



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D. C. 20555

WASHINGTON STATE UNIVERSITY

DOCKET NO. 50-27

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 12  
License No. R-76

1. The Nuclear Regulatory Commission (the Commission) has found that:
  - A. The application for amendment to Facility Operating License No. R-76 filed by Washington State University (the licensee), dated September 6, 1989, as supplemented on November 21, 1989, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's regulations as set forth in 10 CFR Chapter I;
  - B. The facility will operate in conformity with the application, the provisions of the Act, and the regulations of the Commission;
  - C. There is reasonable assurance: (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations set forth in 10 CFR Chapter I;
  - D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public;
  - E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied; and
  - F. Prior notice of this amendment was not required by 10 CFR §2.105(a)(4) and publication of notice of this amendment is not required by 10 CFR §2.106(a)(2).

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2. Accordingly, the license is amended by changes to paragraph 2.C.(1) of Operating License No. R-76 which reads as follows:

(1) Maximum Power Level

The licensee is authorized to operate the facility at steady state power levels not in excess of 1000 kilowatts (thermal) and to pulse the reactor in accordance with the limitations in the Technical Specifications.

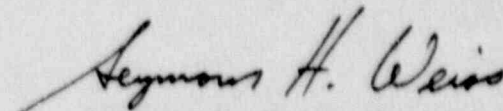
3. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the enclosure to this license amendment, and paragraph 2.C.(2) of Operating License No. R-76 is hereby amended to read as follows:

(2) Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 12, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

4. This license amendment is effective as of its date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION



Seymour H. Weiss, Director  
Non-Power Reactor, Decommissioning and  
Environmental Project Directorate  
Division of Reactor Projects - III,  
IV, V and Special Projects  
Office of Nuclear Reactor Regulation

Enclosure:  
Appendix A Technical  
Specifications Changes

Date of Issuance: January 23, 1990

ENCLOSURE TO LICENSE AMENDMENT NO. 12

FACILITY OPERATING LICENSE NO. R-76

DOCKET NO. 50-27

Replace the following pages of the Appendix A Technical Specifications with the enclosed pages. The revised pages are identified by Amendment number and contains vertical lines indicating the areas of change.

Remove

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Insert

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### 3.0 LIMITING CONDITIONS OF 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 fuel temperature safety limit will not be exceeded during steady-state operation.

Specifications: The reactor power level shall not exceed 1.3 MW under any condition of operation. The normal steady-state operating power level of the reactor shall be 1.0 MW. However, for purposes of testing and calibration, the reactor may be operated at higher power levels not to exceed 1.3 MW during the testing period.

Basis: Thermal and hydraulic calculations performed by the vendor indicate that TRIGA fuel may be safely operated up to power levels of at least 2.0 MW with natural convection cooling.

#### 3.2 Reactivity Limitations

Applicability: These specifications apply to the reactivity condition of the reactor and the reactivity worth of control elements and experiments. They apply for all modes of operation.

Objective: The objective is to ensure that the reactor can be shut down at all times and to ensure that the fuel temperature safety limit will not be exceeded.

Specifications: The reactor shall not be operated unless the shutdown margin provided by control elements shall be 0.25\$ or greater with:

- (1) the highest worth nonsecured experiment in its most reactive state
- (2) the highest worth control element and the regulating element (if not scrammable) fully withdrawn
- (3) the reactor in the cold critical condition without xenon

Basis: The value of the shutdown margin ensures that the reactor can be shut down from any operating condition even if the highest worth rod should remain in the fully withdrawn position. If the regulating rod is not scrammable, its worth is not used in determining the shutdown reactivity.

#### 3.3 Pulse Mode Operation

Applicability: This specification applies to the peak fuel temperature in the reactor as a result of a pulse insertion of reactivity.

Objective: The objective is to ensure that fuel element damage does not occur in any fuel rod during pulsing.

**Specification:** The maximum reactivity inserted during pulse mode operation shall be such that the peak fuel temperature in any fuel rod in the core does not exceed 830°C. The maximum safe allowable reactivity insertion shall be calculated annually for an existing core and prior to pulsing a new or modified core arrangement.

**Basis:** TRIGA fuel is fabricated with a nominal hydrogen to zirconium ratio of 1.6 for FLIP fuel and 1.65 for Standard. This yields delta phase zirconium hydride which has a high creep strength and undergoes no phase changes at temperatures over 1000°C. However, after extensive steady state operation at 1 Mw, the hydrogen will redistribute due to migration from the central high temperature regions of the fuel to the cooler outer regions. When the fuel is pulsed, the instantaneous temperature distribution is such that the highest values occur at the surface of the element and the lowest values occur at the center. The higher temperatures in the outer regions occur in fuel with a hydrogen to zirconium ratio that has now substantially increased above the nominal value. This produces hydrogen gas pressures considerably in excess of that expected for  $ZrH_{1.6}$ . If the pulse insertion is such that the temperature of the fuel exceeds 874°C, then the pressure will be sufficient to cause expansion of microscopic holes in the fuel that grow larger with each pulse. The expansion of the fuel stresses and distorts the fuel rod material which, in turn, can cause overall swelling and distortion of the cladding and entire fuel rod. The pulsing limit of 830°C is obtained by examining the equilibrium hydrogen pressure of zirconium hydride as a function of temperature. The decrease in temperature from 874°C to 830°C reduces hydrogen pressure by a factor of two, which provides an acceptable safety factor. This phenomenon does not alter the steady state safety limit since the total hydrogen in a fuel element does not change. Thus, the pressure exerted on the clad will not be significantly affected by the distribution of hydrogen within the element.

### 3.4 Maximum Excess Reactivity

Applicability: This specification applies to the maximum excess reactivity, above cold critical, which may be loaded into the reactor core at any time.

Objective: The objective is to ensure that the core analyzed in the safety analysis report approximates the operational core within reasonable limits.

Specification: The maximum reactivity in excess of cold, xenon-free critical: shall not exceed 5.6%  $\Delta k/k$  (8.00\$).

Basis: Although maintaining a minimum shutdown margin at all times ensures that the reactor can be shut down, that specification does not address the total reactivity available within the core. This specification, although over-constraining the reactor system, helps ensure that the licensee's operational power densities, fuel temperatures, and temperature peaks are maintained within the evaluated safety limits. The specified excess reactivity allows for power coefficients of reactivity, xenon poisoning, most experiments, and operational flexibility.

### 3.5 Core Configuration Limitation

Applicability: This specification applies to mixed cores of FLIP and standard types of fuel.

Objective: The objective is to ensure that the fuel temperature safety limit will not be exceeded as a result of power peaking effects in a mixed core.

#### Specifications:

- (1) The FLIP fueled region in a mixed core shall contain at least 22 FLIP fuel rods in a contiguous block of fuel in the central region of the reactor core. Water holes in the FLIP region shall be limited to nonadjacent single-rod holes.
- (2) The PTR as defined in Section 1.3 and as calculated by the method used in the FLIP conversion safety analysis report shall not exceed 1.5 for an operational core.