

79

Fairbanks, Carolyn

**From:** Fairbanks, Carolyn *CC*  
**Sent:** Monday, August 27, 2012 4:02 PM  
**To:** Kirk, Mark  
**Cc:** Csontos, Aladar; Hardies, Robert; Stevens, Gary; Tregoning, Robert; Focht, Eric; Benson, Michael; Hiser, Allen; Ray, Neil; Sheng, Simon; Poehler, Jeffrey; Widrevitz, Dan; Rosenberg, Stacey  
**Subject:** COMMENTS - RE: RESEND: draft slides for 8/28 public meeting  
**Attachments:** 2012-08-28 - pub mtg slides - NRR comments.pptx

Attached are comments on 2 slides for the 8-28-2012 meeting. There were no comments on the other slides.

**From:** Hardies, Robert *RR*  
**Sent:** Monday, August 27, 2012 3:37 PM  
**To:** Kirk, Mark  
**Cc:** Csontos, Aladar; Stevens, Gary; Tregoning, Robert; Focht, Eric; Benson, Michael; Hiser, Allen; Ray, Neil; Sheng, Simon; Poehler, Jeffrey; Fairbanks, Carolyn; Widrevitz, Dan  
**Subject:** RE: RESEND: draft slides for 8/28 public meeting

Awesome, thanks.

Robert Hardies  
 Senior Level Advisor for Materials Engineering  
 Division of Engineering  
 Office of Nuclear Reactor Regulation  
 U.S. Nuclear Regulatory Commission

Office Phone 301 415-5802

**From:** Kirk, Mark *RES*  
**Sent:** Monday, August 27, 2012 3:36 PM  
**To:** Hardies, Robert  
**Cc:** Csontos, Aladar; Stevens, Gary; Tregoning, Robert; Focht, Eric; Benson, Michael; Hiser, Allen; Ray, Neil; Sheng, Simon; Poehler, Jeffrey; Fairbanks, Carolyn; Widrevitz, Dan  
**Subject:** RE: RESEND: draft slides for 8/28 public meeting

Ah yes! We can introduce this as a topic for further enlightened investigation when I get to slide 6 ... and I can bring a few backup slides from our end of May briefing of NRR and NRO that I can use to provide additional details, should these be needed.

**From:** Hardies, Robert  
**Sent:** Monday, August 27, 2012 3:34 PM  
**To:** Kirk, Mark  
**Cc:** Csontos, Aladar; Stevens, Gary; Tregoning, Robert; Focht, Eric; Benson, Michael; Hiser, Allen; Ray, Neil; Sheng, Simon; Poehler, Jeffrey; Fairbanks, Carolyn; Widrevitz, Dan  
**Subject:** RE: RESEND: draft slides for 8/28 public meeting

I don't mean that we would go into solution space on item c), I meant that we would introduce it as an item to be worked.

Robert Hardies

B/137

Senior Level Advisor for Materials Engineering  
Division of Engineering  
Office of Nuclear Reactor Regulation  
U.S. Nuclear Regulatory Commission

Office Phone 301 415-5802

**From:** Kirk, Mark  
**Sent:** Monday, August 27, 2012 2:26 PM  
**To:** Hardies, Robert  
**Cc:** Csontos, Aladar; Stevens, Gary; Tregoning, Robert; Focht, Eric; Benson, Michael; Hiser, Allen; Ray, Neil; Sheng, Simon; Poehler, Jeffrey; Fairbanks, Carolyn; Widrevitz, Dan  
**Subject:** RE: RESEND: draft slides for 8/28 public meeting

The stated purpose of the meeting (from the public meeting announcement, attached, was purposely vague and evasive. It said:

The purpose of this meeting is to discuss current findings from the NRC staff evaluation of P-T limits established according to MRP-250 guidelines, as well as of P-T limits established according to current ASME Code practice.

Bob's objective is more precise ... but I would not agree totally. My point of disagreement is on Item (c), which we went over in detail last week at ASME Code. There is not time on the agenda tomorrow to review this in any level of detail ... the code discussion took 5 hours on this topic alone (staff presentation is limited to half an hour giving us time to only highlight what has been said, *ad nauseum*, before), so it is not in our (RES's) plan. My view is that if the industry wants to have continued discussions on / critique the cladding & shallow flaw model, and offer alternatives then that is a fine action item that we can, and should, assign to a smaller working group to take up after tomorrow's meeting.

I agree with Bob's objectives (a) & (b).

Mark

**From:** Hardies, Robert  
**Sent:** Monday, August 27, 2012 2:18 PM  
**To:** Kirk, Mark  
**Cc:** Csontos, Aladar; Stevens, Gary; Tregoning, Robert; Focht, Eric; Benson, Michael; Hiser, Allen; Ray, Neil; Sheng, Simon; Poehler, Jeffrey; Fairbanks, Carolyn; Widrevitz, Dan  
**Subject:** RE: RESEND: draft slides for 8/28 public meeting

The objectives for tomorrow's meeting is?

I think it is to: a) solicit industry help in defining heat up and cooldown actual transient shape and frequency, b) solicit industry help in understanding procedural and physical constraints on heat up and cooldown that might prevent plants from being able to challenge the limiting transient, and c) outline for industry the structure of the FAVOR cladding model to enable industry to offer insight into potentially missing or misapplied metallurgical factors associated with cladding flaw density and cladding and near surface material properties, or anything else they might know that we might find to be enlightening and essential.

Is my understanding correct?

Robert Hardies

Senior Level Advisor for Materials Engineering  
Division of Engineering  
Office of Nuclear Reactor Regulation  
U.S. Nuclear Regulatory Commission

Office Phone 301 415-5802

---

**From:** Widrevitz, Dan *MDR*  
**Sent:** Monday, August 27, 2012 1:45 PM  
**To:** Fairbanks, Carolyn; Poehler, Jeffrey; Sheng, Simon; Hardies, Robert  
**Subject:** FW: RESEND: draft slides for 8/28 public meeting

Eh? See paragraph below, which is Mark's response to my suggestion of having a slide concerning clad-cracking. I'm not sure how to respond...

---

**From:** Kirk, Mark  
**Sent:** Monday, August 27, 2012 1:39 PM  
**To:** Widrevitz, Dan  
**Cc:** Csontos, Aladar; Stevens, Gary; Tregoning, Robert; Focht, Eric; Benson, Michael  
**Subject:** RE: RESEND: draft slides for 8/28 public meeting

Dan –

It is a bit late to include this level of detail in a slide for tomorrow, in my opinion. Some of these points I do not agree with ... or perhaps the more accurate point is that I'm not sure I understand enough to say I agree or not depending only on what is in an e-mail. In my view the work done by ORNL to date speaks to the adequacy and accuracy of the FAVOR model. There may, however, be something we have missed ... and I think that a completely appropriate action coming out of tomorrow's meeting would be for a more comprehensive – broader based – review of the clad model. Maybe NRR would like to collaborate with the industry on such a review as you both seem to have similar questions ☺.

Regarding your PS, several things to consider:

- Within the context of a LEFM model (which we have shown to be appropriate for the crack depth and toughness values we are looking at) the postulated crack is loaded with the stresses acting on the uncracked body.
- For the type of stress relief you postulate to be complete the cracking would have to be quite extensive. That is not, to me, a credible case.
- The cladding is FCC and, as such, very ductile. I can't see crazing occurring.

Mark

---

**From:** Widrevitz, Dan  
**Sent:** Monday, August 27, 2012 1:28 PM  
**To:** Kirk, Mark  
**Subject:** RE: RESEND: draft slides for 8/28 public meeting

In discussion with my colleagues this morning, we noted that it may be profitable to add a slide covering the gaps in FAVOR modeling of the clad to base-metal interface.

Something along these lines:

FAVOR Clad Model

[does/assumes this]

Flaws exist, material properties in clad, material properties in base metal, propagation when criteria met

[does not account for: this]

HAZ toughness, crazing -> stress relaxation, something or other

The benefit of this is striking the other end of the CDF numbers (the first end being our uncertainty with transients).

If this isn't clear, I should be available until ~4PM at 301-415-2620.

--Dan

Ps – Tell me where I'm going wrong, but if the stress was really bad in the clad, wouldn't it delaminate or craze BEFORE driving cracks much deeper into the base metal? Just my old composites classes whispering in my mind's ear.

---

**From:** Kirk, Mark

**Sent:** Monday, August 27, 2012 8:43 AM

**To:** Kirk, Mark; Hardies, Robert; Csontos, Aladar; Rosenberg, Stacey; Widrevitz, Dan; Poehler, Jeffrey; Purtscher, Patrick; Fairbanks, Carolyn; Sheng, Simon; Ray, Neil

**Cc:** Tregoning, Robert; Benson, Michael; Stevens, Gary; Focht, Eric; Rowley, Jonathan

**Subject:** RESEND: draft slides for 8/28 public meeting

I'm sure this e-mail has by now scrolled off everyone's screen, and since I have to date received no comments from anyone I thought I would resend. If you wish to comment on the attached slides for tomorrow's meeting you should do so today. I would like to call NRR's attention to 2 questions regarding schedule (highlighted in yellow below) that are likely to arise at tomorrow's meeting.

---

**From:** Kirk, Mark

**Sent:** Wednesday, August 22, 2012 2:16 PM

**To:** Hardies, Robert; Csontos, Aladar; Rosenberg, Stacey; Widrevitz, Dan; Poehler, Jeffrey; Purtscher, Patrick; Fairbanks, Carolyn; Sheng, Simon; Ray, Neil

**Cc:** Tregoning, Robert; Benson, Michael; Stevens, Gary; Focht, Eric; Rowley, Jonathan

**Subject:** draft slides for 8/28 public meeting

All –

Attached, for your review and comment, is a short set of slides that we (RES Staff) are planning to use to guide discussion at the 8/28 public meeting (the afternoon meeting) on 10 CFR 50 Appendix G, the risk informed revision, and so on. Since we recently (on 8/14) had a detailed technical discussion on this topic at the WGOPC meeting at the ASME Code the purpose of the meeting on the 28<sup>th</sup> is NOT to go into technical details, but rather to plan next steps. In fact you have seen virtually all of the slides in the attachment except for the 8<sup>th</sup> (& final!) slide. I have pasted a copy of that slide below for your convenience.

Calling your attention to the 1<sup>st</sup> major bullet on the slide below I have two questions/comments on which I would value your feedback before the meeting:

- In RES we believe we can pull together documentation of the work we have done to date and have it over to NRR/NRO for review by early to mid October. We feel that it is important to allow the industry to see this information since we are seeking to involve them and want them to do work, but don't want to do so without enabling you all time to comment on the document. To facilitate the easier release of this information we were thinking to (a) just focus on the analysis done and the results (i.e., on the facts) and say nothing of conclusions, and (b) not format this as a NUREG report but more as a topical report, or a note to file. The industry and the public will of course be interested in when such


information can be made available to them. Would it be possible for NRR/NRO to say at the meeting when their reviews could be complete so that the information can be released?

- In the documentation section I have also called attention to the risk analysis that is being documented in the LIC-504 document. Will this document be available for public release? Can it be? The industry was asking for details on this analysis, so if we could provide it to them it would be helpful.

Thanks in advance for your help

mark

## Next Steps

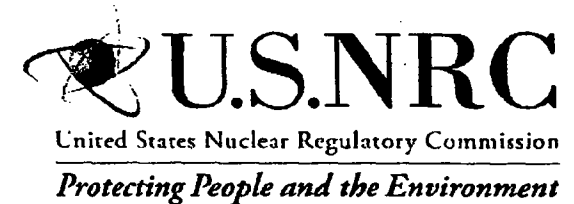


**U.S. NRC**  
United States Nuclear Regulatory Commission  
*Protecting People and the Environment*

- **NRC documentation**
  - Description of current analysis and current results
  - FAVOR 12.0
    - To be released by 10/31/2012
  - NRR LIC-504 document – risk analysis based on currently available information
  
- **Further Analysis**
  - System constraint transients
    - Need information on how these are specified, generic or plant specific, etc.
  - Analysis of actual normal operating transients
    - Need data on these transients
  - Refined risk assessment
    - Need data on event frequency
  - Other ????
  
- **Questions**
  - Do other actions need to be added above?
  - Who will be doing what, and by when?

Mark Kirk  
Senior Materials Engineer  
NRC/RES/DE/CIB  
mark.kirk@nrc.gov

# List of Major Findings



## 1. Concerning risk informed vs. ~~current~~ limiting P-T limit procedures

- a. R-I lowers CPF for cooldown (relative to current procedures)
- b. R-I often increases CPF for heatup (relative to current procedures)
- c. R-I increases CPF for leak tests (relative to current procedures)

## 2. Concerning ~~current P-T limit procedures~~ a postulated transient following the P-T limits

- a. Can produce  $CPF > 10^{-6}$
  - b. The  $\frac{1}{4}T$  flaw does not produce the highest risk for cooldown, shallow flaws do
  - c. Leak tests are permitted at temperatures close to  $RT_{NDT}$  in BWRs
  - d. Actual transients (usually) have  $< CPF$  than idealized transients
- Other P-T limits would produce different results

Today's focus

**(2a) ~~Current~~ Using a postulated transient following the P-T limits, P-T limit procedures can produce CPF > 10<sup>-6</sup>**



Loading Condition	Flaws for which where Current Pressure Limits Produce CPF > 10 <sup>-6</sup>	CPF Range
Cooldown	Embedded Shallow surface breaking	Slightly above 10 <sup>-6</sup> if RT <sub>MAX(AW)</sub> > 247 °F 10 <sup>-4</sup> to 10 <sup>-2</sup> across a wide range of RT <sub>NDT</sub>
Heatup	Deep surface breaking Deep surface breaking	Up to 5x10 <sup>-5</sup> if RT <sub>MAX(AW)</sub> > 247 °F 10 <sup>-4</sup> to 10 <sup>-2</sup> above a/t = 0.2
Leak Test*	Any surface breaking	10 <sup>-4</sup> to 10 <sup>-2</sup> across a wide range of RT <sub>NDT</sub>

\* Leak test temperature can be close to, or below, RT<sub>NDT</sub> depending on margin & vessel geometry