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US Geological Survey
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Denver CO, 80225

November 17, 2015

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

Subj: Response to RAI dated September 21, 2015, regarding R-113 license amendment request (TAC No. ME9424)

Gentlemen:

The attached pages are additional information submitted in response to your Request for Additional Information dated September 21, 2015. Please contact me if you need additional information.

Sincerely,

Tim DeBey
USGS Reactor Supervisor

I declare under penalty of perjury that the foregoing is true and correct.
Executed on 11/17/2015

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

A020
NRR

Response to RAI dated September 21, 2015 concerning a license amendment to the USGS R-113 research reactor license (TAC No. ME9424)

Request:

2. Your response to RAI No. 2, by letter dated August 28, 2015, provided a proposed TS definition of License Area: Rooms 149-152, 154, 157, 158, B10, B10B, B11 of Building 15, and Room 2 of Building 10. NUREG-1537, Part 1, Section 9.5, "Possession and Use of Byproduct, Source, and Special Nuclear Material," provides guidance that licensees should "clearly state the materials and areas of the facility requested to be authorized by the reactor license. The reactor license and technical specifications also will include regulatory conditions that apply to the management of such materials." Provide a justification for the proposed TS definition that you provided in your response to RAI No. 2, a markup of the proposed change in the current USGS TSs, and copy of the proposed TS, or justify why this information is not needed.

Response: The markup of the proposed change to current USGS TS, and copy of the proposed TS, was absent from the initial RAI response, so that is provided in this response.

The proposed TS change is the reformatting of page 2 and the addition of Item 7a to the Specifications, as follows:

7a. Licensed Area

The licensed area shall be the following areas on the Denver Federal Center:

Building 15, rooms 149 through 152 and room 154

Building 15, rooms 157 and 158

Building 15, rooms B10, B10B, and B11

Building 10, room 2

APPENDIX A

TECHNICAL SPECIFICATIONS FOR THE

U.S. GEOLOGICAL SURVEY TRIGA REACTOR

DOCKET NO. 50-274

The dimensions, measurements, and other numerical values given in these specifications may differ from measured values owing to normal construction and manufacturing tolerances, or normal accuracy of instrumentation.

A. Definitions

1. Shutdown

The reactor, with fixed experiments in place, shall be considered to be shutdown (not in operation) whenever all of the following conditions have been met: a) the console key switch is in the "off" position and the key is removed from the console and under the control of a licensed operator (or stored in a locked storage area); b) sufficient control rods are inserted so as to assure the reactor is subcritical by a margin greater than 0.7% delta k/k cold, without xenon; c) no work is in progress involving fuel handling or refueling operations or maintenance of the control mechanisms.

2. Steady State Mode (SS)

Steady state mode shall mean operation of the reactor at power levels not to exceed 1 megawatt utilizing the scrams in Table I and the interlocks in Table II.

3. Pulse Mode

Pulse mode shall mean operation requiring the use of the scrams in Table I and the interlocks in Table II to assure that no more than one rod is pneumatically withdrawn to produce power pulses.

4. Square Wave Mode (SW)

Square wave mode shall mean operation of the reactor with the mode selector switch in the square-wave position requiring use of the scrams in Table I and the interlocks in Table II.

5. Operable

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

6. Experiment

Experiment shall mean: (a) any apparatus, device, or material installed in the core or experimental facilities (except for underwater lights, fuel element storage racks and the like) which is not a normal part of these facilities or (b) any operation to measure reactor parameters or characteristics.

7. Experimental Facilities

Experimental facilities shall mean the rotary specimen rack, vertical tubes, pneumatic transfer system, central thimble, and in-pool irradiation facilities.

7a. **Licensed Area**

The licensed area shall be the following areas on the Denver Federal Center:

Building 15, rooms 149 through 152 and room 154

Building 15, rooms 157 and 158

Building 15, rooms B10, B10B, and B11

Building 10, room 2

8. Reactor Safety Systems

Reactor safety systems shall mean those systems, including their associated input circuits, which are designed to initiate a reactor scram.

9. Standard Thermocouple Fuel Element

A standard thermocouple fuel element shall contain thermocouples imbedded in the fuel halfway to the vertical centerline at the midplane of the fuel section and one inch above and below the midplane.

B. Reactor Building

1. The reactor shall be housed in a closed room designed to restrict leakage. The minimum free volume in the reactor room shall be 3.1×10^8 cubic centimeters.

2. All air or other gas exhausted from the reactor room and from associated experimental facilities during reactor operation shall be released to the environment at a minimum of 21 feet above ground level.

3. The concentration of argon 41 in the reactor building stack effluent air shall be limited to a maximum of 4.8×10^{-6} uCi/ml averaged over a year.

4. The stack effluent air shall be analyzed quarterly to determine the isotopic composition of the radionuclides emitted. The limit of B.3 above shall apply only to argon 41; limits on concentrations for other radionuclides shall be as specified in 10 CFR Part 20.

C. Reactor Pool and Bridge

The reactor shall not be operated if the pool water level is less than 16 feet above the top grid plate. The bulk pool temperature shall be monitored while the reactor is in operation and the reactor shall be shut down if the temperature exceeds 60°C. The reactor core shall be cooled by natural convective water flow.

2. The pool water shall be sampled for conductivity at least weekly. Conductivity averaged over a month shall not exceed 5 micromhos per cm^2. This item is not applicable if the reactor is completely defueled and the pool level is below the water treatment system intake.

3. The control console shall have an audible and visual water level alarm that will actuate when the reactor tank water level is between 12 and 24 inches below the top lip of the tank. This water level alarm shall be functionally tested monthly, not to exceed 45 days between tests. This item is not applicable if the reactor is completely defueled and the pool level is below the water treatment system intake.

4. The pool water shall be sampled for pH at quarterly intervals, not to exceed 4 months. The pH level shall be within the range of 4.5 to 7.5 for continued operation. This item is not applicable if the reactor is completely defueled and the pool level is below the water treatment system intake.

D. Reactor Core

1. The core shall be an assembly of TRIGA aluminum or stainless steel clad fuel-moderator elements, nominally 8.0 to 12 wt% uranium, arranged in a close-packed array except for (1) replacement of single individual elements with incore irradiation facilities or control rods; (2) two separated experiment positions in the D through E rings, each occupying a maximum of three fuel element positions. The reflector (excluding experiments and experimental facilities) shall be water or a combination of graphite and water. The reactor shall not be operated in any manner that would cause any stainless-steel clad fuel element to produce a calculated steady state power level in excess of 22 kW. Aluminum clad fuel-moderator elements will only be allowed in the F and G rings of the core assembly.

2. The excess reactivity above cold critical, without xenon, shall not exceed 4.9% delta k/k with experiments in place.

3. Fuel temperatures near the core midplane in either the B or C ring of elements shall be continuously recorded during the pulse mode of operation using a standard thermocouple fuel element. The thermocouple element shall be of 12 wt% uranium loading if any 12 wt% loaded elements exist in the core. The reactor shall not be operated in a manner which would cause the measured fuel temperature to exceed 735°C in a stainless steel clad element in the B ring or 652°C in a stainless steel clad element in the C ring.

4. Power levels during pulse mode operation that exceed 2500 megawatts shall be cause for the reactor to the shut down pending an

investigation by the reactor supervisor to determine the reason for the pulse magnitude. His evaluation and conclusions as to the reason for the pulse magnitude shall be submitted to the Reactor Operations Committee for review. Pulse mode operation will not be resumed until approved by the Committee.

5. If the reactor is operated in the pulse mode during intervals of less than six months, the reactor shall be pulsed semiannually with a reactivity insertion of at least 1.5% delta k/k to compare fuel temperature measurements and peak power levels with those of previous pulses of the same reactivity value. If the reactor is not pulsed during intervals of six months, then for the first pulse after the time of the last comparative pulse, the reactor shall be pulsed with a reactivity insertion of at least 1.5% delta k/k to compare fuel temperature measurements and peak power levels with those of previous pulses of the same reactivity value.

6. Each standard fuel element shall be checked for transverse bend and longitudinal elongation after the first 100 pulses of any magnitude and after every 500 pulses or every 60 months, whichever comes first. During the first 5 years of aluminum-clad fuel usage, annual fuel transverse bend and longitudinal elongation measurements will be made on 20% of the aluminum-clad fuel elements that have been in the core at any time during that year. The measurement schedule will be controlled such that different fuel elements are measured each year for this initial 5-year period. After this initial 5 years of aluminum-clad fuel usage, if no generic problems have been detected, the inspection schedule will revert back to the standard fuel 60-month schedule.

   The limit of transverse bend shall be 1/16-inch over the total length of the clad portion of the element (excluding end fittings). The limit on longitudinal elongation shall be 1/10 inch for stainless steel clad elements and ½-inch for aluminum clad elements. The reactor shall not be operated in the pulse mode with elements installed which have been found to exceed these limits.

Any element which exhibits a clad break as indicated by a measurable release of fission products shall be located and removed from service before continuation of routine operation. Fuel elements that have been removed from service do not need to be checked for transverse bend or longitudinal elongation.

7. Observance of the license and technical specification limits for the GSTR will limit the thermal power produced by any single fuel element to less than 22 kW if the reactor has at least 100 fuel elements in the core. Therefore the reactor must have at least 100 fuel elements in the core if it is to be operated above 100 kW. Operations with less than 100 fuel elements in the core will be restricted to a maximum thermal power of 100 kW.

E. Control and Safety Systems

1. The standard control rods shall have scram capability and the poison section shall contain borated graphite, or boron and its compounds in solid form as a poison in an aluminum or stainless steel clad.

2. The control rods shall be visually inspected at least once every two years. If indication of significant distortion or deterioration is found, the rod(s) will be replaced.

3. Only one pulsing control rod may be used in the core. The poison section of this rod shall contain borated graphite or boron and its compounds in a solid form as a poison in an aluminum or stainless steel clad. The pulse rod shall be designed to release and fall upon initiation of a scram signal. The maximum reactivity worth of the rod fully inserted by the drive in relation to fully withdrawn shall be equal to or less than 2.9% delta k/k.

4. A pulse may be initiated only when the reactor is at power less than 1 kW. Pulsed reactivity insertion shall not exceed 2.1% delta k/k.

5. The minimum shutdown margin (with fixed experiments in place) provided by operable control rods (including the pulse rod) in the cold clean condition, with the most reactivity of the operable control rods fully withdrawn, shall be 0.4% delta k/k.

6. The maximum rate of reactivity insertion associated with movement of a standard rod shall be no greater than 0.2% delta k/k/sec.

7. The type and minimum number of safety systems which shall be operable for reactor operation are shown in Table I.

8. The type and minimum number of interlocks which shall be operable for reactor operation are shown in Table II.

9. The reactor instrumentation channels and safety systems for the intended modes of operation as listed in Table I shall be verified to be operable at least once each day the reactor is operated unless the operation extends continuously beyond one day, in which case the operability need only be verified prior to beginning the extended operation.

10. A licensed reactor operator shall be present during maintenance of the reactor control and safety systems.

11. Following maintenance or modification of the control or safety systems, the associated system shall be verified to be operable before the reactor is placed in operation.

12. The conditions listed below shall be verified at least once semi-annually, with the exception that if the reactor is operating continuously, the conditions shall be verified after the first shutdown that occurs more than six months after the previous tests. Those items marked with an * are not applicable if the reactor is completely defueled, but they must be verified upon startup if more than six months have passed after the previous tests.

    a. *All reactor interlocks are operable.

    b. *Control element drop times are less than one second (two seconds for pulse rod). If drop time is found to be greater than this, the rod shall not be considered operable.

    c. *Power level safety circuits are operable. The circuits will be tested by the introduction of an electrical signal into the circuit at a point between the detector and the control system.

d. Ventilation system interlocks are operable.

e. *The safety channels indicate the actual power level as determined by a thermal power measurement.

13. On each day that pulse mode operation of the reactor is planned, a functional performance check of the transient (pulse) rod system shall be performed. Semi-annually, at intervals not to exceed eight months, the transient (pulse) rod drive cylinder and the associated air supply system shall be inspected, cleaned and lubricated as necessary.

F. Radiation Monitoring

1. The radiation levels within the reactor laboratory shall be monitored by at least one area radiation monitor during reactor operation or when work is done on or around the reactor core or experimental facilities. The monitor shall have a readout and provide a signal which actuates an audible alarm. During short periods of repair to this monitor, reactor operations may continue while a portable gamma-sensitive ion chamber is utilized as a temporary substitute.

2. A continuous air monitor with readout and audible alarm shall be operable in the reactor room when the reactor is operating.

3. The alarm set points for the above radiation monitoring instrumentation shall be verified at least once a week. This instrumentation shall be calibrated at least once a year.

G. Fuel Storage

1. All fuel elements or fueled devices shall be rigidly supported during storage in a safe geometry (k_{eff} less than 0.8 under all conditions of moderation).

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

H. Administrative Requirements

1. The facility shall be under the direct control of the Reactor Supervisor. He shall be responsible to the Reactor Administrator for safe operation and maintenance of the reactor and its associated equipment. He or his appointee shall review and approve all experiments and experimental procedures prior to their use in the reactor. He shall enforce rules for the protection of personnel against radiation.

2. A Reactor Operations Committee shall review and approve safety standards associated with the operation and use of the facility. Its jurisdiction shall include all nuclear operations in the facility. The Committee shall meet to monitor reactor operations at least semi-annually.

   The Reactor Operations Committee shall be composed of at least four members, appointed by the Director, U.S. Geological Survey, and who shall be knowledgeable in field relating to nuclear safety. The Reactor Supervisor and a qualified health physicist shall be members of the Committee. The Committee shall be responsible for determining whether a proposed change, test, or experiment would constitute a change in technical specifications or an unreviewed safety question as defined in 10 CFR Part 50. The Committee shall establish written procedures concerning its activities, quorums, review of experiments and procedures, and other aspects as appropriate.

3. Written instructions shall be in effect and followed for:

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

   b. Reactor startup, routine operation and reactor shutdown.

   c. Emergency and abnormal conditions, including evacuation, reentry and recovery.

   d. Fuel loading or unloading.

   e. Control rod removal and replacement.

   f. Maintenance operations which may affect reactor safety.

4. Any additions, modifications, or maintenance to the core and its associated support structure, the pool structure, and rod drive mechanisms, or the reactor safety system, shall be made and tested in accordance with the specifications to which the systems or components were originally designed and fabricated, or to specifications approved by the Reactor Operations Committee as suitable and not involving an unreviewed safety question. The reactor shall not be placed in operation until the affected system has been verified to be operable.

5. The reactor facility emergency plan, emergency procedures and physical security plan shall be audited by the Reactor Operations Committee biennially, with the interval not to exceed 30 months.

I. Experiments

1. Prior to performing any new reactor experiment, the proposed experiment shall be evaluated by a person or persons appointed by the Reactor Administrator to be responsible for reactor safety. He shall consider the experiment in terms of its effect on reactor operation

and the possibility and consequences of its failure, including, where significant, consideration of chemical reactions, physical integrity, design life, proper cooling, interaction with core components, and reactivity effects. He shall determine whether, in his judgement, the experiment by virtue of its nature or design does not constitute a significant threat to the integrity of the core or to the safety of personnel. Following a favorable evaluation and prior to conducting an experiment, he shall sign an authorization form containing the basis for the favorable evaluation.

2. A favorable evaluation of an experiment shall conclude that failure of the experiment will not lead to a direct failure of a fuel element or of other experiments.

3. No new experiment shall be performed until the proposed experimental procedures for that experiment or type of experiment have been reviewed and approved by the Operations Committee.

4. The following limitations on reactivity shall apply to all experiments:

   a. The reactivity worth of any individual in-core experiment shall not exceed $3.00.

   b. The total, absolute, reactivity worth of in-core experiments shall not exceed $5.00. This includes the potential reactivity which might result from experimental malfunction, experiment flooding or voiding, and removal or insertion of experiments.

c. Experiments having reactivity worths greater than $1.00 shall be securely located or fastened to prevent inadvertent movement during reactor operation.

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

6. Explosive materials such as (but not limited to) gun powder, dynamite, TNT, nitro-glycerine, or PETN in quantities greater than 25 milligrams shall not be irradiated in the reactor or experimental facilities without out-of-core tests which shall indicate that with the containment provided no damage to the reactor or its components shall occur upon detonation of the explosive. Explosive materials in quantities less than 25 milligrams may be irradiated without out-of-core tests provided that the pressure produced in the experiment container upon detonation of the explosive shall be shown to be less than the design pressure of the container.

7. Experiment materials, except fuel materials, which could off-gas, sublime, volatize or produce aerosols under (a) normal operating conditions of the experiment or reactor, (b) credible accident conditions in the reactor or (c) possible accident conditions in the experiment shall be limited in activity such that if 100%

of the gaseous activity or radioactive aerosols produced escaped to the reactor room or the atmosphere, the airborne concentration of radioactivity averaged over a year would not exceed the limits of Appendix B of 10 CFR Part 20.

8. In evaluating experiments, the following assumptions shall be used:

   a. If the effluent from an experiment facility exhaust hrough a filter installation designed for greater than 99% efficiency for 0.3 micron particles, the assumption shall be used that at least 10% of the aerosols produced can escape.

   b. For materials whose boiling point is above 130oF and where vapors formed by boiling this material could escape only through an undisturbed column of water above the core, the assumption shall be used that at least 10% of these vapors can escape.

9. Each fueled experiment shall be controlled such that the total inventory of iodine isotopes 131 through 135 in the experiment is no greater than 1.5 curies and the maximum strontium-90 inventory is no greater than 5 millicuries.

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

any corrective action taken shall be reviewed by the Reactor Operations Committee and determined to be satisfactory before operation of the reactor is resumed.

TABLE I

MINIMUM REACTOR SAFETY SYSTEMS

Originating Channel	Setpoint	Mode in which effective SS	Pulse	SW
1. Safety Channel 1	110% of full power	X		X
2. Safety Channel 2	110% of full power	X		X
3. Scram button	Manual push	X	X	X
4. Preset timer	Less than or equal to 15 seconds		X	
5. CSC watchdog timer	Loss of refresh signal	X	X	X
6. DAC watchdog timer	Loss of refresh signal	X	X	X

TABLE II

MINIMUM INTERLOCKS

Action Prevented	Mode in which effective SS	Pulse	SW
1. Control rod withdrawal with neutron level less than 10^{-7}% power on the digital power channel.	X		
2. Simultaneous manual withdrawal of two control rods, including the pulse rod.	X		
3. Simultaneous manual withdrawal of two control rods excluding the pulse rod.			X
4. Initiation of pulse above 1 kW.		X	
5. Application of air pressure to pulse rod drive mechanism unless cylinder is fully inserted.	X		
6. Withdrawal of any control rod except pulse rod.		X	