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TENSILE PROPERTIES OF IRRADIATED CALANDRIA TUBES AT LOW TO HIGH RATES OF STRAIN

R.W.L. Fong, C.E. Coleman, R.S.W. Shewfelt[1], P.J. Ellis[2],
Y. Tsuchimoto[3], S. Yoshie[4], Y. Morishita[5], E.V. Pizzinato[6], and C. Albertini[6]

Abstract

Calandria tubes are made from annealed Zircaloy-2 sheet, brake-formed to shape then welded axially. They are used in the fuel channels of CANDU and FUGEN reactors to isolate the hot pressure tube from the cool heavy-water moderator. The calandria tube may contain the pressure of the heat transport fluid in the unlikely event a pressure tube breaks. Assessment of the structural integrity of the calandria tube requires information on the condition of the material after exposure to irradiation during service and the mechanical properties at low to high rates of strain. Calandria tubes have been removed from reactors by Ontario Hydro for evaluation. The effect of irradiation and strain rate on the tensile properties of the Zircaloy-2 material have been measured. After an initial rapid increase in strength with neutron fluence, there is a continuous small increase up to 8 $x10^{25}$ n/m^2. The ductility decreases in a similar manner. The strength of irradiated material increased steadily with strain rate from 10^{-3} s^{-1} to 300 s^{-1} but the ductility decreased to a minimum in the intermediate strain rate regime. The latter result was unexpected and may result from adiabatic heating during high strain rate testing. The increases in strength protect the calandria tubes from accidental loading from either water pressure or impact from the pressure tube.

[1]AECL Whiteshell Laboratories, Pinawa, Manitoba, Canada
[2]Ontario Hydro, Toronto, Ontario, Canada
[3]Electric Power Development Co. Ltd. (EPDC), Nuclear Power Department, Tokyo, Japan
[4]Kawasaki Heavy Industries Ltd., Nuclear Systems Division, Tokyo, Japan
[5]Power Reactor & Nuclear Fuel Development Corporation (PNC), Ibaraki, Japan
[6]JRC Safety Technology Institute, Dynamic Material Properties Laboratory, Ispra, Italy

Fuel Channel Components Branch
Reactor Materials Division
Chalk River Laboratories
Chalk River, Ontario
Canada K0J 1J0