From:	Mohseni, Aby
To:	Mark Leyse
Cc:	Burnell, Scott; Doyle, Daniel; Inverso, Tara; Kokajko, Lawrence
Subject:	Re: Status of PRM-50-93/95
Date:	Wednesday, November 04, 2015 3:28:48 PM
Attachments:	image001.jpg

Mr. Leyse,

Thank you for your email. I have passed the information along to the group that is evaluating the PRMs, and we will add the email to ADAMS.

Respectfully,

Aby Mohseni, Deputy Director, Division of Policy and Rulemaking

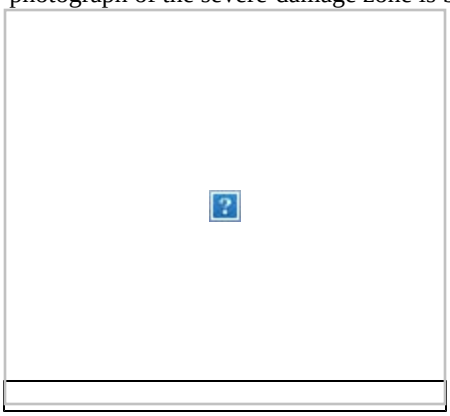
Office of Nuclear Reactor Regulation

U.S. Nuclear Regulatory Commission

From: Mark Leyse [mailto:markleyse@gmail.com]
Sent: Sunday, November 01, 2015 7:43 PM
To: Mohseni, Aby

Dear Mr. Mohseni:
Thank you for answering the two questions--clarifying that TRACE predicted an average temperature at each elevation. And I appreciate your explaining that TRACE is not a licensed evaluation model.
I note that in some cases investigators have used modifications of the TRACE code to predict the peak cladding temperature that would hypothetically occur in different loss-of-coolant accident scenarios. (Examples are cited in papers from Brookhaven National Laboratory and Paul Scherrer Institut listed below where I have references.)
I think it would have been more appropriate for a computer simulation of FLECHT Run 9573 to have predicted the peak cladding temperatures at each elevation. In your e-mail, referring to the NRC's simulation of Run 9573, you said that "the highest temperature recorded by the three thermocouples at the six foot elevation (during the 18 seconds when the data is considered valid) was 1,544 K. This is bounded by the TRACE “average” temperature predictions when metal-water reaction is accounted for with either the Cathcart-Pawel or Baker-Just models." That is not the case for the 8 and 4 foot elevations. At those two elevations, the highest recorded temperature exceeded the TRACE average-temperature predictions.
At the 8 foot elevation (at 18 seconds) the highest recorded temperature was 2208 Fahrenheit (1482 Kelvin), which is 64.4 K higher and 49.3 K higher than the TRACE average-temperature predictions, when using the Cathcart-Pawel and Baker-Just (zirconium-steam) correlations, respectively. At the 4 foot elevation (at 18 seconds) the highest recorded temperature was 1948°F (1337.6 K), which is 12.7 K higher and 7.3 higher than the TRACE average-temperature predictions, when using the Cathcart-Pawel and Baker-Just correlations, respectively. (See page C.41 of WCAP-7665 for the cladding temperatures Westinghouse recorded.)
So what do we know? merely that at the 8 and 4 foot elevations the highest recorded temperatures exceeded TRACE's average-temperature predictions? What we don't know is if the highest recorded temperatures would exceed the highest predicted temperatures at those two elevations. A more appropriate computer simulation would have provided the answer. As I told the NRC Commissioners at the Briefing on Public Participation on NRC Regulatory Decision-Making held on January 31, 2013, the NRC's TRACE simulation of FLECHT Run 9573 has far worse problems. (The reference to my presentation to the Commissioners is below.)
I contend that the NRC's TRACE simulation of Run 9573 is **WORSE THAN WORTHLESS** because the test data from the 7 foot elevation was omitted.
The **PROBLEM** with the NRC's TRACE simulation of Run 9573 is that it did **NOT** simulate the test bundle's **SEVERE-DAMAGE ZONE**.
In April 1971, **Westinghouse reported** that the test bundle had a "severe damage zone." (See page 3.97 of WCAP-7665.) Why is it that in 2015, the NRC does **NOT** acknowledge that the test bundle from Run 9573 had a severe-

damage zone? The NRC's 2012 analysis of Run 9573 did not acknowledge the existence of severe-damage zone. A photograph of the severe-damage zone is below.



The severe-damage zone--within approximately ±8 inches at the 7 foot elevation.

Test Data Omitted from the NRC's TRACE Simulation of Run 9573:

The NRC simulated Run 9573 and did **NOT** include the section of zirconium cladding that incurred thermal runaway, burning in steam: the severe-damage zone. That is like simulating a forest fire and omitting the areas of the forest where trees burned down.

The TRACE simulation of Run 9573's test bundle **ONLY** simulated the sections of the test bundle were in excellent condition. Westinghouse reported that besides the severe damage zone, the test bundle was "in excellent condition." (See page 3.97 of WCAP-7665.)

The TRACE simulation of Run 9573 did not include data from a steam-probe thermocouple (temperature-measuring device) located at the 7 foot elevation--located by the severe-damage zone.

Westinghouse reported that the 7 foot steam-probe thermocouple recorded temperatures exceeding 2500°F, at 16 seconds into Run 9573. (See page 3.97 of WCAP-7665.) A Westinghouse memorandum stated that after 12 seconds the steam-probe thermocouple recorded "an extremely rapid rate of temperature rise (over 300°F/sec)." (See the memorandum reference below.)

A Slight-of-Hand Trick:

As I said, I think the NRC's TRACE simulation of Run 9573 is **worse than worthless** because the test data from the 7 foot elevation was omitted. The test bundle incurred thermal runaway around the 7 foot elevation. The results of the NRC's TRACE simulation are unrealistic, neither indicating that the test bundle incurred thermal runaway nor had a severe-damage zone.

It appears that the NRC has to resort to cherry picking test data, **omitting test data**, in order to prove the adequacy of its computer safety models (and the metal-water reaction-rate correlations that those models use).

By engaging in slight-of-hand tricks the NRC endangers the public it is supposed to protect. The NRC undermines its own philosophy of defense-in-depth, which requires the application of conservative computer safety models.

As you, yourself, said in your e-mail, referring to the NRC's simulation of Run 9573, "the TRACE code...was used here in order to examine the conservatism in the Baker-Just and Cathcart-Pawel correlations and to demonstrate the adequacy of these models when used for complex thermal-hydraulic calculations."

If the NRC is so confident that the Baker-Just and Cathcart-Pawel correlations are adequate, why did it have to resort to omitting test data from its TRACE simulation? That is the test data that indicated thermal runaway!

Let's Compare Run 9573's Test Results with the NRC's TRACE Simulation Results:

As flawed as the NRC's TRACE simulation of Run 9573 is, when comparing it to the Run 9573 test results, it may indicate that the Baker-Just and Cathcart-Pawel correlations are inadequate.

Westinghouse reported that at 18.2 seconds into Run 9573, apparently localized cladding temperatures were in excess of 1644.3 K (2500°F) at (or by) the **7 foot elevation**. Meanwhile, a steam-probe thermocouple (at the 7 foot elevation) indicated thermal runaway, recording a temperature rise greater than 300°F/sec (166.7 K/sec). (See page 3.97 of WCAP-7665 and the memorandum reference.)

TRACE predicted cladding temperatures (at the **6 foot elevation** at 18 seconds) of 1554.2 K (2337.9°F) and 1598.4 K (2417.5°F), using the Cathcart-Pawel and Baker-Just (zirconium-steam) correlations, respectively. TRACE predicted cladding temperatures (at the 6 foot elevation) were increasing at a rate of 13.7 K/sec (24.7°F/sec) and 16.1 K/sec (29.0°F/sec), using the Cathcart-Pawel and Baker-Just correlations, respectively.

TRACE predicted cladding temperatures (at the **8 foot elevation** at 18 seconds) of 1366.3 K (1999.7°F) and 1417.6 K (2092°F), using the Cathcart-Pawel and Baker-Just (zirconium-steam) correlations, respectively. TRACE predicted cladding temperatures (at the 8 foot elevation) were increasing at a rate of 7.8 K/sec (14.0°F/sec) and 10.7

K/sec (19.3°F/sec), using the Cathcart-Pawel and Baker-Just correlations, respectively.

As explained below, in Run 9573, the test bundle was electrically heated more at the 6 foot elevation than at the 7 foot elevation. However, **according to Westinghouse**, local cladding temperatures at the 7 foot elevation (at 18.2 seconds) **EXCEEDED** the cladding temperatures that TRACE predicted for the 6 foot elevation at 18 seconds.

Even when considering the time difference of 0.2 seconds, (18.2 seconds vs. 18 seconds) we still see that local cladding temperatures in excess of 1644.3 K (2500°F) at (or by) the 7 foot elevation, **EXCEED** those TRACE predicted for the 6 foot elevation. Accounting for the time difference of 0.2 seconds, one can extrapolate that at the 7 foot elevation local cladding temperatures were more than 85 K (153°F) and 40 K (72°F) higher than the cladding temperatures TRACE would predict at the 6 foot elevation (at 18.2 seconds), using the Cathcart-Pawel and Baker-Just correlations, respectively.

Three Questions:

First) Please tell me, was the section of the Run 9573 test bundle that Westinghouse called the "severe-damage zone," where local temperatures exceeded 1644.3 K (2500°F) at 18.2 seconds, bounded by the TRACE “average” temperature predictions when the metal-water reaction is accounted for with either the Cathcart-Pawel or Baker-Just models? If your answer is **YES**, please explain why.

Second) Would you please acknowledge the existence of severe-damage zone that Westinghouse reported?

Third) Would you please acknowledge that the NRC's TRACE simulation of FLECHT Run 9573 **excluded** the 7 foot steam-probe thermocouple data that Westinghouse reported? That is the test data that indicated thermal runaway.

At a January 31, 2013 meeting on public participation, the **NRC Commissioners** said: "The staff should consider and respond to Mark Leyse’s comments regarding his petition for rulemaking PRM-50-93 in its review of that petition." (The reference to the Commissioners' meeting is below.)

The Staff has **NOT** responded to the comments I made to the Commissioners. I gave the Commissioners my presentation over two and a half years ago. My comments were about the NRC's flawed TRACE Simulation of Run 9573--about the fact that the data from the 7 foot elevation was omitted. That is the test data that indicated thermal runaway. I also showed the Commissioners photographs of the test bundle's severe damage zone.

This is a not an academic exercise. This is a major safety issue. What about all the power uprates the NRC has approved?

As flawed as the NRC's TRACE simulation of Run 9573 is, when comparing it to the Run 9573 test results, it may indicate that the Baker-Just and Cathcart-Pawel correlations are inadequate. So what does the NRC do? Does it question the safety of all the power uprates it has approved? Does it rush to investigate the other evidence I've provided indicating that power uprates have been qualified by computer models that under-predicted zirconium-steam reaction rates? That is investigate whether public safety has been jeopardized.

Background on FLECHT Run 9573:

In FLECHT Run 9573, the electrical heater rods generated their maximum heat (to simulate decay heat) at the 6 foot elevation, because the test bundle was designed so that the maximum power was generated at the middle elevation (6 feet up from the base) in order to mimic an actual fuel assembly. In Westinghouse's report this is referred to as a "cosine power distribution" (See pages 2.5 and 3.31 of WCAP-7665).

In Run 9573, Westinghouse positioned thermocouples at the 2, 4, 6, 8, 10 foot elevations (up from the base) in the test bundle. (See page 2.10 of WCAP-7665.) And, as stated above, there was a steam-probe thermocouple located at the 7 foot elevation. (The steam-probe thermocouple is referred to on page 3.97 of WCAP-7665.)

Westinghouse stated that “[p]ost-test bundle inspection indicated a locally severe damage zone within approximately ±8 inches of a Zircaloy grid at the 7 ft elevation.” Westinghouse also stated that “[t]he heater rod failures were apparently caused by localized temperatures in excess of 2500°F.” Additionally, Westinghouse stated that during FLECHT Run 9573 "heater element failures started at 18.2 seconds." (See page 3.97 of WCAP-7665.)

Comments on the NRC’s Draft Interim Reviews of PRM-50-93 and PRM-50-95:

On April 12, 2014, I sent the NRC Staff additional comments that reiterate and further expand on issues I raised in my January 31, 2013 presentation to the NRC Commissioners. I request that the Staff also consider and respond to my April 12, 2014 comments. The April 12, 2014 comments are in ADAMS at ML14104B253.

Please this e-mail in ADAMS.

Thank you,

Mark Leyse

References:

1) F. F. Cadek, D. P. Dominicis, R. H. Leyse, Westinghouse, “PWR FLECHT (Full Length Emergency Cooling Heat Transfer) Final Report,” WCAP-7665, April 1971, (ADAMS Accession No. ML070780083).

2) Robert H. Leyse, Westinghouse, Nuclear Energy Systems, Test Engineering, Memorandum RD-TE-70-616,

"FLECHT Monthly Report," December 14, 1970. I submitted this memorandum to the NRC in 2009 when I submitted PRM-50-93. See Mark Leyse, "PRM-50-93," November 17 2009, (ADAMS Accession No. ML093290250), Appendix I.

3) NRC, "Draft Interim Review of PRM-50-93/95 Issues Related to Conservatism of 2200 degrees F, Metal-Water Reaction Rate Correlations, and 'The Impression Left from [FLECHT] Run 9573' ," October 16, 2012, (ADAMS Accession No. ML12265A277).

4) Mark Leyse, "Mark Leyse's Comments for the January 31, 2013 Meeting on Public Participation in NRC Regulatory Decision-Making," January 30, 2013, in NRC, "Public Participation in NRC Regulatory Decision-Making," January 31, 2013, (ADAMS Accession No. ML13031A508).

5) NRC, "Staff Requirements: Briefing on Public Participation on NRC Regulatory Decision-Making, January 31, 2013," March 5, 2013, (ADAMS Accession No. ML13064A407).

Papers and quotes referring to modifications of the TRACE code predicting the peak cladding temperature (PCT):

6) "A PWR plant model based on the reactor system code TRACE has been assembled to enable the simulation of a broad spectrum of anticipated operational occurrences (AOO) and design basis accidents (DBA). … Among the accidents analyzed, the largest performance difference between the oxide fuel and the nitride fuel is in the LBLOCA [large break loss-of-coolant-accidents] where the peak clad temperature (PCT) for the nitride fuel is 30 K lower than that of the oxide fuel." See L-Y. Cheng *et al*., "PWR Plant Model to Assess Performance of Accident Tolerant Fuel in Anticipated Transients and Accidents," Brookhaven National Laboratory, BNL-107113-2015-CP, December 2014, p. 1.

7) "Concerning detection of core heat-up, the relationship between the CET [core exit temperature] and the Peak-Clad-Temperature (PCT) predicted by TRACE for the ROSA test…" See H. Ferroukhi *et al*., "STARS Safety Research in relation to Transient Analysis of the Reactors in Switzerland," Paul Scherrer Institut, 2012, p. 195. The paper is at: https://www.psi.ch/stars/ProgressReportsEN/Year-2012.pdf