From: Tanya Eaton / NRR
To: Kimberly Gruss
Date: Mon, Sep 27, 1999 4:14 PM
Subject: Zirconium fire information

Kim,

I had emailed you a few months ago regarding zirconium fires. I found some information that I wanted to bounce of someone who is knowledgeable regarding zirconium. I realize that in the dust/scrap form, zirconium is highly pyrophoric. However, I have recently found information regarding surface reactions that can occur on massive zirconium. Although not frequent, a few events have occurred in Zirconium heat exchangers that were in corrosive environments like sulfur. I think what happens is that the corrosive environment, combined with the heat generated, cause the surface to break down into a dust formation (due to brittleness) and result in ignition. I don't think spent fuel pools are corrosive environments, so I don't think that case would actually apply to my situation.

However, in a 1997 Sandia report, they did a study on a spent fuel draindown event. They stated that oxidation of zirconium cladding at elevated temperatures by air occurs by the following reaction: $Zr + O2 = ZrO2$. It also states that the zirconium can react with steam to produce ZRO2 and hydrogen gas. Since an instantaneous draindown was assumed, the study did not consider the reaction producing hydrogen. My question is this....we are looking into ways to mitigate a zirconium fire, if one were to occur. It was suggested that the use of a high-expansion foam might be appropriate in an event where the spent fuel liner is cracked due to a seismic event. The foam would be applied to the top of the assemblies and the heat generated hypothetically would break down the foam concentrate and allow the water to trickle down the length of the assembly. Now, if what I found in the Sandia report is true, then that small amount of water, if it trickled down through the restrictive upper channels and down the length of the fuel assembly, would be converted into steam and could react with the zirconium to produce hydrogen gas. Hydrogen gas is thought to increase internal stress, thus promoting metal surface fragmentation. Also, I recall from the TMI experience, that hydrogen burn was a really big deal and caused a lot of damage. I'm wondering if there is any applicability to spent fuel pools and if so, would the temperatures have to be extremely high (greater than 200 C) to produce hydrogen gas. If you have any information on this, or any thoughts, I'd appreciate your feedback. I plan to bring this up in a meeting and I wanted to see if you had ever heard of these "surface reactions" that can occur on zirconium.

Thanks,

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