PROPOSED REPLACEMENT PAGES

for

AMMENDMENT NO. 1

to the

OMAHA DEPARTMENT OF VETERANS AFFAIRS

TRIGA REACTOR

TECHNICAL SPECIFICATIONS

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Proposed New Pages

Amendment No. 1, Omaha DVA TRIGA Reactor

Technical Specifications

The revised pages contain vertical lines indicating the areas of change

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Regulating Rod

The regulating rod is a low worth control rod that need not have scram capability. Its position may be varied manually or by the servo-controller.

Reportable Occurrence

A reportable occurrence is any of the conditions described in Section 6.9.2 of these specifications.

Safety Channel

A safety channel is a measuring channel in the reactor safety system.

Safety Limit

Safety limits are limits on important process variables, which are found to be necessary to reasonably protect the integrity of certain of the physical barriers that guard against the uncontrolled release of radioactivity.

Shim-Safety Rod

A shim-safety rod is a control rod having an electric motor drive and scram capabilities.

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, starting from any permissible operating conditions, and that the reactor will remain subcritical without further operator action.

Steady-State Mode

Operation in the steady-state mode shall mean operation of the reactor at power levels not to exceed 20 kW using the safety systems and the interlocks referenced in Table 3.1 on page 7 of these specifications.

2.0 SAFETY LIMIT

2.1 Safety Limit - Fuel Element Temperature

Applicability: This specification applies to the temperature of 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 will result.

Specificatons:

(1) Because operation at 20 kW steady state results in a very small temperature increase, the fuel temperature does not have to be monitored and consequently there are no instrumented fuel elements.

(2) The bulk pool temperature shall be monitored while the reactor is in operation and the reactor shall be shut down if the temperature exceeds 35°C.

Bases:

The important parameter for a TRIGA reactor is the fuel element temperature. A loss in the integrity of the fuel element cladding could arise from a buildup 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.

Gulf General Atomic has made a great many theoretical and experimental determinations and has concluded that the safety limit on fuel temperature occurring in the pulse mode of operation is 1,150°C ($U\text{-}ZrH_{1.6}$ fuel clad in 304 SS). For $U\text{-}ZrH_{1.0}$ clad in aluminum, the fuel temperature safety limit is 900°C, which will not produce a stress equivalent to the ultimate strength of the aluminum cladding at its temperature. However, the practical limit for operation with the low hydride fuel is the temperature at which the fuel undergoes a phase transformation which is 550°C. The heat transfer parameters for 250 kW operation are as follows: exit coolant temperature 45.5°C, maximum fuel temperature 297°C , average fuel temperature 184°C. Thus, because the Omaha TRIGA reactor operates at only 20 kW, the limit of 35°C on the bulk pool temperature will ensure that the fuel is well below the safety limit.

Under normal operating conditions, if the reactor were operated at a power level of 10 kW, even with the water-cooling system turned off, the average temperature of the approximately 4,000 gal of water in the core tank would be increased at a rate of less than 0.635°C /hour.

3.0 LIMITING CONDITIONS FOR OPERATION

3.1 Steady-State Operation

Applicability: This specification applies to the energy generated in the reactor during steady-state operation.

Objective: The objective is to ensure that the operation of the reactor does not exceed the licensed power.

Specifications: The reactor power level shall not exceed 20 kW under any condition of operation.

3.2 Reactivity Limitations

Applicability: These specifications apply to the reactivity conditions of the reactor and the reactivity worths of control rods and experiments.

Objectives: The objectives are to ensure that the reactor can be shut down at all times and that the safety limit will not be exceeded.

Specifications:

(1) Shutdown Margin

The reactor shall not be operated unless the shutdown margin provided by control rods shall be greater than 0.51$ with:

(a) the highest worth nonsecured experiment in its most reactive state
(b) the highest worth control rod fully withdrawn
(c) the reactor in the cold critical condition without xenon

(2) Excess Reactivity

Specification: The maximum available excess reactivity with secured experiments in place and referred to the cold, xenon-free condition shall be limited to 1.00$.

Bases:

(1) The value of the shutdown margin ensures that the reactor can be shut down from any operating condition even if the highest worth control rod should remain in the fully withdrawn position.

(2) The limit of 1.00$ on excess reactivity is to allow for operational flexibility, including the use of neutron-absorbing experiments, and to ensure that the operational reactor core is reasonably similar to the reactor core analyzed in the SAR. In general, the excess reactivity is limited by the shutdown margin requirement.

3.3 Control and Safety System

3.3.1 Scram Time

Applicability: This specification applies to the time required for the scrammable control rods to be fully inserted from the instant that a safety channel variable reaches the safety system setting.

Objective: The objective is to achieve prompt shutdown of the reactor to prevent fuel damage.

Specification: The maximum scram time for any fully withdrawn rod shall be 2 sec from the time of initiation of scram signal to full insertion of the rod.

Basis: Because the prompt negative temperature coefficient of the reactor limits the reactor power, the safety of the reactor system is not dependent on the rapid insertion of control rods. As indicated on page 48 of the "Application for Contruction Permit and Utilization Facility License" dated March 24, 1959, a rapid insertion of as much as 2$ of excess reactivity would terminate with no safety problem even without backup insertion of control rods.

3.3.2 Reactor Control System

Applicability: This specification applies to the information which must be available to the reactor operator during reactor operation.

Objective: The objective is to require that sufficient information is available to the operator to ensure safe operation of the reactor.

Specification: The reactor shall not be operated unless the percent power and either the linear power level or the log N and period channel is operable.

3.3.3 Reactor Safety System

Applicability: The specification applies to the reactor safety system channels.

Objective: The objective is to specify the minimum number of reactor safety system channels that must be operable for safe operation.

Table 3.1 Minimum reactor safety channels

Safety channel	Function	Set Point
Percent power	Scram	Licensed power
Linear power level	Scram	Licensed power
Log N and period	Scram	Minimum period of 7 seconds
Startup	Prevents withdrawal of all control rods	Minimum of 10 counts per second
Console scram button	Scram	Manual
Ion chamber power supply	Scram	Failure of power supply
Magnet current key switch	Scram	Manual
Simultaneous manual withdrawal of two rods*	Prevents withdrawal	....
Withdrawal of shim or regulating rod with safety rod not all the way out or seated*	Prevents withdrawal	....
Withdrawal of safety rod with shim or regulating rod not seated*	Prevents withdrawal	....
Pool level	....	Alarm when water level is less than 12 ft above top of core
Pool water temperature	Meter indication	35°C

*May be defeated for control rod calibration.

Specification: The reactor shall not be operated unless the safety channels and interlocks described in Table 3.1 are operable. However, the failure of a single scram to function from Items 2 or 3 of Table 3.1, is not to be considered a violation in the sense of this paragraph.

Bases: The redundancy of scrams provides protection from single-system failure and human error. The interlocks and scrams indicated in Table 3.1 minimize the probability of an accident greater than analyzed in the Safety Analysis Report. The power level scrams provide protection to ensure that the reactor can be shut down before the licensed power level is exceeded. The manual scram allows the operator to shut down the system if an unsafe or abnormal condition occurs. In the event of failure of the power supply for the safety chambers, operation of the reactor without adequate instrumentation is prevented.

The interlock to prevent startup of the reactor when the channel measures less than 10 counts per second ensures that sufficient neutrons are available for proper startup. The pool level alarm is intended to alert the operator, or the switchboard operator during unmanned hours, of any significant decrease in pool level.

3.4 Radiation Monitoring System

Applicability: This specification applies to the radiation monitoring information that must be available to the reactor operator during reactor operation.

Objective: The objective is to ensure that sufficient radiation monitoring information is available to the operator to ensure safe operation of the reactor.

Specification: The reactor shall not be operated unless the radiation monitoring channels listed in Table 3.2 are operable.

Table 3.2 Required instrumentation

Radiation monitoring channels*	Function	Number
Area radiation monitor	Monitor radiation levels within the reactor room	1
Continuous air radiation monitor	Monitor radiation levels within the reactor room	1

*For periods of time for maintenance to the radiation monitoring channels, the intent of this specification will be satisfied if they are replaced with portable gamma-sensitive instruments having their own alarms or which shall be kept under visual observation.

5.5 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 that is being stored will not become critical and will not reach an unsafe temperature.

Specifications:

(1) All fuel elements shall be stored in a geometrical array where the k-effective is less than 0.8 for all conditions of moderation.

(2) Irradiated fuel elements and fueled devices shall be stored in an array that will permit sufficient natural convection cooling by water or air so that the fuel element or fueled device temperature will not exceed design safety limits.

Bases: The limits imposed by Specifications 5.5(1) and 5.5(2) are conservative and ensure safe storage.

5.6 Reactor Room and Ventilation System

Applicability: This specification applies to the room which houses the reactor.

Objective: The objective is to ensure that provisions are made to restrict the amount of release of radioactivity into the environment.

Specifications:

(1) The reactor shall be housed in a room in the basement of the Omaha Veterans Administration Medical Center. The room shall be considered a restricted area with locked doors and entrance controlled by reactor laboratory personnel. The minimum free volume in the reactor area shall be 23,000 ft^3.

(2) An exhaust fan will normally be in operation when the reactor room is occupied so as to exhaust room air into the outside atmosphere and keep the room at a slightly negative pressure with respect to the rest of the building.

(3) An emergency shutdown control is located on the reactor console and allows the operator to shut off both the exhaust fan and the incoming air in the case of an emergency.

Bases: The facility is designed such that the ventilation system will normally maintain a negative pressure with respect to the rest of the building. As shown in Chapter 2, paragraphs 2.2.1.3 and 2.2.3.2 of the application for Renewal License, argon-41 generated at 20 kW operation is well below the MPC for unrestricted areas for release to the atmosphere. As specified in Section 3.6(6) of these specifications, experiment materials that could off-gas, sublime, volatilize, or produce aerosols are 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 limit of Appendix B to 10 CFR 20. Thus, even if an experiment failed, the unrestricted concentration would be well below the limits specified in 10 CFR 20, Appendix B.

In case of an emergency, however, the reactor operator (RO) can shut down the ventilation system isolating the reactor room from the rest of the building.

5.7 Reactor Pool Water Systems

Applicability: This specification applies to the pool containing the reactor and to the cooling of the core by the pool 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 pool water level shall be monitored and shall be at least 16 ft above the top grid plate.

(3) A pool level alarm shall indicate loss of coolant if the pool level drops to less than 12 ft above the top of the core.

(4) The pool water outlet pipe shall extend no more than 3 ft below the top of the pool.

Bases: This specification is based on thermal and hydraulic calculations which show that TRIGA core consisting of aluminum-clad $UZrH_{1.0}$ fuel elements can operate in a safe manner at power levels up to 500 kW with natural convection. This allows normal safe operation for the reactor at its licensed power of 20 kW.

Loss-of-coolant alarm when the level drops so that less than 12 ft of coolant are above the core allows corrective action to be taken. This alarm is observed on the reactor console and at the hospital switchboard.

By limiting the outlet pipe length the pool water could be lowered only by this amount if the external coolant piping were to rupture and siphon water from the reactor tank.