CHAIRMAN Resource

From:	Mark Leyse <markleyse@gmail.com>
Sent:	Wednesday, May 25, 2016 5:17 AM
To:	Doyle, Daniel; Mohseni, Aby
Cc:	bobleyse@aol.com; shadis@prexar.com; Burnell, Scott; Bladey, Cindy; Dave Lochbaum; Gordon Thompson; Matthew G. McKinzie; Geoffrey Fettus; Thomas B. Cochran; Ed Lyman; Paul Gallay; Paul Gunter; CHAIRMAN Resource; Valliere, Nanette; Moore, Johari; Patrick.Castlernan@nrc.gov; Frazier, Alan; Cubbage, Amy; Krsek, Robert; michal_freedhoff@markey.senate.gov; Diane Curran; Jim Riccio; Richard Webster; Clay Turnbull; Bloomer, Tamara; Alemayehu, Bemnet
Subject:	[External_Sender] Re: Status of PRM-50-93/95

Dear Mr. Mohseni and Mr. Doyle:

Thank you for the update. (Please place this e-mail in ADAMS.) I understand that the NRC staff will consider and respond to comments I made on PRM-50-93/95 to the NRC Commissioners on January 31, 2013, as part of their review PRM-50-93/95.

On a number of occasions, I have requested that the NRC staff also review and respond to additional comments that I sent in on April 12, 2014. The April 12, 2014 comments reiterate and further expand on issues I raised in my January 31, 2013 presentation to the Commissioners. The April 12, 2014 comments are fully referenced; they are in ADAMS at ML14104B253.

Mr. Mohseni - Please provide me with a definitive answer to this question: Will you direct the NRC staff to consider and respond to the April 12, 2014 comments?

Additionally, on November 24, 2015, Mr. Mohseni disclosed information on TRACE simulations of FLECHT 9573 that is discussed below. The information on TRACE simulations of FLECHT 9573 that is discussed below is pertinent to my presentation to the NRC Commissioners on January 31, 2013. In my presentation, I discussed the fact that the NRC staff did not simulate the portion of the FLECHT 9573 bundle that incurred runaway oxidation. Now that that section of the bundle has been simulated, the results need to be part of the NRC staff's review of PRM-50-93/95.

Sincerely,

Mark Leyse

Information that Mr. Mohseni Disclosed (on November 24, 2015) on the TRACE Simulations of FLECHT 9573:

I. "Low Temperature" Oxidation Rates Are Under-Predicted for FLECHT Run 9573

Westinghouse's "PWR FLECHT (Full Length Emergency Cooling Heat Transfer) Final Report" (hereinafter: "WCAP-7665") states that, "[t]he objective of the PWR FLECHT…test program was to obtain experimental reflooding heat transfer data under simulated loss-of-coolant accident conditions for use in evaluating the heat transfer capabilities of PWR emergency core cooling systems."[1] The FLECHT tests were conducted with bundles of heater rods sheathed in zirconium alloy (Zircaloy) cladding. Runaway oxidation was not expected to occur in any of the tests; however, the FLECHT Run 9573 test bundle incurred runaway oxidation (see Figure 1).

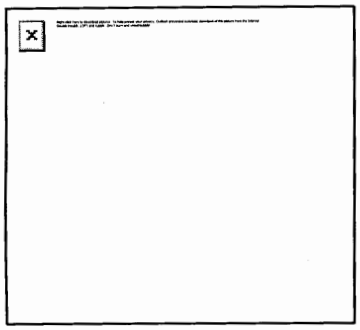

Figure 1. Section of the FLECHT Run 9573 Test Bundle that Incurred Runaway Oxidation

The FLECHT Run 9573 test bundle incurred runaway oxidation around its seven foot elevation. WCAP-7665 states: "Post-test bundle inspection indicated a locally severe damage zone within approximately ±8 inches of a Zircaloy grid at the 7 ft elevation. The heater rod failures were apparently caused by localized temperatures in excess of 2500°F." WCAP-7665 also states: "During the test, heater element failures started at 18.2 seconds... At the time of the initial failures, midplane [at the 6 foot elevation] clad temperatures were in the range of 2200-2300°F. The only prior indication of excessive temperatures was provided by the 7 ft steam probe, which exceeded 2500°F at 16 seconds (2 seconds prior to start of heater element failure)."[2]

The NRC conducted TRACE code computer simulations of FLECHT Run 9573 and found that TRACE *under-predicted* temperatures that were reported by Westinghouse at the 7 ft elevation of the test bundle. On November 24, 2015, Aby Mohseni, Deputy Director of the NRC's Division of Policy and Rulemaking, sent Mark Leyse an e-mail regarding the NRC's TRACE computer simulation of FLECHT Run 9573. In his e-mail, Mr. Mohseni disclosed findings of "the completed simulation [for] the cladding and steam temperatures at the 7-ft elevation (at 18 seconds)."[3]

TRACE *under-predicted* cladding and steam temperatures at the 7-foot elevation of the FLECHT Run 9573 test bundle. TRACE is supposed to *over-predict* temperatures in order to ensure an adequate margin of safety. The Baker-Just and Cathcart-Pawel zirconium-steam reaction correlations were used for the TRACE simulations. The TRACE simulations need to be considered as evidence that the NRC and nuclear industry's computer safety models under-predict the zirconium-steam reaction rates that would occur in the event of a SFP accident.

II. FLECHT Run 9573—a Comparison between the TRACE Predictions and the Results Westinghouse Reported

According to Mr. Mohseni's e-mail, when TRACE used the Cathcart-Pawel and Baker-Just correlations, it predicted *cladding* temperatures of 1526 K (2287°F) and 1561 K (2350°F), respectively. And, when TRACE used the Cathcart-Pawel and Baker-Just correlations, it predicted *steam* temperatures of 1370 K (2006°F) and 1397 K (2055°F), respectively. Those are predicted cladding and steam temperatures for the FLECHT Run 9573 test bundle at the 7-ft elevation, at 18 seconds.[4]

Westinghouse reported that at 18.2 seconds, heater rod failures occurred around the 7 foot elevation when *cladding* temperatures were in excess of 1644 K (2500°F). (Who knows how high the cladding temperatures actually were; they could have been hundreds of degrees Fahrenheit higher than 1644 K (2500°F).)

And Westinghouse reported that at 16.0 seconds, a steam probe at the 7 foot elevation recorded *steam* temperatures that exceeded 1644 K (2500°F). And a Westinghouse memorandum stated that after 12 seconds, the steam-probe thermocouple recorded "an extremely rapid rate of temperature rise (over 300°F/sec)."[5] (Who knows how high the steam temperatures actually were at 18 seconds; they were likely hundreds of degrees Fahrenheit higher than 1644 K (2500°F).)

Taking the time difference of 0.2 seconds (between 18 and 18.2 seconds) into account, when TRACE used the Cathcart-Pawel and Baker-Just correlations, it predicted *cladding* temperatures that were at least 200°F and 140°F lower, respectively, than the temperatures Westinghouse reported. That is *non-conservative*.

When TRACE used the Cathcart-Pawel and Baker-Just correlations, at 18 seconds it predicted *steam* temperatures that were about 500°F and 450°F lower, respectively, than the temperatures Westinghouse measured at 16 seconds. Westinghouse also reported that after 12 seconds, steam temperatures were increasing at a rate greater than 300°F/sec. So steam temperatures were even greater at 18 seconds than they were at 16 seconds. Hence, the TRACE predictions for steam temperatures are *non-conservative*.

The FLECHT Run 9573 results indicate that the currently used zirconium-steam reaction correlations, such as the Cathcart-Pawel and Baker-Just correlations, are inadequate for use in computer safety models like MELCOR.

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[1] F. F. Cadek, D. P. Dominicis, R. H. Leyse, Westinghouse Electric Corporation, WCAP-7665, "PWR FLECHT (Full Length Emergency Cooling Heat Transfer) Final Report," April 1971, (ADAMS Accession No: ML070780083), p. 1.1.

[2] *Id.*, p. 3.97.

[3] Aby Mohseni, Deputy Director of the NRC's Division of Policy and Rulemaking, e-mail to Mark Leyse, regarding the NRC's TRACE computer simulation of the FLECHT Run 9573 test bundle, November 24, 2015, (ADAMS Accession No: ML15341A160).

[4] *Id.*

[5] Robert H. Leyse, Westinghouse, Nuclear Energy Systems, Test Engineering, Memorandum RD-TE-70-616, "FLECHT Monthly Report," December 14, 1970. This Memorandum is available at Appendix I of PRM-50-93. See Mark Leyse, PRM-50-93, November 17, 2009, (ADAMS Accession No: ML093290250), Appendix I.

On Tue, May 24, 2016 at 3:51 PM, Doyle, Daniel <Daniel.Doyle@nrc.gov> wrote:

Mr. Leyse,

I am writing to provide an update on your letters dated November 17, 2009, and June 7, 2010, in which you submitted petitions to the U.S. Nuclear Regulatory Commission (NRC). In your letter dated November 17, 2009, you requested that the NRC amend the regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50 and Appendix K to Part 50 to require that the rates of energy release, hydrogen generation, and cladding oxidation from the metal-water reaction considered in emergency core cooling system evaluation calculations be based on data from multi-rod (assembly) severe fuel damage experiments. In addition, you requested that the NRC create a new regulation to establish a minimum allowable core reflood rate in the event of a loss-of-coolant accident (LOCA). In your letter dated June 7, 2010, you requested that the NRC order Vermont Yankee Nuclear Power Station (Vermont Yankee) to lower the licensing basis peak cladding temperature to 1,832 degrees F in order to provide a necessary margin of safety in the event of a LOCA.

The NRC docketed your November 17, 2009, letter as petition for rulemaking (PRM) 50-93. A notice of receipt and request for public comment on PRM-50-93 was published in the *Federal Register* on January 25, 2010 (75 FR 3876). Your letter dated June 7, 2010, was submitted as a petition for enforcement action under 10 CFR 2.206. On August 6, 2010, the NRC denied your § 2.206 petition because it did not demonstrate that Vermont Yankee was in violation of any NRC regulations. Because your § 2.206 petition asserted that there were generic inadequacies in NRC regulations, the NRC decided to review it under 10 CFR 2.802 as a petition for rulemaking and docketed it as PRM-50-95. Because PRM-50-93 and PRM-50-95 address similar issues, the NRC consolidated these two petitions for review as a single petition for rulemaking activity. Another *Federal Register* notice was published on October 27, 2010 (75 FR 66007), and the comment period was reopened. The public comment period ended on November 26, 2010. Thirty-two public comments have been received to date on the combined petitions. These comments have been posted at regulations.gov (ID: NRC-2009-0554).

The NRC staff is considering the merits of your PRM and the public comments received. As described in the NRC's letter to you dated August 25, 2011, the NRC has decided to increase the visibility to the public of the NRC's review of these particular petitions. The NRC will publicly release its draft interim reviews regarding each group or category of issues on a periodic basis as the review progresses. These draft interim reviews will be posted on regulations.gov. So far, the NRC has publicly released four draft interim reviews:

- Evaluation of CORA test series (8/23/11)
- Evaluation of LOFT LP-FP-2 (9/27/11)
- Evaluation of conservatism of 2200F, metal-water reaction rate correlations, and "the impression left from run 9573" (10/16/12)
- Evaluation of request to establish minimum reflood rate (3/8/13)

The NRC staff will consider and respond to the comments you made regarding PRM-50-93 and PRM-50-95 at the Commission briefing on public participation in NRC regulatory decision-making on January 31, 2013, in the review of these petitions.

The NRC is considering the remaining issues and will notify you as the draft interim reviews are completed. Once the petitions have been resolved, a notice will be published in the *Federal Register* explaining the Commission's finding. You will also receive a letter at that time notifying you of the action that the Commission has taken.

Please feel free to contact me at Daniel.Doyle@nrc.gov or 301-415-3748 if you have questions.

Sincerely,

Dan Doyle

Project Manager

U.S. Nuclear Regulatory Commission

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