S-23

Aug. 18 1978

RES

Dr. Dade W. Moeller, Chairman
Advisory Committee on Reactor
Safeguards
Kresge Center for Environmental
Health
School of Public Health
Harvard University
Boston, Massachusetts

Dear Dr. Moeller:

SRI-5 - CONFIRMATORY PRESSURE VESSEL TEST UNDER PNEUMATIC LOADING

This letter is one of a series to transmit safety research information to you for any assistance it may provide the ACRS.

The HSST program staff at ORNL has successfully tested a flawed, 6-inch thick intermediate test vessel under a sustained pneumatic load. The test, designated as ITV-7A, was completed on June 18 at the Navy Surface Weapons Center, Dahlgren, Virginia. The primary objective of the test was to verify the analytical prediction of non-catastrophic vessel failure under a sustained pneumatic load. This test was conducted in answer to a request by the ACRS on March 8, 1971, to determine the mode and consequences of vessel failure under pneumatic loading conditions. A secondary objective was to evaluate residual stresses in the repair weld in the test vessel. The result of the experiment confirmed the pretest prediction that the sustained pneumatic pressure in the vessel behind the crack did not cause continuing extension of the crack; the test also revealed little if any deviation in strain measurements in the vessel repair weld during test.

For the ITV-7A test, the vessel was first pressurized to 1.1 x operating pressure and then depressurized to evaluate any effect of the simulated proof test pressure on the residual stresses in the repair weld. As noted above, the initial data show very little if any deviation in strain measurements in the repair weld between loading and unloading the vessel. The vessel was then pressurized to about 18,000 psi and depressurized to below 10,000 psi to help extend the flaw by fatigue. Repressurization was then undertaken and at 20,900 psi crack growth was sufficient to cause rapid separation of the final remaining ligament. A thin stainless steel boot welded under the flaw region in

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ITV-7A prevented loss of pneumatic pressure at failure and obviated the necessity to match the flow rate and volume of discharge that could be calculated for a through-wall breach in a PWR vessel. Even though the flaw extended dynamically and there was a sustained load to drive it, crack extension essentially stopped once the through-wall condition was reached. Only increasing pressure would have caused additional slow crack growth until critical flaw size were reached and unstable rapid fracture could be predicted.

This test shows that the analytical predictive capability for vessel failure under pneumatic load is well founded, so that we can accurately predict vessel behavior under such conditions. More importantly, the test shows that at upper shelf level toughness under the very highest pressure that could be predicted for a PWR under accident conditions (about 3,750 psi for a PWR, scaled to about 18,000 psi for ITV-7A) a through-wall flaw will not result in a catastrophic failure so that ECC water can be retained in the vessel.

Sincerely,

Original signed by
D. F. Knuth

Donald F. Knuth, Director
Division of Reactor Safety Research
Office of Nuclear Regulatory Research

cc: R. F. Fraley, ACRS
T. S. McCreless, ACRS

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