From: Robert Einziger
To: Ahn, Tae; Jain, Vijay
Date: 10/6/04 11:23AM
Subject: RE: Re (2): Second Meeting with SFPO

Only PWR assessemblies were considered in the Lanning and Beyer calculations. One would expect that the stress in a BWR rod would be lower due to the thicker cladding and lower fill pressure. On the other hand, ther is some indication that due to the difference in thermal treatment between BWR and PWR cladding, that hydrides in BWR cladding will reorient at a lower critical stress than in PWR cladding. Support for this statement like all the statements about hydride reorientation are not supported by a very large data base in toto and even a smalerl data base if only irradiated fuel is considered.

Hope this clarifies the issue. If not, it might be better if we discus it over the phone 301-415-2597

REE

>>> Vijay Jain <vjain@cnwra.swri.edu> 10/06/04 09:31AM >>>
Bob,
Can you clarify your point number 2. You state that only PWR are considered but hydrides seem to reorient in BWR at lower critical stresses.
Vijay

Vijay Jain
Center for Nuclear Waste Regulatory Analyses
Southwest Research Institute
6220 Culebra Road
San Antonio, TX 78228
V: (210) 522 5439
F: (210) 522 6081

-----Original Message-----
From: Tae Ahn [mailto:TMA@nrc.gov]
Sent: Wednesday, October 06, 2004 8:26 AM
To: Robert Einziger
Cc: RBENKE@cnwra.swri.edu; VJAIN@cnwra.swri.edu; Christopher Ryder; Harold Scott; Jack Guttmann; Lawrence Kokajko; Michael Waters; Marissa Bailey
Subject: Re (2): Second Meeting with SFPO

More home work for the next meeting - for example, I'll revisit the J. Duguid's HLW inventory at the YM site including new fuels and high burnup fuels. I would like to invite Harold and I'll set the time when I hear from Vijay and Rolan. Thanx, Bob.

>>> Robert Einziger 10/06/04 09:13AM >>>
Tae,

Right now I am open all Oct 28 except 9:45 to 11:15.

As to your comments on hydrides.

1 - If 400 C is your limit then you are correct to reduce the stresses in the Lanning/Beyer white paper. Remember thou, that these calculations are for low to medium burnup fuel. For high burnup fuel, the stresses will be much higher as the fgr appears to increase at greater than a linear rate. In addition the reactor allows rods to have an internal pressure up to the system cooling pressure, ~2200 psi and I hear that it can even go up to

~33000 psi in some instances. You may have some rods with extremely high stress in the repository. How many? I do not know.

2 - Only PWR rods were considered. BWR rods have a thicker cladding and lower fill pressure probably resulting in a lower stress. Due to the difference in texture between PWR and BWR rods, radial hydrides tend to form more easily in BWR rods, sometimes even in reactor. It is thought that the critical stress to reorient hydrides in BWR rods is lower than in PWR rods.

3 - We have evidence that hydrides reorient above 90 MPa but most of the data was obtained from unirradiated Zirc in quench type experiments (ie fast cooling). We have very little evidence to show reorientation does not occur below that stress until we get down to normal operating stresses. There are a number of papers that indicate (hypothesis?) that the critical stress will drop with cooling rate. Some say that the critical stress might be higher than 90 MPa. The bottom line is that we just don't know what the critical stress is.

4 - We have no idea how the critical stress will vary with the newer cladding types, which make up the bulk of the fuel being irradiated today.

5 - I don't know what you mean by the "actual solvus temperature is 260 to 300 C". Do you mean that this is the highest temperature you expect in the repository?

6 - At this point we have very little information on how badly the mechanical properties degrade as a function of the number of radial hydrides. Louthan said as little as 40 PPM can have a marked effect in unirradiated cladding. We are trying to get a handle on this during the tests that are being conducted at ANL.

I think the situation is a little different in storage and transportation then in the repository. In the drying cycle, we are going to higher temperatures. The repository may consider hydride reorientation as a closed issue, but the SFPO does not.

>>> Tae Ahn 10/06/04 08:43AM >>>
Bob, how about 10/28 right after the RES meeting (25 - 27) in DC? Vijay Jain of CNWRA then may be able to join along with Rolan Benke.

Harold Scott of RES and I revisited the paper by Lanning and Beyer (FRAPCON-3 study). This estimated cladding stresses for dry cask storage. The hoop stress at 400 C is less than 100 MPa for example fuels and designs. I converted the data at 570 C to 400 C. According to E. Siegmann, the threshold hoop stress at 400 C is ~ 100 MPa for the hydride reorientation. The actual solvus temperature is 260 to 300 C. All our versions of IRSR (Issue Resolution Status Report) have addressed for many years this issue for the post-closure performance.

Tae

CC: Bailey, Marissa; Guttmann, Jack; Kokajko, Lawrence; RBENKE@cnwra.swri.edu; Ryder, Christopher; Scott, Harold; Waters, Michael

From: Robert Einziger
To: Ahn, Tae
Date: 10/6/04 11:37AM
Subject: Re: Second Meeting with SFPO

Take a look at the paper by Ito, Kamimura and Tsukuda "Evaluation of Irradaiation Effect on Spent Fuel Cladding Creep Properties' given at the recent orlando fuels meeting. It graphically shows the difference in hydride structure between PWR and BWR cladding. This work is at much higher stresses than are expected in dry storage, but support the info given in a paper by Foster a number of years ago at an ANS meeting in West Palm.

REE

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