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Attn: ADDRESSEE ONLY
Kim Gruss, Sud Basu, and Harold Scott
U. S. Nuclear Regulatory Commission
11454 Rockville Pike
Rockville, MD 20852-2738

Subject: A Recent Result on Thermal Creep of Surry Cladding after 15-y Dry Cask Storage

Dear Kim, Sud, and Harold,

We have been conducting a series of thermal creep tests on Zircaloy-4 cladding from irradiated Surry rods after they were stored in a dry cask for 15 years. At the beginning of the storage, the rods were also subjected to in-cask thermal benchmark tests in helium, nitrogen and vacuum environments. The conditions of storage and thermal benchmark tests can be found in the NUREG-CR-6745 and PNL-8451 Reports.

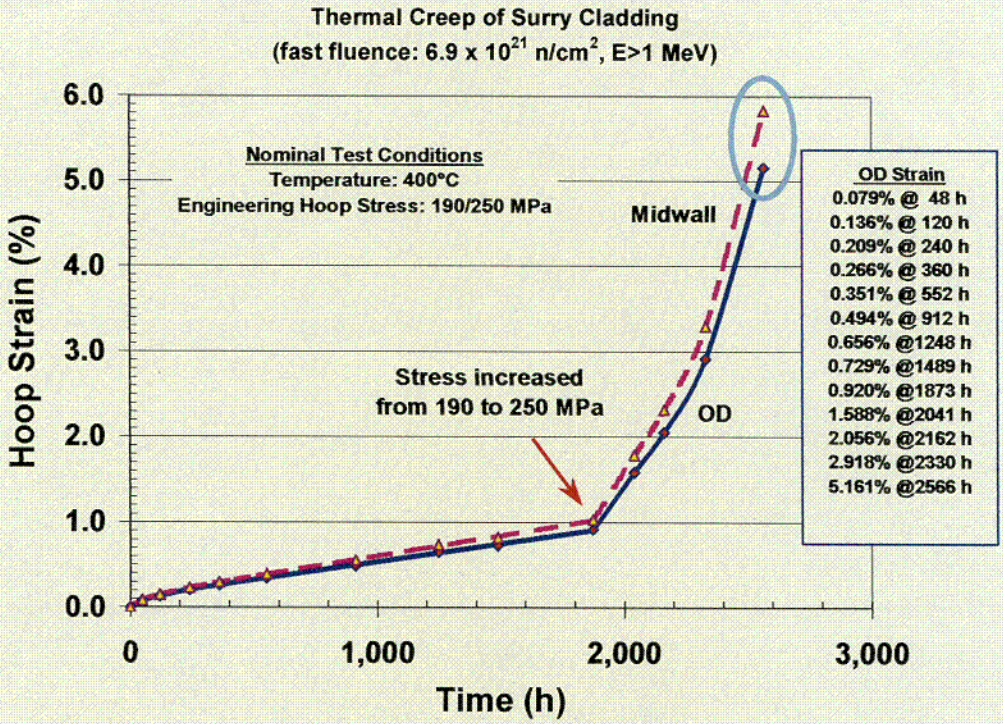
The most aggressive test in our test series is C9 and the magnitude of its creep deformation leads that of the rest. We first subjected the C9 sample to an engineering hoop stress of 190 MPa for 1873 h at 400°C and measured an OD hoop strain of 0.9 % at the end of the 1873 h. (The midwall strain would be 1.0%.). With the sample intact, we subsequently increased the engineering hoop stress to 250 MPa and continue the test for an additional 693 h at the same 400°C temperature. The measurements we made after the additional 693 hours showed the sample crept to an OD hoop strain of 5.2% (5.8% midwall) and, significantly, without failure. Equally significant is the fact that the cladding deformation appears to be azimuthally uniform with no signs of localized bulging, which might be a precursor for burst rupture. The increase in strain rate observed in the last portion of the test is due to a uniform wall thinning, which resulted in an increase in stress at the constant gas pressure. I have enclosed in the attachment two simple diagrams illustrating these features.

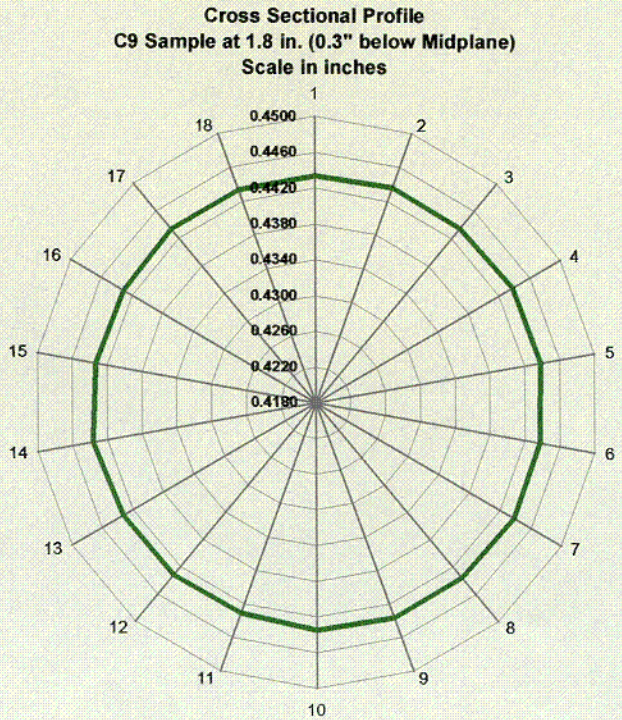
We are continuing the Surry creep test series and will report to you our significant findings on a timely basis. If you have any questions on these tests, please address them to Dr. Mike Billone, the Program Manager at ANL, or myself.

Regards,

Hanchung Tsai
Irradiation Performance Section
Energy Technology Division

cc: Dr. M. C. Billone


Thermal Creep of Surry Cladding
(fast fluence: 6.9 x 10^21 n/cm^2, E>1 MeV)
Hoop Strain (%)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
1,000
2,000
3,000
Time (h)
Nominal Test Conditions
Temperature: 400°C
Engineering Hoop Stress: 190/250 MPa
Stress increased
from 190 to 250 MPa
Midwall
OD
OD Strain
0.079% @ 48 h
0.136% @ 120 h
0.209% @ 240 h
0.266% @ 360 h
0.351% @ 552 h
0.494% @ 912 h
0.656% @1248 h
0.729% @1489 h
0.920% @1873 h
1.588% @2041 h
2.056% @2162 h
2.918% @2330 h
5.161% @2566 h


Cross Sectional Profile
C9 Sample at 1.8 in. (0.3" below Midplane)
Scale in inches
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
0.4500
0.4460
0.4420
0.4380
0.4340
0.4300
0.4260
0.4220
0.4180

C01