From: Aladar Stolmar [astolmar@gmail.com]
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OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Docket ID NRC-2009-0554

Comments from Aladár Stolmár, HU-3021 Lőrinci, Szabadság tér 3, Hungary

Phone: +36-20-404-2713, email: astolmar@gmail.com

Background: I received my nuclear engineering degree (BS) at the Moscow Power (Engineering) Institute in 1973 and worked on the Nuclear Power Plant Paks project in Hungary. In 1985, I immigrated to the USA and worked as a consultant for Westinghouse on the Chernobyl-4 accident investigation, assigned to A. David Rossin, Assistant Secretary of Energy for Nuclear Energy. I also worked for Westinghouse on the AP-600 design and as a senior engineer in the Probabilistic Risk Assessment group investigating processes in accident progression for several NPP worldwide. Currently, I'm back in Hungary and involved in the expansion of NPP Paks. Already, at Westinghouse, I raised a Safety Concern over the misrepresentation of cladding heat-up and ignition in the predecessor codes of Relap, which I still have not seen corrected.

In fact, the correct representation of the cladding condition (locations without any oxide) and the correct representation of the temperature distribution in the steam cooling regime results in an ignition at a much lower temperature than it is predicted in the Relap-5 computer model. I mean, the **prediction** for a steam cooled environment temperature by the code could be as low as 1000 K and the **real, factual** local temperature could already exceed the ignition condition for the Zirconium fire in the steam. And, in fact, the ignition of the Zirconium fire will result-in a non-extinguishable firestorm in the core, as occurred in the TMI-2 core, the Chernobyl-4 core and the Paks-2 refueling pond fuel bundle washing vessel, and had been indicated by the experiments cited by Mark Leyse and others I cite below as well. Until we have a much more detailed experimental investigation of real conditions, I suggest to mandate the prevention of steam bubble formation in the core and in nuclear fuel containing vessels, and I suggest to regulate the containment to consider the maximum possible Hydrogen generation, which is equal to the reaction of the entire Zirconium inventory. (The more detailed investigation also may turn out to require the same strict, conservative limitations.)

I agree with Mark Leyse that the current 10 CFR 50 regulation series is not conservative, because it does not require the demonstration of the prevention of steam bubble formation in the core, leading to a Zirconium fire in the steam; and the prevention of the destruction of the reactor core as it happened in the TMI-2 and Chernobyl-4 severe reactor accidents, nor the prevention of the destruction of nuclear reactor fuel as it happened in the Paks-2 refueling pond. It is due to the fact that the very rapid development of the ignition condition after the bubble formation in the core is misrepresented, shown by the required codes to be much slower than it is in reality. http://aladar-mychernobyl.blogspot.com/

Furthermore, the current 10 CFR 50 series of regulation is not conservative, because it does not require the demonstration of preservation of the containment surrounding the reactor in the event of the detonation of a Hydrogen-air mixture, calculated from the generated amount of Hydrogen from the Zirconium-steam fire, consuming the entire inventory of Zirconium in the core in a single firestorm event.

http://www.osti.gov/energycitations/servlets/purl/10188341-UMoU6M/native/

FULL-LENGTH HIGH-TEMPERATURE SEVERE FUEL DAMAGE TEST #5

D. D. Lanning at al.

April 1988 – Completion Date

September 1993 – Publication Date

Prepared for

U. S. Nuclear Regulatory Commission

Under U.S. Department of Energy

Contract DE-AC06-76RLO1830

Pacific Northwest Laboratory

Richland, Washington 99352

Reports on page 6:

"TEST RESULTS

Following the uncovering and dryout during the coolant boilaway, the rods heated at a rate of 2 to 5 K/s until peak cladding temperatures of 1700° K were attained, at which time the autocatalytic oxidation reaction resulted in a temperature excursion (at a rate of 10 to 50° K/s) and hydrogen generation. Peak local cladding temperatures are estimated to have exceeded 2600° K, based on information from thermocouples on the outside of the bundle liner.

The high-temperature oxidation reaction began at the 2.4- to 3.04-m elevation and formed a localized burn front that moved quickly downward as far as the 1.2-m elevation and then steadily upward. The burn front reached the top end caps (3.80m) and ceased 15 min. before the end of the test. The oxidation reaction consumed 75% of the total zircaloy or almost 100% of the zircaloy in the path of the burn front. The remaining 25% of the zircaloy was always below or near the bundle water level. The amount of hydrogen generated was 300±30 g, close to the total conversion of the 1.26-g/s make-up coolant flow within the 45-min. high-temperature period. The hydrogen flow fluctuated during the 45-min. high-temperature period in response to similar fluctuations (10% to 20% relative) in the bundle coolant flow. The peak hydrogen flow was 190 mg/s, which corresponded to an oxidation power of 28 kW."

This description is a very clear presentation of ignition and fire of Zirconium in the steam in a steam-starved environment.

http://itu.jrc.ec.europa.eu/uploads/media/Activity_Report_2004.pdf

page 42 "Bundle tomography revealed that a large central cavity was apparent above the corium pool at approximately one-third bundle height. At the top there were remnants of distorted, degraded fuel rods, whereas below the corium pool there was small streams of melt material and debris evident."

page 43. "The differences between the degraded bundle geometries of FPT1 and FPT2 can be explained by the fact that under steam-starved conditions (FPT2) Zircaloy metal melts and relocates at a lower temperature, whereas under oxidising conditions (FPT1) the Zircaloy cladding oxidises to a refractory oxide (ZrO_2) and remains in place until very high temperatures are reached later in the accident."

Similar destruction and relocation of nuclear reactor fuel was observed in the TMI-2 and Chernobyl-4 severe reactor accidents and in the Paks-2 refueling pond reactor fuel washing accident.

The similarities in these tests and accidents are the formation of gaseous (steam) bubbles in the upper regions of fuel bundles, the ignition of Zirconium in the steam and generation of Hydrogen and zirconia (ZrO_2) reaction products in a very intense fire, essentially in a firestorm. Therefore, the conservative regulation shall mandate that the owners and operators of Nuclear Reactors and Reactor Fuel Handling Facilities shall demonstrate that **there will be no dry-out of the fuel bundles in any circumstances**.

Also, in order to prevent the exposure of the public to the harmful consequences of an accident in a reactor, the housing of the reactor **(containment) shall withstand the detonation of the air-Hydrogen mixture with the amount of Hydrogen** calculated from the consumption of the **entire inventory of Zircaloy in the reactor core** or in the entire enclosed in a vessel volume, where such bubble formation is possible.

There are several reports presenting the same issue as Mark Leyse. The cladding of nuclear fuel made of **Zirconium alloy ignites and burns in the steam**. The same process can be recognized (and should be recognized) as **the common cause** of the TMI-2 and Chernobyl-4 reactor severe accidents and the Paks-2 refueling pond accident. And the regulations in 10 CFR 50 series shall mandate to deal with the real issues and real processes.

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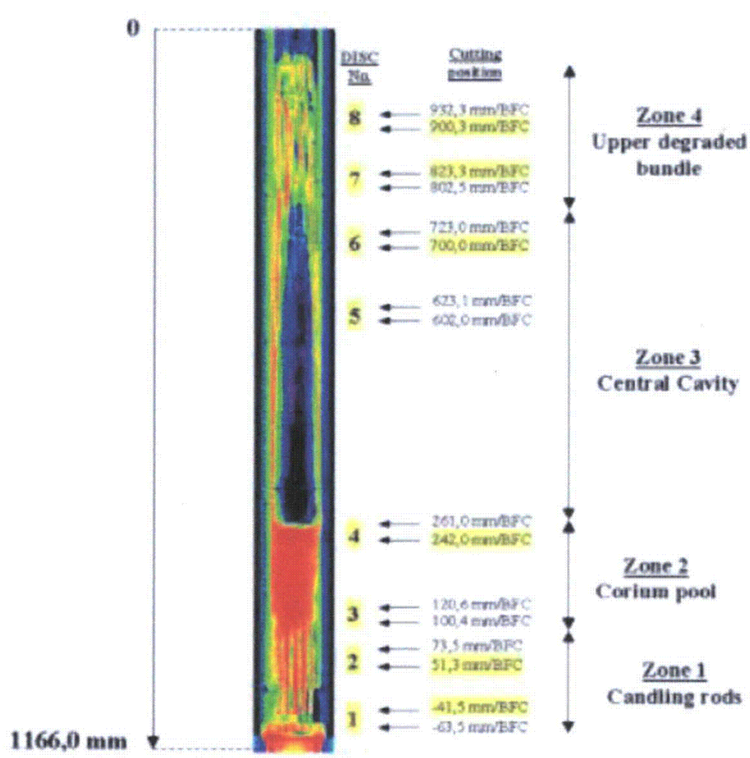

Fig. 6: *False colour tomography of FPT2 bundle after testing showing the central cavity in black (least density) and the corium pool of melted material beneath in red (highest density)*

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