

OAK RIDGE NATIONAL LABORATORY

OPERATED BY
UNION CARBIDE CORPORATION
NUCLEAR DIVISION



POST OFFICE BOX X
OAK RIDGE, TENNESSEE 37830

July 24, 1974

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Dr. H. J. C. Kouts, Director
Division of Reactor Safety Research
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Dr. Kouts:

Subject: Preliminary Test Results for Heavy Section Steel
Technology Intermediate Test Vessel V-7

The seventh of the series of ten six-inch-thick pressure vessels was tested under pressure overload on June 19, 1974. The purpose of this test was to determine the performance of a thick-walled pressure vessel containing a long surface crack that extended nearly through the wall. The vessel had a longitudinally oriented external flaw located in the cylindrical portion of the vessel that was 18.6 inches long by 5.3 inches deep which had been sharpened by an electron beam welding and hydrogen charging technique. A copy of ORNL Dwg. 74-7166 is attached which shows a cross section of the defect in the vessel wall.

The pressure overload test was conducted with water at 196°F. A maximum pressure of 21,360 psi was achieved at which level leakage occurred through stable crack extension of the flaw through the vessel wall. The pressure fell to 18,600 psi and held as the flaw resealed itself. It was then necessary to vent through a relief valve to reduce the system pressure to atmospheric. The maximum pressure obtained was a factor of 2.2 over the design pressure of 9,700 psi for the cylindrical barrel of the vessel. The attached photograph which was taken after the vessel was removed from the test cell shows the flaw and the crack extension at the base of the machined notch which is visible as a contrasting line under the scale.

The fracture analysis procedure used by ORNL to predict the performance of this vessel was very accurate since the pretest prediction of failure was 20,800 psi which is within three percent of the failure pressure. This prediction was developed with the aid of test data from three 1/7-scale models of vessel V-7. It was found that linear elastic fracture mechanics calculations agreed with the model data when the fracture toughness of the steel was considered to be a function of the size of the unbroken ligament beneath the flaw.

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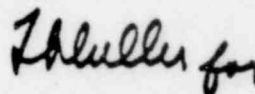
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It is of interest to predict the behavior of a full thickness vessel using this method. Considering a vessel twice the thickness of intermediate test vessel V-7 - i.e., with a wall thickness of 12 inches - similar calculations indicate that a flaw of the same shape would have to exceed 10 inches in depth in order to result in crack extension at the maximum stress reached in vessel V-7. Therefore, comparable pressure overloads could be achieved before failure or leakage occurred.

This test demonstrates, as have the six previous ones on intermediate test vessels, the remarkable capability of these reactor pressure vessel steels to tolerate large defects. In the case of the test just completed, it has been shown that very large flaws which extend nearly through the wall do not result in failure at design pressure level. Further, with over pressure, an innocuous leak-before-break condition has occurred when the materials are operated in the ductile regime.

Sincerely yours,



D. B. Trauger
Associate Director for
Reactor and Engineering Sciences

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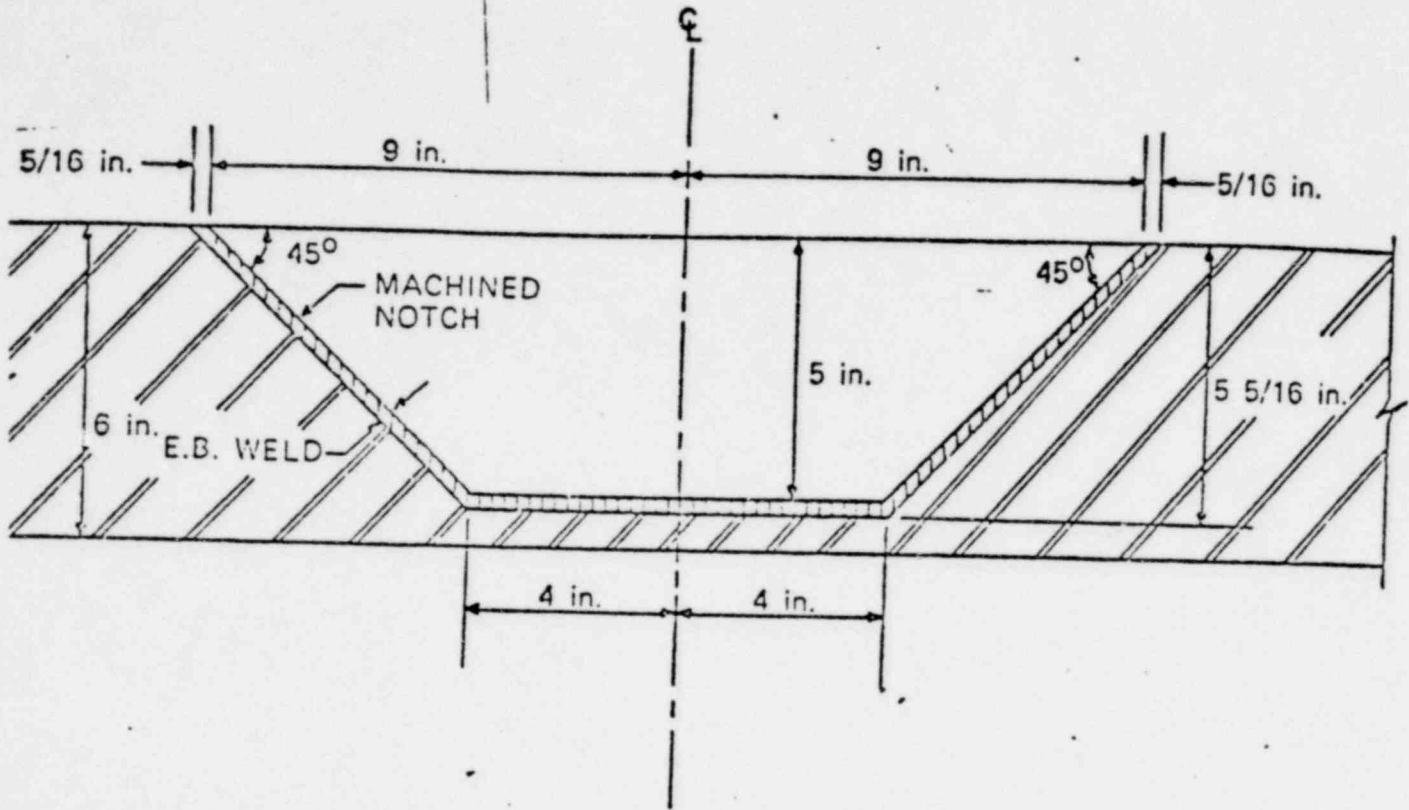
cc: Asst Dir, Water Reactor Safety Research
C. Z. Serpan, AEC-RSR
Dir, R&TS, ORO
F. L. Culler
G. G. Fee
H. Postma
G. D. Whitman

Attachments

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ORNL-DWG 74-7166

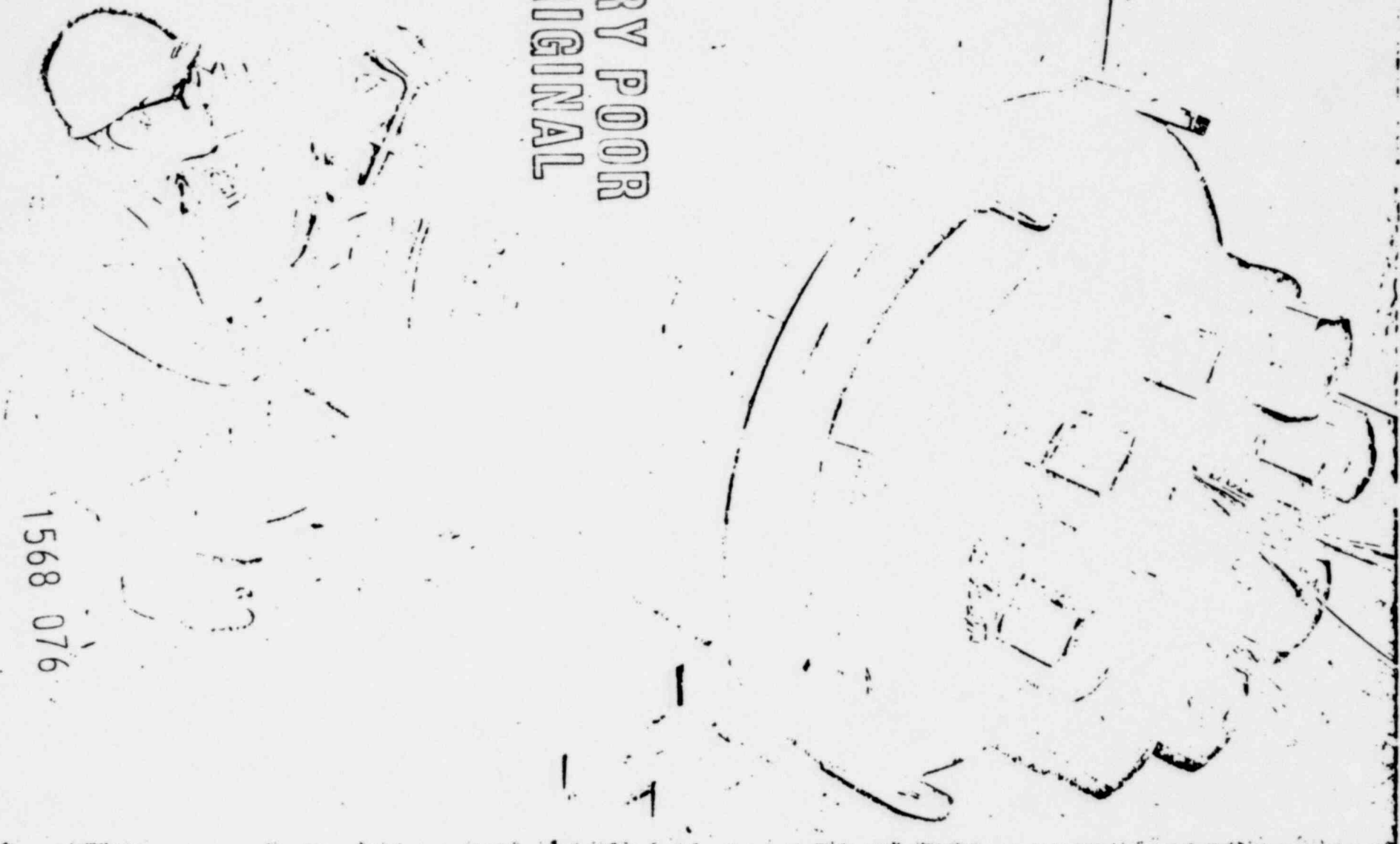


FLAW DESIGN FOR HSST PROGRAM INTERMEDIATE
TEST VESSEL V-7

1568 075

VERY POOR
ORIGINAL

1568 076



Intermediate Test Vessel V-7 After Completion of Test

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