weather conditions would result in an annual TEDE of 0.5 mrem. This is only 5% of the applicable limit of 10 mrem. The calculation was performed with the Environmental Protection Agency's Comply code (SAR 11.1.1.1.4).

3.8 Limitations on Experiments

3.8.1 Reactivity Limits

Applicability. This specification applies to experiments installed in the reactor and its irradiation facilities.

Objective. The objective is to prevent damage to the reactor or excessive release of radioactive materials in the event of an experiment failure.

Specifications. The reactor shall not be operated unless the following conditions governing experiments exist:

a. The absolute reactivity worth of any single movable experiment shall be less than $1.00; and

b. The absolute reactivity worth of any single secured experiment shall be less than $3.00.

Basis. The worst event which could possibly arise is the sudden removal of a movable experiment immediately prior to, or following, a pulse transient of the maximum licensed reactivity insertion. Limiting the worth of a movable experiment to less than $1.00 will ensure that the additional increase of transient power and temperature is slow enough for the high power scram to be effective and, since this transient is not a super-prompt pulse, we would not violate the 1 kW Pulse Interlock which prevents entering pulse mode above 1 kW (SAR 14.3.2.3).

The worst event that is considered in conjunction with a single secured experiment is the sudden removal of the experiment while the reactor is operating in a critical condition at a low power level. This is equivalent to pulse-mode operation of the reactor. Hence, the reactivity limitation for a single secured experiment at $3.00 is the same as that of a maximum allowed pulse, although a scram would be initiated much more quickly for the experiment removal accident (SAR 13.2.2.2.1 and 14.3.1.2).

3.8.2 Materials

Applicability. This specification applies to experiments installed in the reactor and its irradiation facilities.

Objective. The objective is to prevent damage to the reactor or excessive release of radioactive materials in the event of an experiment failure.

Specifications. The reactor shall not be operated unless the following conditions governing experiments exist:

a. Explosive materials, such as gunpowder, TNT, or nitroglycerin, in quantities greater than 25 milligrams TNT-equivalent shall not be irradiated in the reactor or irradiation facilities. Explosive materials in quantities less than or equal to 25 milligrams TNT-equivalent may be irradiated provided the pressure produced upon detonation of the explosive has been calculated and/or experimentally demonstrated to be less than half the design pressure of the container;

b. Each fueled experiment shall be controlled such that the total inventory of ^{131}I-^{135}I in the experiment is no greater than 1.5 curies and the total inventory of ^{90}Sr in the experiment is no greater than 5 millicuries; and

c. Experiments containing corrosive materials shall be doubly encapsulated. The failure of an encapsulation of material that could damage the reactor shall result in removal of the sample and physical inspection of potentially damaged components.

Basis. This specification is intended to prevent damage to reactor components resulting from failure of an experiment involving explosive materials (SAR 13.2.6.2). The 1.5-curie limitation on ^{131}I-^{135}I, and the 5 millicurie limit on ^{90}Sr, ensure that in the event of a failure of a fueled-experiment involving total release of the iodine, the dose in the reactor bay and in the unrestricted area will be considerably less than that allowed by 10 CFR 20 (SAR 13.2.6).

3.8.3 Failures and Malfunctions

Applicability. This specification applies to experiments installed in the reactor and its irradiation facilities.

Objective. The objective is to prevent damage to the reactor or excessive release of radioactive materials in the event of an experiment failure.

Specifications. Where the possibility exists that the failure of an experiment (except fueled experiments) under normal operating conditions of the experiment or reactor, credible accident conditions in the reactor, or possible accident conditions in the experiment could release radioactive gases or aerosols to the reactor bay or the unrestricted area, the quantity and type of material in the experiment shall be limited such that the airborne radioactivity in the reactor bay or the unrestricted area will not result in exceeding the applicable dose limits in 10 CFR 20, assuming that:

a. 100% of the gases or aerosols escape from the experiment;

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

c. If the effluent from an irradiation facility exhausts through a filter installation designed for greater than 99% efficiency for 0.3 micron particles, at least 10% of these aerosols can escape; and

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

Basis. This specification is intended to meet the purpose of 10 CFR 20 by reducing the likelihood that released airborne radioactivity to the reactor bay or unrestricted area surrounding the GSTR will result in exceeding the total dose limits to an individual as specified in 10 CFR 20.

3.9 This section intentionally left blank.

4. Surveillance Requirements

All bases for the following surveillance requirements can be found in the operating procedures within the Reactor Operations Manual or in Safety Analysis Report. The approved operating procedures are periodically reviewed and reapproved by the Reactor Operations Committee (ROC).

4.0 General

Applicability. This specification applies to surveillance requirements of systems related to reactor safety.

Objective. The objective is to verify the operability of systems related to reactor safety.

Specifications.

1. Surveillance requirements may be deferred during extended reactor shutdown (except section 4.3 specifications 1 and 3, and section 4.7 specification 2); however, deferred requirements shall be completed prior to reactor startup unless reactor operation is required for performance of the surveillance. Such surveillance shall be performed as soon as practicable after reactor startup. Scheduled surveillance, which cannot be performed with the reactor operating, may be deferred until a planned reactor shutdown.

2. Any additions or modifications to the ventilation system, the core and its associated support structure, the pool or its penetrations, the primary coolant system, the rod drive mechanism or the reactor safety system shall be made and tested to assure that the systems will meet their functional requirements in accordance with manufacturer specifications or specifications reviewed by the ROC. A system shall not be considered operable until after it is successfully tested.

3. The reactor control and safety systems, pool water level alarm, and radiation monitoring systems shall be tested to be operable after the completion of non-routine maintenance of the respective items.

Basis. These specifications relate to changes in reactor systems which could affect the safety of the reactor. These changes will be formally addressed by following the requirements of 10 CFR 50.59. As long as changes or replacements to these systems meet or exceed the original design specifications, then it can be assumed that they meet the presently accepted operating criteria. Additional requirements may be needed, based on the evaluation through the 10 CFR 50.59 process. This specification is not intended to circumvent or replace the regulations in 10 CFR 50.59.

4.1 Reactor Core Parameters

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

Objective. The objective is to verify that the reactor does not exceed the authorized limits for power, shutdown margin, core excess reactivity, specifications for fuel element condition and verification of the total reactivity worth of each control rod.

Specifications.

1. A channel calibration shall be made of the power level monitoring channels by the calorimetric method at least annually.

2. The total reactivity worth of each control rod shall be measured following any significant change in core or control rod configuration.

3. The maximum reactivity insertion rate of a standard control rod shall be measured following any significant change in core or control rod configuration.

4. The core shutdown margin shall be determined at least annually and following any significant change in core or control rod configuration. Significance is determined to be any reactivity change expected to be greater than $0.30, not including reactivity changes from xenon fission product poisons or experiment movements.

5. The core excess reactivity shall be determined annually or following any significant change in core or control rod configuration. Significance is determined to be any reactivity change expected to be greater than $0.30, not including reactivity changes from xenon fission product poisons or experiment movements.

6. The mechanical stop on the transient rod shall be checked each day when pulsing is scheduled unless the total rod worth of the transient rod is less than $3.00.

7. Verification of core configuration to include aluminum-clad fuel only in the F and G rings of the core and to have a minimum of 110 elements in the core shall be determined by visual means prior to each day of operation.

8. All fuel elements shall be inspected for damage or deterioration and measured for length and transverse bend at least at quinquennial intervals or if 500 pulses have been performed since the last fuel inspection.

NOTE: These checks are not required if reactor fuel has been removed from the tank.

Basis. Experience has shown that the identified frequencies will ensure performance and operability for each of these systems or components. Movement of the core components 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 small, so that an annual measurement is sufficient to ensure compliance with the specifications. Experience at TRIGA reactors indicates that examination of a five-year cycle is adequate to detect problems. A five-year cycle reduces the handling of the fuel elements and thus reduces the risk of accident or damage due to handling.

4.2 Reactor Control and Safety Systems

Applicability. This specification applies to the surveillance requirements of reactor control and safety systems.

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

Specifications.

1. The control rods shall be visually inspected for damage or deterioration at least biennially.

2. The scram time shall be measured at least annually or after any repair or non-routine maintenance is performed on a control rod drive.

3. A channel check of each of the reactor safety system channels in Table 3.2 for the intended mode of operation shall be performed prior to each day's operation or prior to each operation extending more than one day. The same channel checks shall be performed after modifications or repairs to the scram channels to ensure operability of the respective channels.

4. A channel test of items in Table 3.2 relating to pulsing shall be performed during each startup for pulse mode operation. A channel test of each other item in Table 3.2 and 3.3 in section 3.2.3, other than the NM1000, shall be performed at least semi-annually.

NOTE: These checks are not required if the reactor fuel has been removed from the tank.

Basis. Inspection of the control rods allows early detection of signs of deterioration indicated by signs of changes of corrosion patterns or of swelling, bending, or elongation.
The channel checks performed daily before operation and after any modifications or repairs provide timely assurance that the systems will operate properly during operation of the reactor.
Experience has shown that the identified frequencies will ensure performance and operability for each of these systems or components.

4.3 Reactor Primary Tank Water

Applicability. This specification applies to the surveillance requirements for the reactor tank water.

Objective. The objective is to ensure that the reactor tank water level and the bulk water temperature monitoring systems are operating and to verify appropriate alarm settings.

Specifications.

1. A channel check of the reactor tank water level alarm setpoint shall be performed at least semi-annually.

2. A channel check of the reactor tank bulk water temperature alarm setpoint shall be performed quarterly. A channel calibration of the reactor tank bulk water temperature system shall be performed at least annually.

3. The reactor tank water conductivity shall be measured monthly. NOTE: These checks are not required if the reactor fuel has been removed from the tank.

Basis. Experience has shown that the frequencies of checks on systems which monitor reactor primary water can adequately keep the tank water at the proper level and maintain water quality at such a level to minimize corrosion and maintain safety. Experience at the GSTR shows that the surveillance specification on the conductivity is adequate to detect the onset of degradation of the quality of the pool water in a timely fashion. Experience also indicates that the surveillance specification on pool water level and pool water temperature are adequate to detect losses of pool water in a timely manner and to enable operators to take appropriate action when the coolant temperature approaches the specified limit. The quarterly and annual surveillances of the temperature monitor are also adequate to assure operability of the temperature channel. The pool water level alarm system is a reliable unit and therefore the specification of a semiannual test is sufficient to assure operability of the pool water level alarm.

4.4 This section intentionally left blank.

4.5 Ventilation and Confinement System

Applicability. This specification applies to the reactor bay ventilation and confinement system.

Objective. The objective is to ensure the proper operation of the ventilation and confinement system in controlling releases of radioactive material to the unrestricted area.

Specifications.

1. A channel check of the reactor bay ventilation shall be performed prior to each day's operation or prior to each operation extending more than one day.

2. A channel test of the reactor bay ventilation system's ability to automatically switch to the emergency mode upon actuation of the CAM high alarm shall be performed quarterly.

Basis. Experience has demonstrated that checks of the ventilation system on the prescribed frequencies are sufficient to ensure proper operation of the system and its control over releases of radioactive material.

4.6 This section intentionally left blank.

4.7 Radiation Monitoring System

Applicability. This specification applies to the surveillance requirements for the area radiation monitoring equipment and the air monitoring systems.

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

Specifications.

1. A channel check of the radiation area monitor and continuous air monitor shall be performed monthly.

2. A channel test of the continuous air monitor shall be performed quarterly.

3. A channel calibration of the radiation area monitor and continuous air monitor and ^{41}Ar monitor shall be performed annually.

4. The environmental dosimeters shall be changed and evaluated at least annually.

Basis. Experience has shown that an annual calibration is adequate to correct for any variation in the system due to a change of operating characteristics over a long time span. The frequency of changing and evaluating environmental dosimeters are also adequate to provide the required record based on past experience.

4.8 Experimental Limits

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

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

Specifications.

1. The reactivity worth of an experiment shall be estimated or measured, as appropriate, before routine reactor operation with that experiment to ensure that the limits of section 3.7.1 are not exceeded.

2. An experiment shall not be installed in the reactor or its irradiation facilities unless a safety analysis has been performed and reviewed for compliance with section 3.8.2 and 3.8.3 by the Reactor Supervisor or ROC in full accord with section 6.2.3, and the procedures which are established for this purpose.

Basis. Experience has shown that experiments which are reviewed by the staff of the GSTR and the ROC can be conducted without endangering the safety of the reactor or exceeding the limits in the Technical Specifications.

4.9 This section intentionally left blank.

5. Design Features

5.1 Site and Facility Description

Applicability. This specification applies to the U.S. Geological Survey TRIGA Reactor site location and specific facility design features.

Objective. The objective is to specify the location of specific facility design features.

Specifications.

1. The licensed area includes the following locations on the Denver Federal Center:

    a. Building 15: Rooms 149 through 152, Rooms 154, 157, 158, B10, B10B, and B11;

    b. Area inside the wrought iron fence and south cooling tower wall that is near the SW corner of Building 15;

    c. Building 10: Room 2.

2. The reactor bay volume is ~12000 cubic feet, and it is designed to restrict leakage.

3. The reactor facility shall be equipped with a ventilation system designed to exhaust air and other gases from the reactor bay and release them from vertical level at least 21 feet above ground level.

4. Emergency controls for the ventilation system shall be located in the reactor control room.

Basis. The reactor building and site description are strictly defined (SAR Chapter 2). The facility is designed such that the ventilation system will normally maintain a negative pressure in the reactor bay with respect to the outside atmosphere so that there will be no uncontrolled leakage to the unrestricted environment. Controls for normal and emergency operation of the ventilation system are located in the reactor control room. Proper handling of airborne radioactive materials (in emergency situations) can be conducted from the reactor control room with minimum exposure to operating personnel (SAR 9.1 and 13.2.1).

5.2 Reactor Coolant System

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

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

Specifications.

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

2. The tank water inlet and outlet pipes to the heat exchanger and to the demineralizer shall be equipped with siphon breaks 14 feet above the top of the core or higher.

NOTE: These specifications are not required to be met if the reactor core has been defueled.

Basis.

1. This specification is based on thermal and hydraulic calculations which show that the TRIGA core can operate in a safe manner at power levels up to 1.9 MW with natural convection flow of the coolant water (SAR 4.5.4.5).

2. In the event of accidental siphoning of tank water through inlet and outlet pipes of the heat exchanger or demineralizer system, the tank water level will drop to a level no less than 14 feet from the top of the core (SAR 5.2).

5.3 Reactor Core and Fuel

5.3.1 Reactor Core

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

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

Specifications.

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

2. The TRIGA core assembly may consist of stainless-steel clad fuel elements (8.5 to 12.0 wt% uranium), aluminum-clad fuel elements (8.0 wt% uranium), or a combination thereof.

3. The fuel shall be arranged in a close-packed configuration except for single element positions occupied by in-core experiments, irradiation facilities, graphite dummies, aluminum dummies, stainless steel dummies, control rods, and startup sources. The core may also contain two separated experiment positions in the D through E rings, each occupying a maximum of three fuel element positions.

4. G-ring grid positions may be empty (water filled).

5. The reflector, excluding experiments and irradiation facilities, shall be graphite, water, or a combination of graphite and water. A reflector is not required if the core has been defueled.

Basis.

1. Standard TRIGA cores have been in use for years and their characteristics are well documented. Analytic studies performed at GSTR for a variety of mixed fuel arrangements indicate that such cores with mixed loadings would safely satisfy all operational requirements (SAR 4.2).

2. The core will be assembled in the reactor grid plate which is located in a tank of light water. Water in combination with graphite reflectors can be used for neutron economy and the enhancement of irradiation facility radiation requirements (SAR 4.2).

5.3.2 Control Rods

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

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

Specifications.

1. The shim and regulating control rods shall have scram capability and contain borated graphite, B_4C powder or boron, with its compounds in solid form as a poison, in aluminum or stainless steel cladding. These rods may incorporate fueled followers.

2. The transient control rod shall have scram capability and contain borated graphite, B_4C powder or boron, with its compounds in a solid form as a poison in an aluminum or stainless steel cladding. The transient rod drive mechanism shall have an adjustable upper limit to allow a variation of reactivity insertions. This rod may incorporate an aluminum-or air-follower.

Basis. The poison requirements for the control rods are satisfied by using neutron absorbing borated graphite, B_4C powder or boron with its compounds in a solid form. These materials must be contained in a suitable clad material such as aluminum or stainless steel to ensure mechanical stability during movement and to isolate the poison from the tank water environment. Control rods (that are fuel-followed) provide additional reactivity to the core and increase the worth of the control rod. The use of fueled-followers has the additional advantage of reducing flux peaking in the water-filled regions vacated by the withdrawal of the control rods. Scram capabilities are provided for rapid insertion of the control rods which is the primary safety feature of the reactor. The transient control rod is designed for rapid withdrawal from the reactor core which results in a reactor pulse. The nuclear behavior of the air- or aluminum-follower, which may be incorporated into the transient rod, is similar to a void. A more detailed description of the control rods and their properties can be found in SAR 4.2.2.

5.3.3 Reactor Fuel

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

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

Specifications.

1. Aluminum-clad TRIGA fuel. The individual unirradiated aluminum-clad fuel elements shall have the following characteristics:

   a. Uranium content: nominally 8.0 wt% with a nominal 20% ^{235}U enrichment;

   b. Hydrogen-to-zirconium atom ratio nominally 1 to 1; and

   c. Cladding is aluminum of a nominal 0.030 inch thickness.

2. Stainless-steel clad TRIGA fuel. The individual unirradiated standard TRIGA fuel elements shall have the following characteristics:

   a. Uranium content: nominal range of 8.5 to 12.0 wt% with a nominal 20% ^{235}U enrichment;

   b. Hydrogen-to zirconium atom ratio nominally between 1.6 to 1 and 1.7 to 1; and

   c. Cladding is 304 stainless steel of a nominal 0.020 inch thickness.

Basis.

1. A nominal uranium content of 8 wt% in an aluminum-clad TRIGA element is less than the traditional stainless-steel clad element design value of 8.5 wt%. Such a decrease gives a lower power density. The nominal hydrogen-to-zirconium ratio of 1 to 1 could result in a phase change of the ZrH if fuel temperature is allowed to exceed 535 °C. Although this would not necessarily cause a rupture of the fuel cladding, it would cause distortion and stressing of the cladding.

2. A maximum nominal uranium content of 12 wt% in a standard TRIGA element is about 50% greater than the lower-loaded nominal value of 8.5 wt%. Such an increase in loading would result in an increase in power density of less than 50%. An increase in local power density of 50% reduces the safety margin by, at most, 10%. The maximum hydrogen-to-zirconium ratio of 1.7 to 1 could result in a maximum stress under accident conditions to the fuel element cladding of about a factor of 1.5 greater than the value resulting from a hydrogen-to-zirconium ratio of 1.6. However, this increase in the cladding stress during an accident would not exceed the rupture strength of the cladding.

5.4 Fuel Storage

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

Objective. The objective is to ensure that fuel which is being stored shall not become critical and shall not reach an unsafe temperature.

Specifications.

1. All fuel elements shall be stored in a geometrical array where the k-effective is less than 0.9 for all conditions of moderation.

2. Irradiated fuel elements and fuel devices shall be stored in an array which will permit sufficient natural convection cooling by water or air such that the temperature of the fuel element or fueled device will not exceed design values.

3. If stored in water, the water quality must be maintained according to section 3.3.b.

Basis. The limits imposed are conservative and ensure safe storage (NUREG-1537).

6. Administrative Controls

6.1 Organization

Individuals at the various management levels, in addition to being responsible for the policies and operation of the reactor facility, shall be responsible for safeguarding the public and facility personnel from undue radiation exposures and for adhering to all requirements of the operating license, technical specifications, and federal regulations. The minimum qualification for all members of the reactor operating staff shall be in accordance with ANSI/ANS 15.4, "Standard for the Selection and Training of Personnel for Research Reactors."

6.1.1 Structure

The reactor administration shall be related to the USGS and USNRC structure as shown in Figure 1.

6.1.2 Responsibility

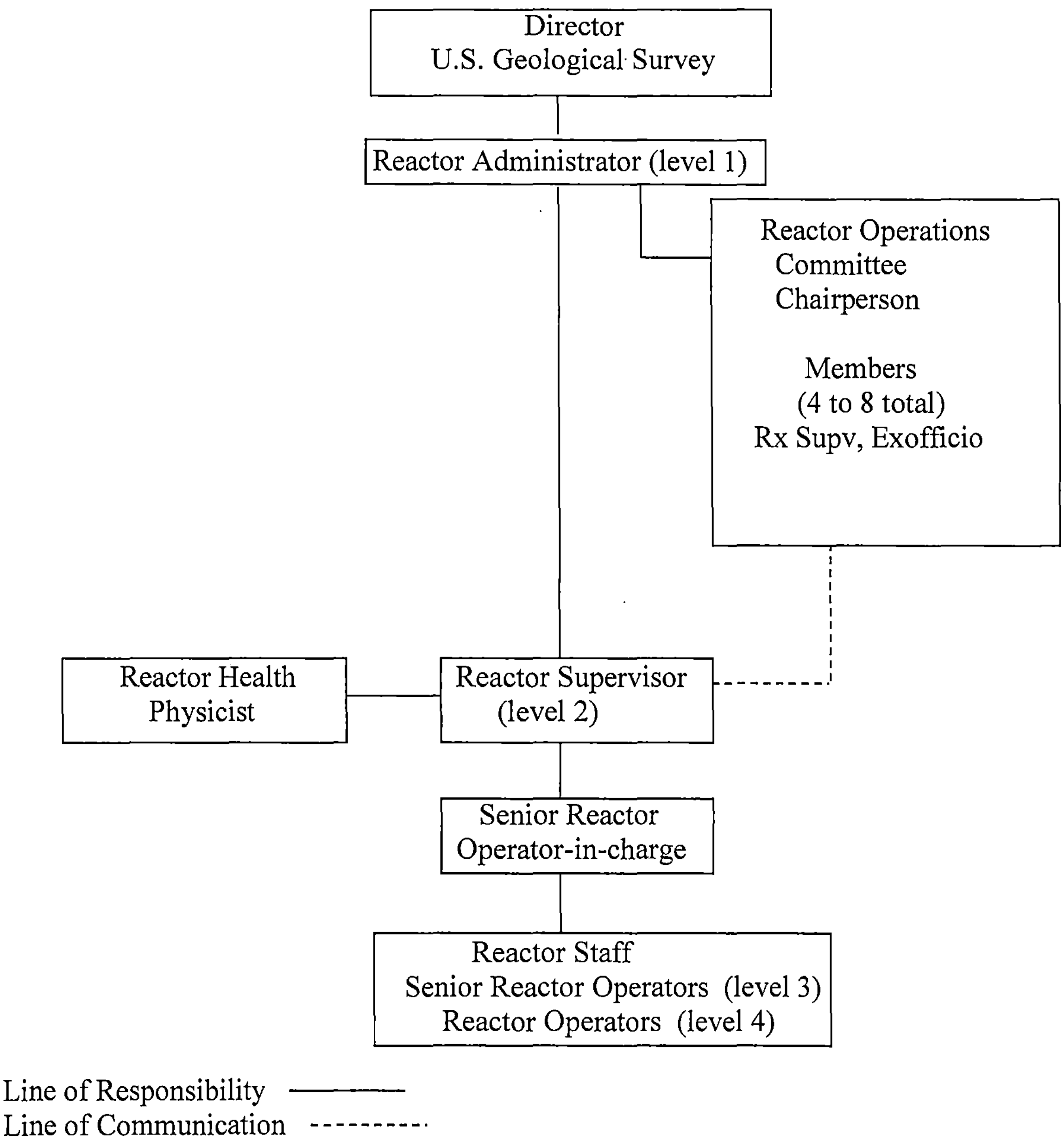
The following specific organizational levels and responsibilities shall exist:

a. Reactor Administrator (Level 1): The Reactor Administrator is responsible to the USGS Director and is responsible for guidance, oversight, and management support of reactor operations;

b. Reactor Supervisor (Level 2): The Reactor Supervisor reports to the Reactor Administrator and is responsible for directing the activities of the Reactor Operators and Senior Reactor Operators and for the day-to-day operation and maintenance of the reactor;

c. Senior Reactor Operator (Level 3): The Senior Reactor Operators report to the Reactor Supervisor and are primarily involved in the oversight and direct manipulation of reactor controls, oversight and direct operation and maintenance of reactor related equipment, and oversight of recovery from unplanned shutdowns; and

d. Reactor Operator (Level 4): The Reactor Operators report to Senior Reactor Operators and the Reactor Supervisor and are primarily involved in the direct manipulation of reactor controls, monitoring of instrumentation, and direct operation and maintenance of reactor-related equipment.



1: Administrative Structure

6.1.3 Staffing

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

    a. A Licensed Operator in the control room;

    b. A second person present within the Denver Federal Center who is able to carry out prescribed instructions;

    c. If neither of these two individuals is a Senior Reactor Operator, a Senior Reactor Operator shall be readily available on call. Readily available on call means an individual who:

        i. Has been specifically designated and the designation is known to the operator on duty;

        ii. Can be contacted by phone, within 5 minutes, by the operator on duty; and

        iii. Is capable of getting to the reactor facility within a reasonable time under normal conditions (e.g., 30 minutes or within a 15-mile radius).

    d. It is not necessary to have a SRO on call if the Reactor Operator in the control room is a SRO. If the Reactor Operator in the control room is a SRO, a second person shall be available at the facility or on call; and

    e. A list of facility personnel and contact information shall be available to the operator on duty.

2. Events requiring the direction of a Senior Reactor Operator

    a. Initial approach to critical after each completed shutdown checklist;

    b. Initial approach to power after each completed shutdown checklist;

    c. All fuel or control rod relocations within the reactor core region;

    d. Relocation of any in-core components (other than normal control rod movements) or irradiation facility with a reactivity worth greater than one dollar; or

    e. Recovery from an unscheduled shutdown or an unscheduled significant (>50%) power reduction.

6.1.4 Selection and Training of Personnel

The selection, training and requalification of operations personnel shall follow the guidance of ANSI/ANS 15.4-2007, "Standard for the Selection and Training of Personnel for Research Reactors."

6.2 Review and Audit

The ROC shall have primary responsibility for review and audit of the safety aspects of reactor facility operations.

6.2.1 Composition and Qualifications

The ROC shall be composed of at least four voting members, including the Chairman. All members of the Committee shall be knowledgeable in subject matter related to reactor operations. To expedite Committee business, a Committee Chairman may be appointed. The Chairman of the ROC is listed by name on the Committee roster.

The Committee is appointed by the USGS Director. No definite term of service is specified; but should a vacancy occur in the Committee, the Director will appoint a replacement. The remaining members of the Committee will be available to assist the Director in the selection of new members. The Reactor Supervisor is an ex-officio member of the Committee, and the Reactor Supervisor is the only non-voting member of the Committee. The ROC reports to the Reactor Administrator.

6.2.2 Charter and Rules

The ROC consists of USGS members and non-USGS members, and the Committee must meet at least semi-annually.

Criteria have been established for the conduct of the meetings and a charter for the Committee is written in the USGS Survey Manual. Dissemination and review of Committee minutes shall be done within 60 days of each respective Committee meeting.

A quorum for review, audit, and approval purposes shall consist of not less than one-half of the committee membership, provided that the operating staff does not constitute a majority of the committee membership. The Chairperson or an alternate must be present at all meetings in which the official business of the committee is being conducted. Approvals by the committee shall require an affirmative vote by a majority of the non-Survey members present and an affirmative vote by a majority of the Survey members present.

6.2.3 Review and Audit Function

Semi-annual meetings will be held to review and audit reactor operations.

The following items shall be reviewed:

a. Determinations that proposed changes in the facility, procedures, tests, or experiments are allowed without prior authorization by the responsible authority, as detailed in 10 CFR 50.59;

b. All new procedures and major revisions thereto having safety significance, proposed changes in reactor facility equipment, or systems having safety significance;

c. All new experiments or classes of experiments that could cause a reactivity change near a technical specification limit or result in the release of radioactivity;

d. Proposed changes in technical specifications, license, or charter;

e. Violations of technical specifications, license, or charter. Violations of internal procedures or instructions having safety significance;

f. Operating abnormalities having safety significance;

g. Reportable occurrences listed in section 6.7.2; and

h. Audit reports.

A written report or minutes of the findings and recommendations of the review shall be submitted to the Reactor Administrator and the review and/or audit group members within 3 months after the review has been completed.

The audit function shall include selective (but comprehensive) examination of operating records, logs, and other documents. Discussions with cognizant personnel and observation of operations should be used also as appropriate. In no case shall the individual immediately responsible for the area perform an audit in that area. The following items shall be audited:

a. Facility operations for conformance to the technical specifications and applicable license or charter conditions: at least once per calendar year (interval between audits not to exceed 15 months);

b. The retraining and requalification program for the operating staff: at least once every other calendar year (interval between audits not to exceed 30 months);

c. The results of action taken to correct those deficiencies that may occur in the reactor facility equipment, systems, structures, or methods of operations that affect reactor safety: at least once per calendar year (interval between audits not to exceed 15 months); and

d. The reactor facility emergency plan and implementing procedures: at least once every other calendar year (interval between audits not to exceed 30 months).

Deficiencies uncovered that affect reactor safety shall immediately be reported to the Reactor Administrator. A written report of the findings of the audit shall be submitted to the Reactor Administrator and the review and audit group members within 3 months after the audit has been completed.

These meetings will also include annual audits of the reactor facility and reactor records by the Committee.

6.3 Radiation Safety

The Reactor Supervisor, in coordination with the Reactor Health Physicist, shall be responsible for implementation of the radiation safety program. The requirements of the radiation safety program are established in 10 CFR 20. The program should use the guidelines of the ANSI/ANS 15.11-2009, ``Radiation Protection at Research Reactor Facilities.''

6.4 Procedures

Written operating procedures shall be prepared, reviewed, and approved to ensure the safety of operation of the reactor, but shall not preclude the use of independent judgment and action should the situation require such. Procedures shall be in effect and in use for the following items:

a. Surveillance checks, calibrations, and inspections that are required by Technical Specifications;

b. Startup, operation and shutdown of the reactor;

c. Implementation of emergency and security plans;

d. Core changes and fuel movement;

e. Performing maintenance on major components that could affect reactor safety;

f. Administrative controls for operations, maintenance, and experiments that could affect reactor safety;

g. Radiation protection, including ALARA requirements; and

h. Use, receipt and transfer of licensed radioactive material, if appropriate.

6.5 Experiment Review and Approval

All experiments proposed for the reactor will be either Class I or Class II experiments. The classification of the proposed experiments will be the responsibility of the Reactor Supervisor.

Class I experiments include all experiments that have been run previously or that are minor modifications to a previous experiment. These are experiments which involve small changes in reactivity, no external shielding changes, and/or limited amounts of radioisotope production. The Reactor Supervisor has the authority to approve the following, as part of the 10 CFR 50.59 process:

a. Experiments for which there exists adequate precedence for assurance of safety;

b. Experiments which represent less than that amount of reactivity worth necessary for prompt criticality; or

c. Experiments in which any significant reactivity worth is stable and mechanically fixed, that is, securely fastened or bolted to the reactor structure.

Class II experiments include all new experiments and major modifications of previous experiments. These experiments must be reviewed and approved, as part of the 10 CFR 50.59 process, by ROC before being run. The USGS Radiation Safety Committee may also be consulted. These experiments may involve larger changes in reactivity, external shielding changes, and/or larger amounts of radioisotope production. These include:

a. In-core experiments which involve, in an unstable form, reactivity worth greater than that necessary to produce a prompt critical condition in the reactor core;

b. Experiments involving corrosive chemicals, pressures or temperatures which, if failure should occur, could endanger the safety of the reactor core;

c. Dynamic experiments which could introduce appreciable reactivity worth into the reactor by failure or malfunction. Included in this group are circulation systems which operate in or at the core and by which if a failure occurred, the core could be damaged;

d. Experiments which are dynamically coupled to the reactor core and together function as a system, i.e. to measure nuclear absorption cross sections, or study transient responses;

e. Experiments which interfere in any way with the normal function of any of the reactor safety circuits;

f. Experiments which could produce radiation levels sufficient to cause serious personnel radiation injury; or

g. Experiments which by their unusual hazard could produce injury or death.

6.6 Required Actions

6.6.1 Actions to Be Taken in Case of Safety Limit Violation

In the event a safety limit is exceeded:

a. The reactor shall be shutdown and reactor operation shall not be resumed until authorized by the NRC;

b. An immediate notification of the occurrence shall be made to the Reactor Supervisor, Reactor Administrator, ROC; and

c. A report, and any applicable follow-up report, shall be prepared and submitted to the NRC. The report shall describe the following:

i. Applicable circumstances leading to the violation including, when known, the cause and contributing factors;

ii. Effects of the violation upon reactor facility components, systems, or structures and on the health and safety of personnel and the public; and

iii. Corrective action to be taken to prevent recurrence.

6.6.2 Actions to Be Taken in the Event of an Occurrence of the Type Identified in Section 6.7.2 Other than a Safety Limit Violation

For all events which are required by Technical Specifications to be reported to the NRC within 24 hours under section 6.7.2, except a safety limit violation, the following actions shall be taken:

a. The reactor shall be secured and the Reactor Supervisor notified;

b. Operations shall not resume unless authorized by the Reactor Supervisor;

c. The ROC shall review the occurrence at their next scheduled meeting; and

d. Where appropriate, a report shall be submitted to the NRC in accordance with section 6.7.2.

6.7 Reports

6.7.1 Annual Operating Report

An annual report covering the previous calendar year shall be created and submitted, no later than March 31 of the year following the report period, by the Reactor Supervisor to the NRC consisting of:

a. A brief summary of operating experience including the energy produced by the reactor and the hours the reactor was critical;

b. The number of unplanned shutdowns, including corrective actions taken (when applicable);

c. A tabulation of major preventative and corrective maintenance operations having safety significance;

d. A brief description, including a summary of the safety evaluations, of changes in the facility or in procedures and of tests and experiments carried out pursuant to 10 CFR 50.59;

e. A summary of the nature and amount of radioactive effluents released or discharged to the environs beyond the effective control of the licensee as measured at or prior to the point of such release or discharge. 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, a statement to this effect is sufficient;

f. A summarized result of environmental surveys performed outside the facility;

g. A summary of exposures received by facility personnel and visitors where such exposures are greater than 25% of that allowed; and

h. Results of fuel inspections (when performed).

6.7.2 Special Reports

In addition to the requirements of applicable regulations, and in no way substituting therefore, reports shall be made by the Reactor Supervisor to the NRC as follows:

a. A report within 24 hours by telephone, digital submission, or fax to the NRC Operations Center followed by a written report within 14 days that describes the circumstances associated with any of the following:

i. Any release of radioactivity above applicable limits into unrestricted areas, whether or not the release resulted in property damage, personal injury, or exposure;

ii. Any violation of a safety limit;

iii. Operation with a LSSS less conservative than specified in the Technical Specifications;

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

v. Failure of a required reactor safety system component which could render the system incapable of performing its intended safety function unless the failure is discovered during maintenance tests or periods of reactor shutdown;

vi. Any unanticipated or uncontrolled change in reactivity greater than $1.00;

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

viii. Abnormal and significant degradation in reactor fuel, cladding, or coolant boundary

b. A report within 30 days in writing to the NRC, Document Control Desk, Washington, D.C. of:

i. Permanent changes in the facility organization involving Level 1-2 personnel; or

ii. Significant changes in the transient or accident analyses as described in the Safety Analysis Report.

6.8 Records

6.8.1 Records to be Retained for a Period of at Least Five Years or for the Life of the Component Involved if Less than Five Years

1. Normal reactor operation (but not including supporting documents such as checklists, data sheets, etc., which shall be maintained for a period of at least two years);

2. Principal maintenance activities;

3. Reportable occurrences;

4. Surveillance activities required by the Technical Specifications;

5. Reactor facility radiation and contamination surveys;

6. Experiments performed with the reactor;

7. Fuel inventories, receipts, and shipments;

8. Approved changes to the operating procedures; and

9. ROC meetings and audit reports.

6.8.2 Records to be Retained for at Least One Operator License Term

1. Records of retraining and requalification of Reactor Operators and Senior Reactor Operators shall be retained for at least one license term; and

2. Records of retraining and requalification of licensed operators shall be maintained while the individual is employed by the licensee, or until that operator's license is renewed, whichever is shorter.

6.8.3 Records to be Retained for the Lifetime of the Reactor Facility

1. Gaseous and liquid radioactive effluents released to the environs;

2. Offsite environmental monitoring surveys;

3. Reviews and reports pertaining to a violation of the safety limit, the limiting safety system setting, or a limiting condition of operation;

4. Radiation exposures for all personnel monitored; and

5. Drawings of the reactor facility.

Attachment 3: Latest financial statement of the USGS

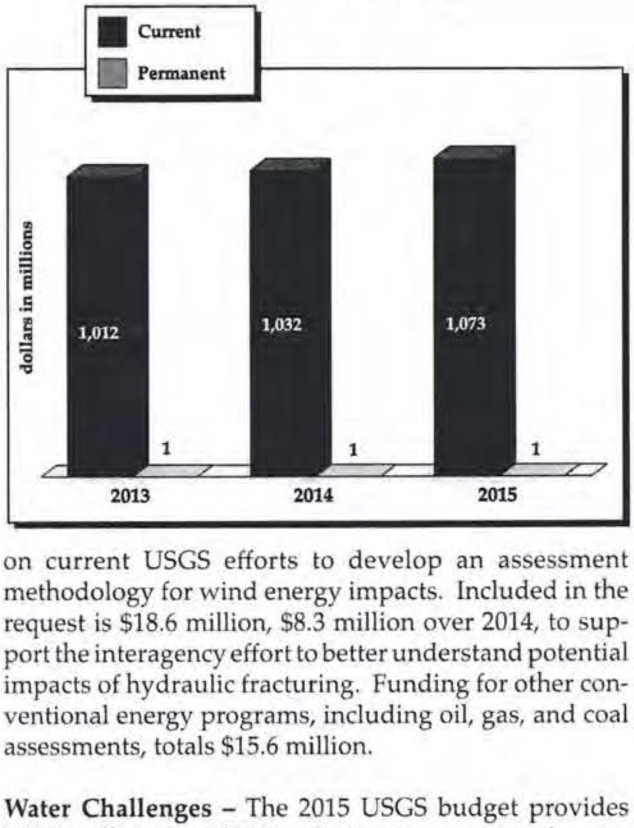
U.S. GEOLOGICAL SURVEY

Mission – The mission of the U.S. Geological Survey is to provide reliable scientific information to describe and understand the Earth, minimize loss of life and property from natural disasters, support the sustainable stewardship of land and water, and manage biological, energy, and mineral resources.

Budget Overview – The 2015 U.S. Geological Survey budget request is $1.1 billion, an increase of $41.3 million above the 2014 enacted level. The USGS estimates staffing will equal 8,259 full time equivalents in 2015, a decrease of 18 FTE from the 2014 enacted. The 2015 budget reflects the Administration's commitment to invest in research and development to support a robust economy and resilient Nation. The 2015 budget investments maximize the impacts of research, development, and monitoring, in support of natural resource decisionmaking and will enable USGS to continue to provide world-class science and support priorities outlined in the USGS Science Strategy. The budget prioritizes programs unique to USGS which have national impacts, and provide monitoring, research, and tools to make science immediately usable, particularly in support of Interior's resource and land management missions and trust responsibilities. To optimize investments in these priorities, some targeted reductions were made. Highlights of the budget include increases for priorities in ecosystem restoration, water resources management, sustainable energy development, climate resilience, and earth observation systems, including streamgages and Lidar elevation data, which provide critical data to the Nation. Continuation of a hydraulic fracturing research and development effort with the Department of Energy and the Environmental Protection Agency will support research to better understand and minimize potential environmental, health, and safety impacts of energy development through hydraulic fracturing.

Powering Our Future – The 2015 USGS budget provides $40.7 million for the Secretary's Powering Our Future initiative, $8.1 million above the 2014 enacted level. A program increase of $1.3 million supports agencies responsible for alternative energy permitting on Federal lands. These funds will be used to study geothermal resources as a potential energy source and will build on current USGS efforts to develop an assessment methodology for wind energy impacts. Included in the request is $18.6 million, $8.3 million over 2014, to support the interagency effort to better understand potential impacts of hydraulic fracturing. Funding for other conventional energy programs, including oil, gas, and coal assessments, totals $15.6 million.

USGS Funding



Water Challenges – The 2015 USGS budget provides $14.5 million for USGS activities in support of water assessments, an increase of $6.4 million above the 2014 enacted level. The increase will enhance implementation of the WaterSMART Availability and Use Assessment through State water use grants to develop water use and availability datasets, develop regional water availability models, integrate and disseminate data through online science platforms, and support the National Groundwater Monitoring Network. In 2015, USGS will begin development of a model that integrates hydrological and biological variables, to better understand water resource needs of ecosystems when making decisions.

Ecosystems – The 2015 budget includes $162.0 million for the Ecosystems activity, $9.2 million above the 2014 enacted level. Through the Ecosystems activity, USGS

U.S. Geological Survey Facts

- **Founded by an Act of Congress in 1879.**
- **Is the Nation's largest water, earth, and biological science and civilian mapping agency.**
- **Employs over 8,300 scientists, technicians, and support staff working in more than 400 locations throughout the United States.**
- **With over 2,000 strategic partnerships, USGS is a primary Federal source of science-based information on ecosystem science, climate and land use change, energy and mineral resources, environmental impacts, natural hazards, water resource use and availability, and updated maps and images for the Earth's features available to the public.**
- **Generates and maintains data from over 8,000 streamgages and over 2,700 earthquake sensors that are available to the public.**
- **Provides direct access to 16 million Landsat images spanning the globe from 1972 to present; archives contain 7.6 million air photos dating to 1939 and over 100 other satellite, cartographic, and topographic datasets characterizing the Earth's surface; and available data is provided at no cost to the user.**

conducts research and monitoring to better understand how ecosystems are structured and function. Information generated by the Ecosystems activity helps improve management of the Nation's natural resources and address hazards that threaten land, coastlines, and populations.

The 2015 budget includes a program increase of $2.0 million for research on new methods to eradicate, control, and manage Asian carp in the Upper Mississippi River Basin and prevent entry into the Great Lakes. Program increases totaling $2.5 million are provided for the following priority ecosystem restoration initiatives: California Bay-Delta, Chesapeake Bay, Columbia River, Everglades, and Puget Sound; and $300,000 is provided for science support for Outer Continental Shelf ecosystems decisions. In addition to the increase for hydraulic fracturing discussed above, program increases totaling $1.8 million are provided to address native pollinators, brown treesnakes, and new and emerging invasive species of national concern.

A program increase of $2.0 million will support efforts to further the science and integration of ecosystems services frameworks into decisionmaking and implement efforts to assess and sustain the Nation's environmental capital. Additional program increases include: $200,000 for wildlife health, $1.0 million for energy future and wildlife sustainability, $1.0 million for the CRU Scientists for Tomorrow youth initiative, and $500,000 for wildfire restoration ecology. Increases are partially offset by reductions in several activities within the Ecosystems Mission Area.

Climate and Land Use Change – The 2015 budget provides a total of $149.1 million for Climate and Land Use Change, an increase of $17.1 million from 2014. The proposed budget for the Climate Variability subactivity is $72.0 million, an increase of $18.4 million above the 2014 enacted level. This subactivity provides practical scientific information to inform resilient and adaptive natural resource and land management on a landscape scale and prioritizes and advances the implementation of the President's Climate Action Plan.

The National Climate Change and Wildlife Science Center and the eight Department of the Interior Climate Science Centers are funded at $35.3 million, an increase of $11.6 million. This includes a program increase of $3.0 million for CSC grants, focused on providing translational and applied science needed for decisionmaking, particularly in resource management and biological sequestration. To further collaboration, better leverage resources, and reduce potential for duplication, a program increase of $2.3 million will support coordination efforts with other Federal climate science entities and ensure scientific results and products are made available to the public in a centralized, web-accessible format. Also provided are program increases of $2.5 million for applied science and capacity-building in support of tribal climate adaptation needs in each CSC region, $800,000 for climate adaptation and resiliency research leading to a Vulnerability Assessment Database and Field Guide, and $3.0 million for research on drought impacts and adaptive management.

The budget includes program increases of $2.6 million in the Climate Research and Development program to focus on emerging science needs and $2.0 million to begin research on climate and land cover change effects. A program increase of $2.0 million is included for the development of decision support tools to support biological carbon sequestration in natural resource and land management.

The 2015 budget request for the Land Use Change subactivity is $77.1 million, $1.3 million below the 2014 enacted level. This subactivity ensures Earth observation imagery collected via satellite is available and accessible to users and provides analyses of these data to quantify rates of land use change, identify key driving forces, and forecast future trends of landscape change. The Landsat satellite program in the Land Remote Sensing program is funded at $53.3 million, level with 2014, and includes funding for maintenance and operation of ground systems and satellite operations.

In 2015, USGS will continue to work with the National Aeronautics and Space Administration to analyze user requirements and implement a 20-year sustained land imaging program to provide for Landsat data continuity. Funding for the land imaging program is provided in the 2015 budget for NASA, which will be responsible for development of a sustained, space-based, global land imaging capability for the future. The USGS will continue its operational role in managing the collection, archiving, and dissemination of Landsat data to users and the Land Remote Sensing program will continue to further the advancement of the science, usability, and centralized sharing of Landsat data, applications, and software.

The 2015 budget provides program increases of $1.0 million in the Land Remote Sensing program and $500,000 in the Land Change Science program for Landsat science products for climate and natural resource assessments. The budget also provides a program increase of $500,000 in the Land Change Science program for Chesapeake Bay ecosystem restoration. Increases are partially offset by reductions in several activities within the Climate and Land Use Change mission area.

Energy, Minerals, and Environmental Health – The 2015 budget includes $99.1 million for Energy, Minerals, and Environmental Health. The proposed budget for the Mineral and Energy Resources subactivity is $73.2 million, an increase of $1.3 million above the 2014 level. This subactivity includes programs that conduct research and assessments on the location, quantity, and quality of the Nation's mineral and energy resources. In addition to an increase for hydraulic fracturing discussed above, the budget includes a program increase of $1.3 million for alternative energy permitting on Federal lands.

The 2015 request for the Environmental Health subactivity is $25.8 million, $6.2 million above the 2014 enacted level. This subactivity conducts research on the impacts of human activities that introduce chemical and pathogenic contaminants into the environment and threaten human, animal, and ecological health. In addition to an increase for hydraulic fracturing discussed above, the 2015 budget provides program increases totaling $400,000 for Chesapeake Bay and Columbia River ecosystem restoration, $200,000 each, shared equally between Contaminant Biology and Toxic Substances Hydrology. The budget also provides a program increase of $1.5 million in Toxic Substances Hydrology for research on emerging contaminants and chemical mixtures. The budget provides program increases of $673,000 in Contaminant Biology and $2.5 million in Toxic Substances Hydrology for environmental impacts of uranium mining. Increases are partially offset by reductions in several activities within the Energy, Minerals, and Environmental Health mission area.

Natural Hazards – The 2015 budget provides $128.3 million for Natural Hazards, nearly level with 2014 enacted. This activity provides scientific information and tools to reduce potential fatalities, injuries, and economic loss from volcanoes, earthquakes, tsunamis, and landslides, among others. This activity also includes efforts to characterize and assess coastal and marine processes, conditions, vulnerability, and change. The 2015 budget provides a program increase in Earthquake Hazards of $700,000 for induced seismicity studies for hydraulic fracturing. Increases are partially offset by reductions in activities within the Natural Hazards mission area.

Water Resources – The 2015 budget includes $210.4 million for Water Resources, $3.1 million above the 2014 enacted level. This activity includes programs that collect, manage, and disseminate hydrologic data, model and analyze hydrologic systems, and conduct research and development leading to new understanding of and methods for gathering data. The activities are supported by a national network of streamgages, wells, and monitoring sites, which are leveraged by funds from State, tribal, and local partners. The 2015 budget provides program increases of $2.4 million in Groundwater Resources for the National Groundwater Monitoring Network and $1.2 million for the National Streamflow Information Program for streamgages.

Program increases totaling $1.9 million are provided for the following priority ecosystem restoration initiatives: California Bay-Delta, Chesapeake Bay, Puget Sound, and the upper Mississippi River. In addition to an increase for hydraulic fracturing discussed above, a program increase in Hydrologic Research and Development includes $700,000 for streamgage research and development. Program increases in Hydrologic Networks and Analysis include $2.0 million for WaterSMART State

Water Use Grants and $750,000 for hydrologic modeling and groundwater sustainability initiatives.

Program increases in the Cooperative Water Program include $2.0 million for WaterSMART Water Use Research and $1.0 million for work with Tribes. The Water Resources Research Act Program is funded at $3.5 million, a decrease of $3.0 million from 2014. Increases are partially offset by reductions in several activities within the Water Resources mission area.

Core Science Systems – The 2015 budget provides $109.4 million for Core Science Systems, $593,000 above the 2014 enacted level. This activity provides the Nation with access to science, information, and geospatial frameworks used to manage natural resources and plan for and respond to natural hazards. Biologic and geologic data archives and geospatial data in The National Map provide critical data about the Earth, its complex processes, and natural resources. In addition to an increase for hydraulic fracturing discussed above, the 2015 budget includes a program increase of $2.0 million for the Big Earth Data Initiative.

The budget provides program increases of $800,000 for priority ecosystem restoration initiatives in Columbia River and Puget Sound and $800,000 for EcoINFORMA. Program increases in the National Geospatial Program include $5.0 million for Lidar collection through the 3-D Elevation Program, $236,000 for Alaska Mapping, and $1.9 million for The National Map modernization. Increases are partially offset by reductions in several activities within the Core Science Systems Mission Area.

Science Support – The 2015 budget request includes $108.3 million for Science Support, a $2.4 million decrease below the 2014 enacted level. This activity funds the executive, managerial, and accounting activities, information technology, and bureau support services of USGS. The 2015 budget request includes program increases in Administration and Management of $1.0 million for Youth and Education in Science, $300,000 for Tribal Science Coordination, $500,000 for the Mendenhall Program, $200,000 for Outreach to Underserved Communities, and $200,000 for Science Coordination. The Science Support activity includes a reduction in Information Services of $2.3 million for administrative services within USGS.

Facilities – The 2015 budget provides $106.7 million for Facilities, $6.3 million above the 2014 enacted level. This activity provides safe, functional workspace, laboratories, and other facilities needed to accomplish the USGS scientific mission. A program increase of $5.4 million will be used to reduce the facilities footprint of USGS nationwide by consolidating and improving the efficiency of space and real property.

Fixed Costs – Fixed costs of $6.2 million are fully funded.

SUMMARY OF BUREAU APPROPRIATIONS
(all dollar amounts in thousands)

Comparison of 2015 Request with 2014 Enacted

	2014 Enacted		2015 Request		Change	
	FTE	Amount	FTE	Amount	FTE	Amount
Current						
Surveys, Investigations, and Research	5,222	1,032,000	5,204	1,073,268	-18	+41,268
Subtotal, Current	5,222	1,032,000	5,204	1,073,268	-18	+41,268
Permanent						
Operations and Maintenance of Quarters	0	38	0	34	0	-4
Contributed Funds	6	937	6	714	0	-223
Subtotal, Permanent	6	975	6	748	0	-227
Reimbursable, Allocation, and Other						
Reimbursable	2,787	0	2,787	0	0	0
Allocation	36	0	36	0	0	0
Working Capital Fund	226	0	226	0	0	0
Subtotal, Reimbursable, Allocation, and Other	3,049	0	3,049	0	0	0
TOTAL, U. S. GEOLOGICAL SURVEY	**8,277**	**1,032,975**	**8,259**	**1,074,016**	**-18**	**+41,041**

HIGHLIGHTS OF BUDGET CHANGES
By Appropriation Activity/Subactivity

APPROPRIATION: Surveys, Investigations, and Research

	2013 Actual	2014 Enacted	2015 Request	Change
Ecosystems				
Status and Trends	20,473	20,473	20,917	+444
Fisheries	20,886	20,886	22,257	+1,371
Wildlife	44,252	44,757	45,123	+366
Environments	34,024	36,244	37,538	+1,294
Invasive Species	12,080	13,080	17,639	+4,559
Cooperative Research Units	17,371	17,371	18,551	+1,180
Subtotal, Ecosystems	149,086	152,811	162,025	+9,214
Climate and Land Use Change				
Climate Variability	54,809	53,589	71,974	+18,385
Land Use Change	78,386	78,386	77,107	-1,279
Subtotal, Clim. and Land Use Chge.	133,195	131,975	149,081	+17,106
Energy, Minerals, and Environmental Health				
Mineral Resources	45,931	45,931	46,345	+414
Energy Resources	25,970	25,970	26,902	+932
Contaminant Biology	8,647	9,647	12,000	+2,353
Toxic Substances Hydrology	9,967	9,967	13,826	+3,859
Subtotal, Energy, Minerals, and Environmental Health	90,515	91,515	99,073	+7,558
Natural Hazards				
Earthquake Hazards	50,753	53,803	54,117	+314
Volcano Hazards	22,721	23,121	23,308	+187
Landslide Hazards	2,985	3,485	3,511	+26
Global Seismographic Network	4,853	4,853	4,866	+13
Geomagnetism	1,888	1,888	1,905	+17
Coastal and Marine Geology	40,336	41,336	40,632	-704
Subtotal, Natural Hazards	123,536	128,486	128,339	-147
Water Resources				
Groundwater Resources	8,348	8,948	11,429	+2,481
National Water Quality Assessment	58,859	58,859	59,090	+231
National Streamflow Info Program	27,701	33,701	35,060	+1,359
Hydrologic Research and Developmt	10,915	10,915	11,323	+408
Hydrologic Networks and Analysis	28,884	28,884	30,423	+1,539
Cooperative Water Program	59,474	59,474	59,561	+87
Water Resources Research Act Prog	3,268	6,500	3,500	-3,000
Subtotal, Water Resources	197,449	207,281	210,386	+3,105
Core Science Systems				
Science Synthesis, Analysis, and Research Program	23,914	24,314	24,439	+125
Nat'l Cooperative Geologic Mapping	24,397	24,397	24,533	+136
National Geospatial Program	59,332	60,096	60,428	+332
Subtotal, Core Science Systems	107,643	108,807	109,400	+593
Science Support *(new name)*				
Administration and Management *(new name)*	86,985	86,985	86,392	-593
Information Services *(new name)*	23,719	23,719	21,875	-1,844
Subtotal, Science Support *(new name)*	110,704	110,704	108,267	-2,437

APPROPRIATION: **Surveys, Investigations, and Research** *(continued)*

	2013 Actual	2014 Enacted	2015 Request	Change
Facilities				
Rental Payments and Operations and Maintenance	93,141	93,141	99,417	+6,276
Deferred Maintenance and Capital Improvement	6,899	7,280	7,280	0
Subtotal, Facilities	100,040	100,421	106,697	+6,276
TOTAL APPROPRIATION	1,012,168	1,032,000	1,073,268	+41,268

Detail of Budget Changes

	2015 Change from 2014 Enacted
TOTAL APPROPRIATION	+41,268
Ecosystems	+9,214
Status and Trends	+444
Native Pollinators	+300
Fixed Costs	+144
Fisheries Program	+1,371
Hydraulic Fracturing	+2,200
Fisheries Program Research	-1,000
Fixed Costs	+171
Wildlife Program	+366
Energy Future and Wildlife Sustainability	+1,000
Wildlife Health	+200
Wildlife Program Research	-1,200
Fixed Costs	+366
Environments Program	+1,294
Ecosystem Priority	
California Bay-Delta	+500
Chesapeake Bay	+300
Columbia River	+300
Puget Sound	+400
National Ecosystems Services Framework	+1,000
Sustaining Environmental Capital	+1,000
Outer Continental Shelf Ecosystems Decisions	+300
Wildfire Restoration Ecology	+500
Environments Program Research	-3,220
Fixed Costs	+214
Invasive Species	+4,559
Brown Treesnakes	+500
Ecosystem Priority	
Everglades	+1,000
Great Lakes Asian Carp Control Framework	+1,000
Upper Mississippi River Asian Carp Control	+1,000
New and Emerging Invasives of National Concern	+1,000
Fixed Costs	+59
Cooperative Research Units	+1,180
CRU Scientists for Tomorrow	+1,000
Fixed Costs	+180

	2015 Change from 2014 Enacted
Climate and Land Use Change	+17,106
Climate Variability	+18,385
Climate Adaptation and Resiliency – Vulnerability Assessment Database and Field Guide	+800
Interagency Coordination	+2,250
Translational Science Grants	+3,000
Tribal Climate Science Partnerships	+2,500
Emerging Science Needs	+2,600
Grand Challenge	
Drought Impacts and Adaptive Mgmt.	+3,000
Climate and Land Cover Change Effects	+2,000
Carbon Inventory and Decision Support Tools	+2,000
Fixed Costs	+235
Land Use Change	-1,279
Landsat Science Products for Climate and Natural Resources Assessments	+1,500
Ecosystem Priority: Chesapeake Bay	+500
National Civil Applications Program Civil Applications Committee	-2,547
Land Change Science Research	-1,000
Fixed Costs	+268
Energy, Minerals, and Environmental Health	+7,558
Mineral Resources	+414
Fixed Costs	+414
Energy Resources	+932
Hydraulic Fracturing	+950
Alternative Energy Permitting and Fed. Lands	+1,300
Oil, Oil Shale, and Gas Assessments	-500
Energy Research	-1,000
Fixed Costs	+182
Contaminant Biology	+2,353
Hydraulic Fracturing	+1,400
Ecosystem Priority	
Chesapeake Bay	+100
Columbia River	+100
Environmental Impacts of Uranium Mining	+673
Fixed Costs	+80

Detail of Budget Changes
Surveys, Investigations, and Research *(continued)*

	2015 Change from 2014 Enacted
Toxic Substances Hydrology	+3,859
Ecosystem Priority	
Chesapeake Bay	+100
Columbia River	+100
Emerging Contaminants and Chem. Mixtures.	+1,450
Environmental Impacts of Uranium Mining	+2,500
Contaminants in Wastewater Projects	-369
Fixed Costs	+78
Natural Hazards	-147
Earthquake Hazards	+314
Hydraulic Fracturing - Induced Seismicity	+700
Geodetic Monitoring and Active-Source Seismic Profiling	-700
Fixed Costs	+314
Volcano Hazards	+187
Fixed Costs	+187
Landslide Hazards	+26
Fixed Costs	+26
Global Seismographic Network	+13
Fixed Costs	+13
Geomagnetism	+17
Fixed Costs	+17
Coastal and Marine Geology	-704
Coastal Vulnerability Studies	-1,000
Fixed Costs	+296
Water Resources	+3,105
Groundwater Resources	+2,481
WaterSMART	
Nat'l Groundwater Monitoring Network	+2,400
Fixed Costs	+81
National Water Quality Assessment	+231
Ecosystem Priority	
California Bay-Delta	+1,000
Chesapeake Bay	+500
Upper Mississippi River	+200
Water Quality Monitoring	-2,000
Fixed Costs	+531
National Streamflow Information Program	+1,359
Streamgages	+1,200
Fixed Costs	+159
Hydrologic Research and Development	+408
Hydraulic Fracturing	+901
Ecosystem Priority: Puget Sound	+200
Streamgage Research and Development	+700
Monitoring and Assessments	-1,500
Fixed Costs	+107
Hydrologic Networks and Analysis	+1,539
WaterSMART: State Water Use Grants	+2,000
National Hydrologic Modeling and Groundwater Sustainability	+750
Watershed Support, Information Delivery, and Technical Support	-1,500
Fixed Costs	+289

	2015 Change from 2014 Enacted
Cooperative Water Program	+87
WaterSMART: Water Use Research	+2,000
Tribes	+1,000
Monitoring and Assessments	-3,264
Fixed Costs	+351
Water Resources Research Act Program	-3,000
Funding to State Institutes	-3,000
Core Science Systems	+593
Science Synthesis, Analysis, and Research	+125
Hydraulic Fracturing	+185
Ecosystem Priority: EcoINFORMA	+800
Big Earth Data Initiative	+2,000
Bio-Science Data Synthesis	-3,000
Fixed Costs	+140
National Cooperative Geologic Mapping	+136
Hydraulic Fracturing	+2,000
Glacial Aquifers Project	-2,000
Fixed Costs	+136
National Geospatial Program	+332
Ecosystem Priority	
Columbia River	+350
Puget Sound	+450
3-D Elevation Program	+5,000
Alaska Mapping	+236
The National Map Modernization	+1,908
Land Cover Data	-422
The National Atlas	-2,674
Nation's 133 Largest Urban Areas	-4,082
Program Coordination and Partnership Development	-822
Fixed Costs	+388
Science Support *(new name)*	-2,437
Admin. and Management *(new name)*	-593
Youth and Education in Science	+1,000
Tribal Science Coordination	+300
Outreach to Underserved Communities	+200
Mendenhall Program Postdocs	+500
Science Coordination	+200
Administrative Services	-2,200
Fixed Costs	-593
Information Services *(new name)*	-1,844
Administrative Services	-2,300
Fixed Costs	+101
IT Transformation Fixed Costs	+355
Facilities	+6,276
Rental Payments and Operations and Maintenance	+6,276
Operations and Maintenance Efficiencies – Reduce Facilities Footprint	+5,365
Fixed Costs	+911
Subtotals for Changes Across Multiple Subactivities	
Fixed Costs	[+6,200]

Attachment 4: Details of decommissioning cost estimate

GSTR Decommissioning Cost Estimate in 2015 Dollars

A 2015 decommissioning cost estimate will be performed using the same methodology that was used for the 2006 estimate, as described below.

Table 1: SUMMARY OF 2006 DECOMMISSIONING COST ESTIMATE

Category	Cost (2006 $)
Planning, calculations and inventories	$ 102,926
Fuel transportation to DOE site	$ 171,543
Dismantling, decontamination and disposal	$ 2,524,286
USGS preparation and miscellaneous expenses	$ 171,543
Subtotal	$ 2,970,298
Contingency (25%)	$ 742,574
Total	**$ 3,712,872**

Adjustment factor

The adjustment factor was designed for updating reference Pressurized Water Reactor (PWR) and Boiling Water Reactor (BWR) decommissioning estimates, but serves as a convenient method to adjust GSTR decommissioning cost estimates over time. Whenever a calculation is specified for a PWR or BWR, an average of the PWR and BWR factors is used.

The decommissioning cost inflation equation of 10 CFR 50.75(c)(2) is divided into three general categories that test to escalate similarly: (1) labor, materials and services; (2) energy and waste transportation; and (3) radioactive waste burial/treatment. A relatively simple equation is used to update the estimate of cost by multiplying the revised original cost estimate (in our case, $3,712,872 in 2006 $) by a factor developed using the three categories described above. The equation is:

Estimate Cost (Year 2015) = [2006 $ Cost]*($A\ L_x + B\ E_x + C\ B_x$)

where

A = fraction of the [2006 $ Cost] attributable to labor, materials, and services (0.65)

B = fraction of the [2006 $ Cost] attributable to energy and transportation (0.13)

C = fraction of the [2006 $ Cost] attributable to waste burial (0.22)

L_x = labor, materials and services cost adjustment, January of 2006 to latest month of 2015 for which data is available

E_x = energy and waste transportation cost adjustment, January of 2006 to latest month of 2015 for which data is available

B_x = LLW burial/disposition cost adjustment January of 2006 to December 2015

$= (R_{2015} + \sum S_{2015})/(R_{2006} + \sum S_{2006})$

where

R_{2015} = radioactive waste burial/disposition costs in 2015 dollars

$\sum S_{2015}$ = summation of surcharges in 2015 dollars

R_{2006} = radioactive waste burial/disposition costs in 2006 dollars

$\sum S_{2006}$ = summation of surcharges in 2006 dollars

Determination of L, E and B

These ratios are determined using the information supplied in the most recently published NUREG-1307, Report on Waste Burial Charges, Revision 15, January 2013 and by using the most recent U.S. Department of Labor-Bureau of Labor Statistics (BLS) data.

Labor adjustment factor

The Employment Cost Index (ECI) is taken from Table 5 of current BLS data entitled "Employment Cost Index for total compensation, for private industry workers, by occupational group and industry" under the sub-occupational heading of "All workers." The base L_x is taken from Table 3.2, Regional Factors for Labor Cost Adjustment in NUREG-1307 referenced above.

L_{2015} = [(ECI, December 2015)*(Base L_x)]/100
= [124.5*2.06]/100

L_{2006} = [(ECI, 2006)*(Base L_x)]/100
= [100.8*2.06]/100

To take into account only the inflation from 2006 to 2015, you must divide L_{2015} by L_{2006}, giving simply the labor adjustment factor L_x:

$L_x = L_{2015}/L_{2006}$
$= ([124.5*2.06]/100 \div [100.8*2.06]/100)$
$= 124.5/100.8$
$L_x = 1.235119...$

Energy adjustment Factor

The adjustment factor for energy, Ex, is a weighted average of two components, namely, industrial electrical power, P_x, and light fuel oil, F_x.

For the reference PWR: $E_x(PWR) = 0.58\ P_x + 0.42\ F_x$
For the reference BWR: $E_x(BWR) = 0.54\ P_x + 0.46\ F_x$

P_x and F_x are the ratios of the current Producer Price Indexes (PPI) divided by the corresponding indexes for 2012.

P_x = 199.8 (average 2012 value for code 0543)/172.9 (average 2006 value for code 0543) = 1.16

F_x = 329.8 (average 2012 value for code 0573)/212.0 (average 2006 value for code 0573) = 1.56

Therefore:

$E_x(PWR) = 0.58*1.09 + 0.42*1.07 = 1.328$

$E_x(BWR) = 0.54*1.09 + 0.46*1.07 = 1.344$

E_x for the GSTR is calculated as an average of E_x(PWR) and E_x(BWR), therefore

$E_x(average) = 1.336$

Because the factors P_x and F_x are already corrected to include only inflation from 2006 to 2010, call E_x(average) simply E_x, therefore:

$E_x = 1.336$

Waste Burial Adjustment Factor

The adjustment factor for waste burial/treatment, Bx, is taken directly from Table 2-1 of NUREG-1307, Bx Values for Generic LLW Disposal Sites, Direct Disposal with Vendor. For facilities that have no disposal site available for LLW, the NUREG assumes the cost of disposal is the same as that provided for the Atlantic Compact, for lack of a better alternative at this time. Data for 2012 is the most current at this time and will be assumed to approximate 2015 data.

$B_{2012}(PWR) = 13.885$
$B_{2012}(BWR) = 14.160$

$B_{2006}(PWR) = 8.600$
$B_{2006}(BWR) = 9.345$

Bx for GSTR is calculated as an average of B_x(PWR) and B_x(BWR) and therefore:

$B_{2012}(average) = 14.0225$
$B_{2006}(average) = 8.973$

To account for only the inflation from 2006 to present, you must divide B_{2012}(average) by B_{2006}(average), giving simply the waste burial adjustment factor B_x:

$B_x = B_{2012}(average)/ B_{2006}(average)$
$= 1.563$

Adjusted Decommissioning Cost Estimate

Estimated Cost (in 2015 $)
= [Cost in 2006 $]*[A L_x + B E_x + C B_x]
= [$ 3,712,872]*[0.65*1.235119... + 0.13*1.336 + 0.22*1.563]
= $ 4,902,355 (this includes the 25% contingency)

Attachment 5: Financial assurance statement from the USGS Director

U.S. Geological Survey Statement of Intent
Required To Renew the
U.S. Geological Survey TRIGA Reactor License No. R-113; Docket No. 50-274

Pursuant to 10 Code of Federal Regulations 50.75(e)(1)(iv), the U.S. Geological Survey (USGS) is providing this "Statement of Intent" in support of the USGS request to renew TRIGA Reactor License No. R-113a. The TRIGA Reactor is located at the Denver Federal Center in Lakewood, Colorado.

The USGS is a bureau of the U.S. Department of the Interior (DOI) which is a Federal agency of the United States Government. The USGS was established by the Organic Act of March 3, 1879, as amended (43 U.S.C. 31 et seq.). The USGS receives a Federal appropriation each year to fund the bureau's programs. The current USGS Federal appropriation is provided through the "Department of the Interior, Consolidated Appropriations Act, 2016" (Public Law No. 114-113). Federal appropriations provide the authority to Federal agencies to incur obligations and to make payment from the U.S Treasury for purposes specified in the appropriations (31 U.S.C. 701(2) and the Federal Appropriations Law Manual, Volume 1, Chapter 2, A.2.a, pages 2-5).

Should the USGS effect a decision to decommission the USGS TRIGA Reactor, the USGS would include in its annual Budget Justification a request for Federal appropriated funds to decommission the USGS TRIGA Reactor. Based on the current cost estimate in 2015 dollars, the amount requested for the decommissioning would be $4.9 million. This amount would be requested sufficiently in advance of decommissioning to prevent delay of required activities.

The authority of the USGS Director to enter into binding obligations on behalf of the USGS is provided by the DOI Departmental Manual (DM) Chapters 220 DM 10 - General Administrative Delegation, and 205 DM 6 - General Delegations-Budget and Financial Management.

Suzette M Kimball

Suzette M. Kimball
Director
U.S. Geological Survey

3/24/2016
Date

Attachment 6: Interagency Agreement between USGS and DOE

UNITED STATES DEPARTMENT OF ENERGY

INTERAGENCY AGREEMENT FOR ENRICHED URANIUM

[redacted]

Geological Survey Int

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