UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D. C. 20555

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June 18, 1979

Honorable Victor Gilinsky
Commissioner
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: SUMMARY COMPA[illegible]SON OF STAINLESS STEEL AND ZIRCALOY FUEL ROD CLADDING

Dear Dr. Gilinsky:

This is in response to your memorandum of May 8, 1979 concerning the relative merits of stainless steel and zircaloy fuel rod cladding. The following discusses cladding performance of these two materials under both normal operating and accident conditions.

Early cladding development programs (1950's to mid-1960's) studied both stainless steel and zircaloy cladding extensively. Both materials have been used in power reactors. A consensus was eventually reached that zircaloy is the more desirable of the two materials, and by the mid-1960's, zircaloy was predominant. Safety aspects of both types of clad material were reviewed by the ACRS. Today, only two U.S. commercial nuclear power plants (Conn. Yankee - PWR, and LaCrosse - BWR) use stainless steel clad fuel rods.

There are primarily three factors which enter the comparison of the two materials for normal operation:

1. Stainless steel cladding is susceptible to stress corrosion cracking in a BWR environment during normal operation whereas zircaloy is not. Consequently, stainless steel clad rods experienced much higher defect levels in BWRs. For PWRs, stress corrosion cracking of this nature has not been a problem.

2. There is a large neutron economy advantage in the use of zircaloy as opposed to stainless steel because zircaloy has a much lower neutron capture cross-section. This translates into lower uranium ore and enrichment requirements.

3. Of the tritium generated in the fuel by fission, much more is chemically trapped by zircaloy than by stainless steel. Thus, use of zircaloy significantly reduces environmental releases of tritium and problems associated with this nuclide at nuclear power plants.

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In regard to accident conditions, as indicated in your memorandum, stainless steel has an advantage over zircaloy in releasing only approximately 16% as much heat on being oxidized by steam. However, during this reaction the two alloys will generate comparable amounts of hydrogen. Other properties that are important in accident sequences are rate of oxidation and melting temperature. The rate of oxidation is reasonably low for both materials up to about 1650°F. For temperatures between 1650°F and 2000°F, stainless steel has a somewhat lower rate. In the temperature range of most importance for accident conditions, greater than 2000°F, zircaloy has a slower rate of oxidation although this aspect is complicated by the higher heat of reaction. Also, zircaloy has a higher melting point (3360°F vs. 2550°F) than stainless steel.

For an accident such as occurred at TMI-2, there is no reason to believe stainless steel would have had any performance advantage over zircaloy.

Sincerely,

Max W. Carbon

Max W. Carbon
Chairman

cc: Chairman Hendrie
Commissioner Kennedy
Commissioner Bradford
Commissioner Ahearne
Office of the Secretary
ACRS Members

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