University of Pittsburgh

SCHOOL OF ENGINEERING
Department of Metallurgical and Materials Engineering

August 27, 1980

Mr. Bernard J. Snyder, Program Director
Three Mile Island Program Office
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Snyder:

I thank you for sending me a copy of NUREG-0683 entitled Draft Progromatic Environmental Impact Statement related to decontamination and disposal of radioactive wastes resulting from the March 28, 1979, accident at Three Mile Island Nuclear Station, Unit 2. I have read the report with great interest and concern since I have spent 25 years doing research on the chemical reactions of Zirconium and Zircaloy II and IV with oxygen, nitrogen, hydrogen and steam. These studies have shown me that great care must be used in handling zirconium and its alloys. The following are my comments and recommendations.

The authors of NUREG-0683 should be alerted to the possibility that zirconium hydrides $ZrH_{1.4}$ and $ZrH_{1.98}$ may exist in the damaged TMI-2 reactor core. According to section 7.1.1 entitled Status and Specific Considerations it is stated that "a large fraction of the fuel rods have ruptured, and there has been oxidation of Zircaloy in the core (about 50% of the total core inventory of Zircaloy, i.e. fuel cladding, control rod guide tubes, and instrument tubes, has oxidized)." No mention is made here or anywhere in NUREG-0683 that hydrides of zirconium may be formed.

Zircaloy may form hydrides especially under the temperatures of 2500°F which occurred in the accident and at the high pressures of hydrogen which exist in the early stages of the accident. Although oxide films may protect Zircaloy from the hydrogen reaction under normal reactor operating conditions, one must not assume that hydride formation does not occur under conditions of the accident at TMI-2. Here cracks, edges, and other defects offer easy access sites for hydrogen into the metal. With the formation of hydride, spalling of the hydride and oxide occurs. Rapid disintegration of the fuel rods results.

The presence of zirconium hydride in addition to highly cracked residual Zircaloy particles may change the procedures and techniques required for the removal of the damaged core materials and for the transportation and ultimate disposal. All debris from the reactor must at all times be kept under water to protect personnel and to prevent fires. Zirconium hydride, $ZrH_{1.4}$, reacts explosively when exposed to oxygen or air. Large quantities of heat are released to form one mole of ZrO_2 and 0.7 moles of H_2O. Breaking of casks of debris-containing zirconium hydride could result in dangerous fires, explosions and scattering of radioactive material.

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The author strongly recommends that the NRC staff re-examine the decontamination procedures of the TMI-2 reactor core.

Very truly yours,

Earl A. Gulbransen
Research Professor and
Professional Engineer

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