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Activation Analysis
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Nuclear Medicine
Reactor Engineering

December 1, 2004

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
Attn: Document Control Desk

Subject: Revision to Technical Specification 5.3, "Primary Coolant System"
Docket No. 50-20, License No. R-37

Gentlemen:

Enclosed is a requested change to the above referenced Technical Specification. The change would allow materials made of titanium alloys to be in contact with primary coolant.

Enclosed is a copy of the proposed wording of MITR Technical Specification No. 5.3 and its supporting safety analysis.

Your earliest attention to this request would be most appreciated.

Sincerely,

Thomas H. Newton, Jr.
Reactor Engineer
MIT Research Reactor

John A. Bernard
Director of Reactor Operations
MIT Research Reactor

I declare under penalty of perjury that the foregoing is true and correct.
Executed 1 Dec 04 (Date) _______ (Signature)

TN/gw

cc: USNRC - Senior Reactor Inspector,
Research and Test Reactors Section
New, Research and Test Reactors Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

USNRC - Senior Project Manager,
Research and Test Reactors Section as above

A020

5.3 Primary Coolant System

Applicability

This specification applies to the design of the primary coolant system.

Objective

To assure compatibility of the primary coolant system with the safety analysis.

Specification

The reactor coolant system shall consist of a reactor vessel, a single cooling loop containing three heat exchangers, and appropriate pumps and valves. All materials, including those of the reactor vessel, in contact with primary coolant (H_2O), shall be aluminum alloys stainless steel, or titanium alloys except small non-corrosive components such as gaskets, filters and valve diaphragms The reactor vessel shall be designed in accordance with the ASME Code for Unfired Pressure Vessels. It shall be designed for a working pressure of 24 psig and 150°F. Heat exchangers shall be designed for 75 psig and a temperature of 150°F. The connecting piping shall be designed to withstand a 60 psig hydro test.

Basis

The reactor coolant system has been described and analyzed in the Safety Analysis Report as a single loop system containing two heat exchangers. Additional analysis based on the use of three heat exchangers, has been described in the NRC staff's Safety Evaluation of Amendment No. 14 to these Technical Specifications. Materials of construction, being primarily stainless steel, are chemically compatible with the H_2O coolant. The stainless steel pumps are heavy-walled members in areas of low stress and should not be susceptible to chemical attack or stress corrosion failures. The failure of the gaskets and valve bellows, although undesirable, would not result in catastrophic failure of the primary system; hence, strict material limitations are not required for technical specifications The design, temperature, and pressure of the reactor vessel and other primary system components provide adequate margins over operating temperatures and pressures, and it is believed prudent to retain these margins in order to further reduce the probability o a primary system failure. The reactor vessel was designed to Section VIII, 1968 edition, of the ASME Code for Unfired Pressure Vessels. Subsequent design changes should be made in accordance with the most recent edition of this code.

Since the safety analysis is based on the reactor coolant system as presently designed and with the present margins, it is considered necessary to retain this design and these margins or to redo the analysis.

Safety Review #-M-04-3 Titanium Contact with Primary Coolant

Description of Change

Titanium will be used in the core tank and in the heat exchangers and hence be in contact with the primary coolant.

Tech. Spec. 5.3 must be modified to state: "All materials, including those of the reactor vessel, in contact with primary coolant (H_2O), shall be aluminum alloys, stainless steel, **or titanium alloys**, except small non-corrosive components such as gaskets, filters and valve diaphragms."

Safety Evaluation

1. The corrosion resistance of titanium is similar or superior to that of the stainless steels and aluminum that come in contact with 50°C primary coolant (de-ionized water), in the core tank.

   "Titanium and its alloys are fully resistant to water, all natural waters, and steam to temperatures in excess of 315°C (600°F)." (Ref. 1)

   "The immunity to attack of α alloys is observed regardless of oxygen level or in high-purity water, such as that normally used in nuclear reactor coolant systems." (Ref. 1)

2. Titanium placed in contact with dissimilar metals does not produce increased levels of galvanic corrosion.

   "In their normal passive condition, titanium alloys are most often the cathode when coupled to most common engineering alloys in service. As a result, galvanic corrosion of titanium is very rare, and occurs only under very unusual conditions." (Ref. 2)

   "Titanium, zirconium and tantalum are extremely noble because of their passive films. In general, these alloys are not susceptible to galvanic corrosion, and their ease of polarization tends to minimize adverse galvanic effects on other metals or alloys" (Ref. 3)

3. The activation of titanium is similar or superior to that of the stainless steels or aluminum that are subject to neutron irradiation.

   "If you compare the gamma dose rate estimations in R/h at one meter, titanium is 0.2, 6061 aluminum is 0.36, and 1018 steel is 0.85 when they are scaled to the same weight measurements. The only activation product that results from titanium is Sc-46. This has roughly the same gamma constant as Co-60 but its half life is 83.8 days." (Ref. 4)

Ref. 1

ASM International Handbook Committee. "Corrosion of Titanium and Titanium Alloys" ASM Metals Handbook. ASM International. Vol. 2. U.S.A. 1990. 676-677.

Ref. 2

ASM International Handbook Committee. "Corrosion of Titanium and Titanium Alloys" ASM Metals Handbook. ASM International. Vol. 2. U.S.A. 1990. 690.

Ref. 3

ASM International Handbook Committee. "General Corrosion" ASM Metals Handbook. ASM International. Vol. 2. U.S.A. 1990. 85.

Ref. 4

MIT NRL. "Safety Review #-0-86-9" MIT NRL., April, 1988.