From: Michael Waters
To: Tae Ahn
Date: 10/7/04 9:11AM
Subject: Re: Second Meeting with SFPO

Tae, goodwork in leading us through this complicated issue.

I believe we need to consider SNF cladding performance from both a standpoint of Postclosure performance during the performance period (if any?), and a standpoint of Preclosure consequence source terms from Category I and II events. I am eager to meet with Einziger and other experts again to continue these technical discussions. We need to methodically step through the entire life cycle of the SNF at the Facility, and identify the important cladding integrity issues , as it relates to pre and post-closure performance requirements. There are multiple issues. The HP team has identified one example, as described below.

Thanks,

Mike

Preclosure HP Issue (as it relates to G06):
Because of uncertainty in cladding, one could argue that we may have to consider a significant number of fuel rod failures from Preclosure impact events that impart even a moderate level of strain on the cladding. Note that Bob also mentioned in our meeting that the failure strain limit for high burnup fuel could be much less than 1%, which is even lower than recent thinking. There are additional issues that Bob pointed out with respect to "damaged" fuel being handled in a dry environment under high heat loads.

One key issue with respect to Preclosure release source terms, is the number of failure points and type of pin failure (e.g. burst, split, guillotine break). The most recent draft of the Research PRA for Spent Fuel Storage has shown that normal and high burnup fuel fail differently, In addition, increased number of failure points for high burnup fuel increased long-distance doses by more than an order of magnitude for cask drop events. This work was supported by Sandia, Research, and SFPO experts.

I do not think current source term guidance values (e.g. ISG-5) really considered a potential drop of a bare fuel assembly in a loading pit, nor considered the range of future types of fuel cladding and burnups?

In summary, the Preclosure HP Team will need support from structural/materials expertise to help validate the release source term used by DOE....especially for bare fuel assembly events. Fortunately, there appears to be significant margin for public doses calculated by DOE, but they could be significantly ratcheted up if one takes an alternate approach to release source terms than current guidance values. Note that calculated worker doses may have less of a margin with associated performance standards.

THE PRECEDING INFORMATION IS DRAFT/PREDECISONAL AND NOT FORMAL NRC POSITION

>>> 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: Biswajit Dasgupta; Christopher Ryder; Dennis Galvin; Gregory Hatchett; Jack Guttmann; Marissa Bailey; Oleg Povetko; Robert Johnson; Roland Benke