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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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 NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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METALLURGY AND REACTOR FUELS SUBCOMMITTEE

OPEN SESSION

+ + + + +

TUESDAY, MAY 3, 2016

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ROCKVILLE, MARYLAND

+ + + + +

The Subcommittee met at the Nuclear
 Regulatory Commission, Two White Flint North, Room
 T2B1, 11545 Rockville Pike, at 1:05 p.m., Ronald G.
 Ballinger, Chairman, presiding.

COMMITTEE MEMBERS:

RONALD G. BALLINGER, Chairman

CHARLES H. BROWN, JR. Member

DANA A. POWERS, Member

JOY L. REMPE, Member

PETER RICCARDELLA, Member-at-Large

GORDON R. SKILLMAN, Member

JOHN W. STETKAR, Member

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DESIGNATED FEDERAL OFFICIAL:

DEREK WIDMAYER

ALSO PRESENT:

KATHRYN BROCK, RES

MARK KIRK, RES

MARVIN LEWIS, Public Participant*

ANDREA D. VALENTIN, Executive Director, ACRS

*Present via telephone

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P R O C E E D I N G S

(1:05

p.m.)

CHAIRMAN BALLINGER: Okay. Good afternoon. The meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards Subcommittee on metallurgy and reactor fuels. I'm Ron Ballinger, Chairman of the Subcommittee.

MEMBER POWERS: What is wrong with you?

CHAIRMAN BALLINGER: ACRS members -- and I use that term lightly -- in attendance: Pete Riccardella, Gordon Skillman, Dana Powers, John Stetkar, Charlie Brown, and the esteemed Joy Rempe. Derek Widmayer of the ACRS staff is the Designated Federal Official for this meeting.

The purpose of today's meeting is for the NRC staff to discuss the final draft Regulatory Guide 1.230. Regulatory guidance on the alternate Pressurized Thermal Shock rule and draft final report NUREG-2163, technical basis for regulatory guidance on the alternate Pressurized Thermal Shock rule, otherwise known as 10 CFR 50.61a.

The Subcommittee considered this matter at a Subcommittee meeting held in October 2015 and

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1 many others but decided to meet again and hear from
2 the staff after it received comments on the draft
3 documents. The Subcommittee will gather
4 information, analyze relevant issues and facts,
5 formulate proposed positions and actions as
6 appropriate, for consideration by the full
7 Committee at the upcoming June 235th meeting of the
8 ACRS.

9 Rules for participation in today's
10 meeting were announced as part of the notice of the
11 meeting published in the Federal Register.
12 Detailed proceedings for conduct of the ACRS was
13 previously published in the Federal Register on
14 October 1, 2014. The meeting will be open to the
15 public, except for a portion of the meeting at the
16 end which will be closed in order to discuss public
17 comments and the proposed NRC staff resolutions to
18 those comments.

19 We have received no written comments or
20 requests for time to make oral statement. A
21 transcript of today's meeting is being kept and
22 will be made available, as stated in the Federal
23 Register Notice. Therefore, we request that
24 meeting participants use the microphones located in
25 the meeting room when addressing the Subcommittee

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1 and push the little green button when you need to
2 talk. Participants should first identify
3 themselves and speak with sufficient clarity and
4 volume so that they may be readily heard.

5 A telephone bridgeline has been
6 established for this meeting. To preclude
7 interruption of this meeting, please mute your
8 individual telephones and lines during
9 presentations and the Subcommittee discussion. We
10 ask that attendees in the room please silence all
11 cell phones and things that beep and other devices
12 that make noise to minimize disruptions.

13 And we'll now proceed with the meeting.
14 I'll call on Mark Kirk. Whoa.

15 MS. BROCK: Good afternoon.

16 CHAIRMAN BALLINGER: Call on Kathryn
17 Brock -- boy, that is a good entrance -- Deputy
18 Director of the Office of Research, Division of
19 Engineering, to make introductory remarks. Thank
20 you.

21 MS. BROCK: Thank you very much. So
22 it's my pleasure to introduce Dr. Mark Kirk, who is
23 going to be presenting the NRC's response to public
24 comments on what's now designated as Reg Guide
25 1.230 and its supporting technical basis, NUREG-

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1 2163.

2 These documents provide methods
3 acceptable to the staff by which licensees could
4 choose to implement the alternate Pressurized
5 Thermal Shock rule, or PTS. As Mark will talk to
6 you about in some detail, this issue on PTS goes
7 back around two decades, and Mark has been always
8 happy to come to ACRS to address this committee and
9 your comments have always been very helpful to us,
10 and we appreciate it.

11 So at this stage, we're ready to move
12 forward with the final reg guide, subject to this
13 committee's approval. Thanks very much.

14 CHAIRMAN BALLINGER: Okay. All yours.

15 MS. BROCK: Okay, all right. Thank
16 you. Well, hopefully, my closeout performance
17 here. So in terms of an overview, I'll just give
18 some background on the alternate PTS rule
19 development, on the PTS rule regulatory guide,
20 including the reg guide development process and its
21 current status, and provide an overview of the
22 contents of the tech basis and the reg guide. The
23 tech basis is a companion NUREG that went out for
24 public comment at the same time as the reg guide.

25 I'll provide a few slides on plants

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1 that might possibly use 10 CFR 50.61a -- and I'll
2 probably go back and forth between saying 50.61a
3 and the alternate PTS rule, they both mean the same
4 thing -- and Reg Guide 1.230 in the future. Then I
5 believe, at that point, the meeting gets closed to
6 discuss the staff's responses to public comments on
7 the reg guide and tech basis.

8 And at the end, we're looking for this
9 committee to either send a memo to NRC Research
10 approving the reg guide and NUREG for publication
11 or to send a letter to the EDO, of course,
12 objecting to that. But you'll figure that out, I'm
13 sure.

14 MEMBER POWERS: ACRS speaks only
15 through its letters.

16 MR. KIRK: Yes.

17 CHAIRMAN BALLINGER: And that's up to
18 the full Committee.

19 MR. KIRK: Okay, okay.

20 MEMBER REMPE: And if we were to issue
21 a memo, like a Hackett-Gram or a Valentine memo, it
22 would not be an approving thing. It would just say
23 we have no comments on this thing.

24 MR. KIRK: Okay, okay, thank you. So
25 the first topic is just to set the scene, the quick

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1 overview -- I say quick in a bit of quotation marks
2 -- on the development and background of the
3 alternate rule. This is the last 18 years of my
4 life. I was thinking of including a picture of
5 myself in 1998, but the contrast to my current
6 state of decrepitude was too horrible for me to
7 reconcile, so I went without pictures. You're
8 welcome.

9 CHAIRMAN BALLINGER: They had film back
10 in those days. Is there any film left?

11 MR. KIRK: I think it was a
12 Daguerreotype, but I'm not really sure. Anyway,
13 this project started shortly before I joined the
14 NRC staff in 1998, and I quickly got involved in it
15 and it's been very interesting. And the first two
16 years or so, we spent a lot of time meeting among
17 ourselves, having public meetings, interacting with
18 our industry counterparts to develop a PFM Code to
19 simulate what would happen to a nuclear reactor
20 pressurized water reactor in the unlikely event of
21 a Pressurized Thermal Shock Event.

22 Once we had a code, of course it didn't
23 work perfectly the first time, so there were
24 several modifications to the code. And we were
25 briefing the ACRS all along the way. We used to

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1 come here about twice a year, as I recall.

2 And, finally, at the end of the phase
3 that I've called building the technical case in the
4 2005 - 2006 time frame, the technical reports were
5 all given a favorable nod by this committee. And
6 about a year later, the Commission directed the
7 staff to begin rulemaking.

8 The rulemaking process itself, in this
9 case, took about two and a half years, as my
10 colleague sitting in the back, Matt Mitchell,
11 remembers. I believe he had hair at that time.

12 We went out for two rounds of public
13 comments and, ultimately, arrived at what was
14 published on, I believe, January the 3rd, 2010 as
15 the alternate PTS rule. As government printing
16 goes, it then took about six more months and three
17 re-publications to get everything correct.

18 Since that time, we've been working on
19 guidance for using the rule. The industry,
20 however, works a little bit quicker than the
21 government and, actually, two submittals came in to
22 use the rule before we get the draft guidance
23 released for public comment.

24 Beaver Valley submitted in the middle
25 of, in the summer of 2013. Palisades submitted in

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1 the summer of 2014. I'll tell you the rest of the
2 story later, but "Beaver Valley submits" is crossed
3 out because they later elected to withdraw their
4 submittal for reasons I'll explain later. But the
5 Palisades submittal was fully reviewed by the
6 staff, went through several rounds of RAIs, two as
7 I recall, and was eventually approved a little
8 before Christmastime of last year.

9 Pertinent to the discussions here,
10 Draft Guide 1299, which is subject to the favorable
11 ratings from this committee and the printing press
12 is still working will become Reg Guide 1.230, was
13 released for public comment at the end of 2014 or
14 early 2015, and today we're talking about those
15 public comments and I'll say the relatively small
16 ways in which they've changed the draft reg guide
17 and how we plan on moving forward.

18 A little bit of background. What's in
19 10 CFR 50.61a and why was it developed? And as
20 it's indicated on the slide, this was explained in
21 Chapter 1 of NUREG-2163, which you'll also hear me
22 call the tech basis document.

23 So the path to 50.61a, we'll talk a
24 little bit about the motivation for doing this at
25 all, the overall approach that the staff employed,

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1 the key results, and a brief discussion of the
2 provisions of the alternate rule.

3 So, of course, the original PTS rule,
4 to which this is an alternate, was developed in the
5 early 1980s and promulgated, I always get this
6 wrong and I shouldn't, I think in 1986. At the
7 time, there was, I think, broad recognition
8 throughout the nuclear community and among the NRC
9 staff that the calculations and the data that
10 supported the original PTS rule, 50.61, had within
11 it a lot of embedded conservatisms that, at the
12 time, were not seen as being necessary to be made
13 better because the nuclear industry was a lot
14 younger then, plants weren't coming up on 40-year
15 licenses or going for 60 or 80, so the
16 conservatisms that were embedded in the
17 embrittlement screening criteria that are still
18 part of the original PTS rule 50.61 weren't seen to
19 be in any way limiting or excessively conservative.

20 I should say, from that time, there was
21 talk among various parties of an interest in
22 revising the rule or doing a better job. That
23 finally culminated with staff interest pushed
24 forward by Mike Mayfield in the late 1990s and was
25 motivated by several things. One was, just looking

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1 at it from a technical viewpoint, was a desire to
2 do a better job, to treat everything more
3 realistically. But, of course, just technically
4 doing a better job isn't enough reason to do
5 something. There are also some key regulatory
6 motivations, and they're listed here. One is that
7 doing a better job would reduce unnecessary burden
8 associated with the original rule. As I said, the
9 technical insights indicated that the then existing
10 screening criteria were more conservative than were
11 needed to maintain safety and that those screening
12 criteria don't necessarily increase the overall
13 plant safety and, in fact, could divert resources
14 on other more risk-significant matters.

15 Part of the reason motivating the
16 alternate rule was the experience, and I'll say, I
17 think, routinely bad experience, from the early
18 1990s with plant-specific analysis using PRA and
19 PFM as a means of showing that operating beyond the
20 then existent 50.61 screening criteria was
21 acceptable, otherwise known as Yankee Row. So
22 there was an interest in doing something more
23 generically for the fleet with the hope that things
24 like Yankee Row and the associated uncertainties
25 associated with that process would not be repeated.

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1 And also, as we got into the late 1990s
2 - early 2000s, things that weren't apparent in the
3 mid-1980s, like license renewal, and now I've been
4 around long enough I can say license renewal-
5 renewal or the NRC's acronym for that is SOR, those
6 things weren't even thought of. Now they're
7 thought of. Now license renewal has happened, and
8 we're talking about subsequent license renewal. So
9 having screening limits that are overly
10 conservative creates an artificial impediment to
11 those processes.

12 MEMBER SKILLMAN: Mark, before you
13 change that slide, for those who have been around
14 for a long time, 300 degrees Fahrenheit and 270
15 Fahrenheit are numbers that we've all come to know
16 and trust. For instance, that's about where you go
17 ahead and give permit to the fourth pump start, so
18 you don't lift your fuel. That's where the density
19 has become low enough that starting a fourth
20 reactor coolant pump doesn't cause your fuel to
21 chatter. It's married to the springs. 270 is
22 commonly a run back. The secondary dumps or the
23 atmospheric dumps might bring the plant back to 270
24 automatically.

25 Those numbers were chosen many years

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1 ago based on knowing how a P will operate. And I
2 think if one were to check the Westinghouse, the
3 Babcock, and the CEs, all used approximately those
4 same numbers. And so I'm wondering if simply by
5 anointing them as too conservative, the baby being
6 thrown out with the bath water, something is being
7 lost.

8 MR. KIRK: I'd like to just clarify
9 what I think you told me. You're saying that, in
10 plant operation, those numbers mean something?

11 MEMBER SKILLMAN: Certain events have
12 been associated with these numbers.

13 MR. KIRK: Yes.

14 MEMBER SKILLMAN: And I'm not
15 suggesting that they, in themselves, represent a
16 conservatism that should be retained. All I'm
17 saying is, when you look at those numbers and if
18 you're an old P handler, you say I know what those
19 numbers mean.

20 MR. KIRK: Yes, in tech specs, they're
21 all over the place. And I'm, well, I'm not a plant
22 operations person, but I certainly wouldn't be
23 suggesting that that operational practice should
24 change. And, in fact, I can say for certain that,
25 to the analyses that we did reflected current plant

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1 operating procedures. So to the extent that we
2 analyzed transients involving the things that
3 you've said, and I'll just have to plead ignorance
4 because, again, that's not my specialty, the
5 assumption moving forward is that those operational
6 events would not be changing as a result in the
7 change in the embrittlement screening criteria.

8 I'll just say I haven't personally,
9 before you mentioned this which probably reflects
10 that I should get out more often, heard anybody
11 say, oh, now, we change these plant operational
12 procedures because the NRC has put out a new --

13 MEMBER SKILLMAN: No, you can't because
14 you still have those other thermal hydraulic issues
15 that you have to deal with --

16 MR. KIRK: Right, right.

17 MEMBER SKILLMAN: -- that is like when
18 the density is appropriate, so you don't lift your
19 fuel if you start the fourth --

20 MR. KIRK: So I think there are other,
21 I mean, I think you've maybe provided a better
22 answer than I have. There are other reasons to
23 keep those operating procedures in place that are
24 completely different than screening limits related
25 to plant integrity.

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1 MEMBER SKILLMAN: Thank you.

2 MR. KIRK: Okay. So our overall
3 approach was that we started with commissioned
4 guidance in the form of the Safety Goal Policy
5 Statement, the June 1990 Safety Requirements
6 Memorandum and Reg Guide 1.174 to derive a
7 performance metric in terms of -- well, basically,
8 here the conservative assumption was that large
9 early release frequency was equal to yearly
10 frequency of through-wall cracking, and so that was
11 set at a one times seven to the minus six level,
12 and then we performed a number of probabilistic
13 fracture mechanics analyses driven by PRA at the
14 start to define the sequence of things that could
15 go wrong that could lead to a Pressurized Thermal
16 Shock or excessive cool-down and the frequency with
17 which they happen. The PRA then fed the thermal
18 hydraulic analyses to define the pressure
19 temperature and heat transfer boundary conditions
20 that go into the structural mechanics and fracture
21 mechanics analysis. There are a bunch of other
22 inputs that aren't shown here.

23 But that then gives us a conditional
24 probability of through-wall cracking. It's then
25 multiplied, matrix multiplied by the event

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1 frequencies, to estimate the yearly frequency of
2 through-wall cracking. We did that analysis for
3 three plants, or I should say models of three
4 plants, that we studied in detail, those being the
5 Palisades plant, the Beaver Valley plant, and
6 Oconee; developed from that this relationship
7 between vessel damage as quantified by vessel
8 transition temperature, showed that, of course, as
9 that increases, as embrittlement increases, the
10 yearly frequency of through-wall cracking
11 increased. Used that to develop a screening
12 criteria consistent with defense-in-depth
13 principles and then looked at what were the key
14 things driving these values to see if we could
15 generalize those results to all plants in the
16 fleet. And I'll talk a little bit more about that
17 as we go on, which is now.

18 So in terms of some of the key results
19 I'd like to highlight: What are the operational
20 transients that most influence the PTS risk?
21 Similarly, what are the material features that most
22 influence the PTS risk? And then sort of the key
23 question to our development of a rule that could
24 apply to all PWRs is to see if these dominant
25 material features and transients are, more or less,

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1 similar across the fleet or do they vary by a
2 plant-by-plant or designer-by-designer basis? And
3 then talk about finally the new embrittlement --
4 well, then new, this is a slide from I think 2007 -
5 - embrittlement screening criteria based on these
6 calculations.

7 So we did a pretty thorough job at
8 modeling, I'll just say all the classes of cool-
9 down transients that could occur under postulated
10 accident conditions. So we had a spectrum of pipe
11 breaks from very small to very large, stuck-open
12 valves that later re-closed. On the secondary
13 side, we had main steam line breaks and basically
14 tried to model the plant as accurately as we could
15 for things that could go wrong and ruin your day,
16 from a plant operations perspective.

17 Looking at all of that, so we modeled
18 all these different variations of cool-down events
19 with and without pressure. But then when we got to
20 looking at the results, things pretty much fall
21 into one of three categories, which I've depicted
22 here. I should say things fell into one of three
23 categories for cool-down events that had risk
24 significance.

25 In the end in this project, we

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1 calculated an awful lot of zeros, so one category
2 with significant cool-downs is medium- and large-
3 diameter pipe breaks. The second category is
4 stuck-open primary side valves. So a stuck-open
5 valve is something like a small-diameter pipe
6 break, but the key thing there is the valve re-
7 closes later in the transient and leads to a
8 pressurization spike.

9 And then the third is main steam line
10 breaks, and all of these are plotted versus
11 embrittlement and degrees Rankine, and everybody
12 always asks me why I use degrees Rankine, and I
13 think I had a good technical reason years ago and,
14 in the fullness of time, it's been revealed that it
15 just annoys people. So as Candidate Clinton said,
16 it seemed like a good idea at the time, but now I
17 realize it was a mistake.

18 So this slide 16 is pretty much the
19 same as slide 15 but easier to look at because I've
20 re-expressed the through-wall cracking frequencies
21 as ratios of each other. And this really more
22 better communicates the message, which is -- and
23 now I've gone back to degrees Fahrenheit just to
24 confuse everyone -- at lower levels of
25 embrittlement, the stuck-open valves that re-close

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1 late in the transient and lead to a re-
2 pressurization spike, they're the transients that
3 are dominating a risk because you need that light
4 pressure spike to get a crack going in, admittedly
5 an embrittled but a not too embrittled material.

6 However, as you embrittle the material
7 more and more, of course all of these through-wall
8 cracking frequencies are going up, but the rate of
9 increase per increment of embrittlement, if you
10 will, for the medium- and large-diameter pipe
11 breaks is larger, such that when you get out to
12 reference temperatures in the range where we're
13 setting our screening criteria, it's actually the
14 medium- and large-diameter pipe breaks that are
15 dominating the risk, that are making up 70 to 80-
16 percent of the risk.

17 Sort of interesting change from the
18 results from the early 1980s is the main steam line
19 breaks, which in the first analysis of PTS in the
20 80s were seen to be the risk dominant transient,
21 now become almost a bit player, and so you ask why.
22 And this is where modeling assumptions become
23 important, and actually there are two illustrations
24 here where modeling assumptions become important.
25 In the original PTS analysis, there was no risk

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1 significance to medium- and large-diameter pipe
2 breaks because they were eliminated from the
3 analysis a priori. It was assumed that you needed
4 pressure, you needed the "P" in PTS to get a
5 through-wall crack.

6 Since the events weren't analyzed, of
7 course they couldn't be risk significant because
8 they were assumed to be zero. When we actually
9 analyzed them, we found that when you get out to
10 sufficient levels of embrittlement, there's not
11 enough crack risk capacity in the material, and
12 they did indeed go through-wall.

13 So a big, you know, sort of change in
14 perspective for what transients matter in PTS and
15 what don't came in this analysis when we learned
16 that, well, when we analyzed something that we had
17 previously eliminated based on, shall I say,
18 engineering judgment, we find out that it really
19 was risk significant, so it should have been
20 analyzed before.

21 Conversely, the opposite is true of
22 main steam line break. In the circa 1980s
23 analysis, the main steam line break was analyzed as
24 a whopping fast cool-down, which, of course, it has
25 to be because you're breaking a huge diameter pipe,

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1 so you're creating a big heat transfer area. But
2 to be conservative, the steam line break was
3 assumed to go down to essentially ambient
4 temperature water, something in the 50 - 60-degree
5 Fahrenheit range. Of course, that can't happen in
6 the primary because the main steam lines are
7 secondary, so the cold is the primary when the main
8 steam line breaks is the boiling point of water,
9 212 Fahrenheit or 100 degrees Celsius.

10 When we included that more realistic model in this
11 set of analysis, we found out that, yes, the main
12 steam line break contributes something but not
13 nearly as much as we saw before.

14 So, you know, this graph I think
15 illustrates some lessons learned in building these
16 models, but it also, I think, provides a very
17 useful lesson moving forward that your perception
18 of reality of course depends on what you model and
19 what you model depends on how you decide to model
20 it. And that drives plant decisions, so we should
21 take care.

22 MEMBER RICCARDELLA: Mark, the new
23 limits, they have separate limits for axial weld
24 plate, circ weld, and forging, and, yet, the last
25 two slides you just said maxed our T. Is that any

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1 specific --

2 MR. KIRK: In here, I've just added it
3 versus the axial weld reference temperature just
4 really for purposes of --

5 MEMBER RICCARDELLA: All right.
6 Because that governs --

7 MR. KIRK: -- for purposes of
8 illustration, but the reason, I think I've said all
9 this so I'll skip this slide, but since you've
10 raised it, the reason for the maximum, the
11 differences in the maximum reference temperature
12 limits, depending upon, essentially, the product
13 form is best illustrated on this slide now, slide
14 18 in your pack, is that -- I'm sorry. I should
15 back up just a little bit.

16 In the probabilistic fracture mechanics
17 models, we see different flaw size populations and
18 different flaw orientations, depending upon what
19 product form in the RPV shell it's going into. So
20 welds get flaws drawn from particular flaw
21 distribution, but they have the orientation of the
22 weld itself because they're all nominally lack of
23 fusion flaws. So axial welds get axially-oriented
24 flaws, circumferential welds get circumferentially-
25 oriented flaws.

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1 So we just compare on your screen the
2 left most and right most slides. You're seeing
3 here flaws from the same population, but the
4 orientation has turned 90. And that makes a major
5 difference when you're trying to propagate a crack
6 through the wall of a pressurized sander in that,
7 as you grow the axial flaw, the deeper the axial
8 flaw gets as it goes through the cylinder, the
9 driving force to fracture just keeps going up and
10 up and up and so, essentially, it just gets pushed
11 out the back of the cylinder.

12 MEMBER RICCARDELLA: Part of it is P
13 over T versus P over $2T$, right? That's one part of
14 it.

15 MR. KIRK: Well, that's one part of it.

16 MEMBER RICCARDELLA: The other part is
17 the --

18 MR. KIRK: But, I mean, so the
19 magnitude is certainly higher for the axial flaw,
20 but there's also, due to just the geometry of the
21 cylinder, as you make the circumferential flaw
22 deeper --

23 MEMBER RICCARDELLA: The K equations
24 are different.

25 MR. KIRK: Yes, the K equations are

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1 different, and so the circ flaw equations hit a
2 peak K somewhere around 30 to 40 percent of the way
3 through the wall under the fixed script conditions
4 that you get in a thermally-driven event. So
5 there's a very natural crack arrest mechanism for
6 circumferential flaws, and, as a result, if you
7 look at any given reference temperature level, if
8 you take your 750 Rankine -- forgive me -- and you
9 go to the curve for the axial flaws, you've got
10 about a 10 to the minus 6 through-wall cracking
11 frequency, whereas that same embrittlement in a
12 circ weld, you're down nearly two decades lower.

13 And the curves you see here is the
14 reason why the reference temperature screening
15 limit, screening criteria I should say, in the rule
16 are so significantly different for the different
17 product forms. The plates are, you're drawing from
18 a different population than the welds. And, also,
19 since there's no preferred orientation in plates
20 for flaws, they're seated 50-percent
21 circumferentials, 50-percent axial. So they wind
22 up being intermediate.

23 MEMBER RICCARDELLA: But, in general,
24 you have smaller flaws --

25 MR. KIRK: Yes. And, in general, the

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1 flaws are much, yes, much smaller. But, you know,
2 an interesting -- well, in the original, in 50.61,
3 of course there's a difference in the screening
4 criteria for axial welds and circ welds, a
5 difference between 270 and 300. You can't see the
6 screening criteria here, so that difference is
7 reflective of this difference in driving force.
8 But in the new calculations, the difference in
9 temperature screening criteria is much, much more
10 than 30 degrees.

11 MEMBER SKILLMAN: Excuse me. Can you
12 explain what the first bullet means, please?

13 MR. KIRK: So the primary side fault.
14 So of the three dominant or sort of dominant
15 transient classes of primary side pipe breaks,
16 there's primary side pipe breaks, there's stuck-
17 open valves in the primary side that re-close
18 later, and there's main steam line breaks. So only
19 one of those is the secondary side fault, the first
20 two being primary side faults, and they together
21 are responsible for pretty much 95 percent of the
22 calculated risk.

23 MEMBER SKILLMAN: And a 35-degree
24 Fahrenheit is your ECCS tank in-flow temperature
25 minimum?

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1 MR. KIRK: Yes, if you have storage on
2 the outside.

3 MEMBER SKILLMAN: Okay, thank you. Now
4 I understand.

5 MR. KIRK: Yes, okay. Sorry. It was
6 that point you were focused on, yes. And I should
7 say in the analysis we did look at differences
8 between ECCS injection temperature, and it, of
9 course, does make a difference.

10 MEMBER RICCARDELLA: Was that a random
11 variable?

12 MR. KIRK: No, we modeled both, and now
13 you're asking me to go back over a decade in my
14 memory. But we modeled both, and it was weighted
15 by an event frequency. You modeled hot, cold and
16 hot?

17 MR. KIRK: Cold and hot, yes.

18 MEMBER RICCARDELLA: Okay, got it.

19 MR. KIRK: But, you know, as an
20 example, if somebody wanted to come in -- so in the
21 screening criteria, the significance of that
22 particular variable doesn't really come out.
23 That's been, I'll say, sort of mushed into the
24 screening criteria by the fact the screening
25 criteria are based on upper bounds to these three

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1 curves here. So we're taking the worst of the
2 conditions modeled, whereas, say if somebody wanted
3 to come in and do a plant-specific analysis and
4 that plan happened to be say in the southern part
5 of the United States where it never gets that cold
6 or they happen to have indoor refueling water
7 storage, they could make that argument and show
8 that the specific calculations for their plant
9 would not be as severe as we've assumed here.

10 And this just shows, again, slide 19
11 shows, and I think a little bit of an easier
12 format, the same message as 18, that, for all
13 intents and purposes, it's the axial weld flaws and
14 the properties of the belt line materials that can
15 be associated with axial weld flaws that drive the
16 PTS risk and that the flaws and plates and the
17 circumferential weld flaws -- excuse me -- play a
18 much more minor role.

19 So we've already talked through this.
20 The axial cracks dominate risk due to their
21 orientation and, well, due to their orientation,
22 and so it's the properties of the materials
23 associated with the actual cracks that dominate the
24 screening criteria, which would be the axial weld
25 properties or the properties of the adjacent plate,

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1 whichever is worse.

2 This is now, you know, sort of one of
3 two ways of looking at the results, and this is, in
4 fact, the way it was codified into the reference
5 temperature limits in 50.61a. Since I like graphs
6 better than tables, this is a graph that depicts
7 I'll say a portion of the tables in 50.61a.

8 So if we had a plant that was made of
9 axial welds and plates, you know, here would be the
10 screening criteria in the table for the axial weld
11 on the horizontal access, the screening criteria on
12 the plate on the vertical axis, and then you'll
13 also see in the tables that there's a combination,
14 a limit on the combination of those two. And
15 really all those are in the tables is an attempt to
16 depict, I'll say, the ISO through-wall cracking
17 frequency surface that came out of curve-fitting
18 these three curves. So what we're saying here, and
19 I think I must have that slide, yes, I have that
20 slide, unfortunately, some place else, what we're
21 saying here is that the through-wall cracking
22 frequency is limited to 10 to the minus 6. It then
23 arises due to the sum of the part due to the axial
24 weld reference temperature, the plate reference
25 temperature, and the circ weld reference

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1 temperature, and you can invert that equation and
2 express it in terms of reference temperatures, as
3 we've done in the rule.

4 The graphs also depict the fact that
5 the rule, that these screening criteria in the rule
6 depend on the thickness of the wall of the vessel.
7 And that's simply a reflection that this is a
8 thermally-driven event, so the thicker wall
9 supports higher stresses during thermal shock so
10 more driving force.

11 MEMBER RICCARDELLA: The thermal
12 stress?

13 MR. KIRK: Right, right.

14 MEMBER RICCARDELLA: Not the flaw size?

15 MR. KIRK: Well, the flaw size, I mean,
16 the flaw sizes are, there's a lot reflected in
17 here. But the differences based on thickness are a
18 reflection of the thermal stress effects.

19 So what you see here, this is a graph
20 actually from NUREG-1807 where, based on plant-wide
21 data we had available at the time and based on, I
22 must say, a now defunct view of capacity factor --
23 here we used a capacity factor of 80 percent to
24 represent 60 years. Of course, we know it's higher
25 now. But this showed that all the dots represent

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1 the operating PWRs, and they're all, at least based
2 on this generic analysis -- of course, people have
3 to do a plant-specific analysis, but based on a
4 simple examination of the fleet, it seemed that
5 everybody would remain compliant with 50.61a if
6 they chose to use it through the end of 60 years.

7 Just another way to look at these same
8 data is to look at histograms of the distributions
9 of reference temperatures in the fleet, again using
10 the same 48 EFP-wide data, and overlay those
11 histograms on the results, the through-wall
12 cracking frequency results that set the screening
13 limits. And, you know, just to show you how to
14 read one of these, you look at the, in this
15 analysis, the highest estimated axial weld -- I'm
16 sorry -- the highest estimated reference
17 temperature in an axial weld was a little bit under
18 740 Rankine, so that's what that bar represents.
19 And if you go up and over, that's getting you a
20 through-wall cracking frequency a little bit less
21 than 10 to the minus 7. Obviously, these graphs
22 would need to be revised today, but this is just
23 what was published in NUREG-1807.

24 So in both cases, both slides 21 and 22
25 are showing you a consistent picture that the

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1 plants that were operating at the time are bid
2 inside the 50.61a screening criteria in terms of
3 reference temperature. And, of course, that also
4 means that the estimated through-wall cracking
5 frequency is below 10 to the minus 6.

6 So everything I've done so far gives
7 you a very quick overview of the information that
8 we've developed to support the alternate PTS rule.
9 Now we'll do a whirlwind tour through the alternate
10 PTS rule itself. You need to meet three gating
11 criteria to use the rule. You need to have a plant
12 whose construction permit was issued before 2010,
13 and I'm going to talk about the reasons for each of
14 these in detail. You need to show that the
15 embrittlement trends, as revealed by the plant-
16 specific surveillance program for your plant,
17 follow those assumed in the calculation of these
18 through-wall cracking frequencies, and you also
19 need to show that the flaw population in your
20 plant, as revealed by ISI, is represented well or
21 bounded by that assumed in the calculation.

22 Having made all those checks, you then
23 demonstrated that, yes, the screening criteria in
24 50.61a would be appropriate to use for your plant.

25 CHAIRMAN BALLINGER: There's a mention

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1 of ASME code also, right? It says that the plant
2 was designed in accordance with a particular
3 revision of the ASME code --

4 MR. KIRK: Yes, or earlier, I think.

5 CHAIRMAN BALLINGER: Yes, or earlier.
6 I forget. 1989 or something like that? I don't --

7 MR. KIRK: You're right. I'm not
8 exactly sure how that --

9 CHAIRMAN BALLINGER: Yes, that was one
10 of the checkmarks.

11 MR. KIRK: Yes, yes, yes.

12 MEMBER SKILLMAN: 1998 edition or
13 earlier.

14 CHAIRMAN BALLINGER: 1998 edition or
15 earlier.

16 MR. KIRK: Okay. And, again, that was
17 simply a reflection of the population of plants
18 that formed the basis for the calculations that led
19 to these screening limits. So let's take that in
20 the construction permit. In practical terms,
21 there's not a lot of changes in the ASME code pre-
22 '98 or post-'98 that's going to affect these
23 calculations. But all we're saying in the rule is
24 if you want to apply theses limits to a newer plant
25 or to a later ASME code-version plant, it's the

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1 responsibility of the licensee to make the case
2 that these same screening criteria apply, the NRC
3 isn't taking it on itself.

4 MEMBER RICCARDELLA: But you'd have to
5 assume that a newer plant would be pretty smart
6 about their chemistry that they put in the --

7 MR. KIRK: You would assume that.
8 Certainly, I would not expect somebody to be
9 building a high-copper plant nowadays, unless
10 they're Rip Van Winkle.

11 So a quick comparison of 10 CFR 50.61
12 to 10 CFR 50.61a. You know, it must be said that
13 50.61a has less restrictive reference temperature
14 or embrittlement screening criteria, and that
15 enables longer operations licensable to this
16 provision of the rules. But a gating criteria must
17 be satisfied to use that alternative rule.

18 So there's sort of three steps here.
19 There's the reference temperature screening
20 criteria, which we said is less restrictive in the
21 voluntary rule. We have a similar somewhat more
22 stringent plant-specific -- sorry, my language is
23 bad -- plant-specific surveillance data check. You
24 need to go through a larger battery of statistical
25 tests, but, frankly, that's a few more columns in

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1 your spreadsheet. That's really not a big deal.

2 The more significant hurdle to using
3 the voluntary rule versus 50.61 is 50.61 doesn't
4 have an inspection requirement, whereas 50.61a
5 does. And the purpose of the inspection
6 requirement is, of course, acknowledging that the
7 population of flaws that went into the
8 probabilistic fracture mechanics calculation
9 significantly drives the results of that
10 calculation. We want to have a common-sense check
11 to see that the flaw population assumed in the
12 calculation well represents or bounds that found in
13 any particular plant. And that's why the
14 inspection requirement is in 50.61a.

15 MEMBER RICCARDELLA: I mean, all the
16 plants have inspection requirements from --

17 MR. KIRK: Well, yes, yes, yes.

18 MEMBER RICCARDELLA: It's just that --

19 MR. KIRK: But not as --

20 MEMBER RICCARDELLA: -- your inspection
21 relative to the flaw assumption.

22 MR. KIRK: Right, right. I was just
23 speaking in terms of the PTS rules --

24 MEMBER RICCARDELLA: And help me --

25 MR. KIRK: -- not the ASME

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1 requirements.

2 MEMBER RICCARDELLA: How is for axial
3 welds 222 less restrictive than 270? In the new
4 rule, for axial welds, if it's a thick wall, it's
5 222 degrees.

6 MR. KIRK: Every time I do this,
7 somebody asks a question I haven't had before, and
8 I think this is the one for today. Thick welds?
9 Well, okay, first, one thing that might get me out
10 of this -- 222? Oh, good. 222 plus 60 is still
11 higher. Because in the alternate rule, there's no
12 margin because the margin has already been included
13 in the limit.

14 MEMBER RICCARDELLA: I remember.
15 Thanks.

16 MR. KIRK: Good. Not a new question.
17 Okay. We'll keep going. So now we'll get into the
18 provisions of the regulatory guide, which, you
19 know, tell you in a little bit more detail than is
20 practical to include in the rule a method that the
21 staff finds acceptable to comply with the rule. So
22 the bureaucratic slide on time line, and I have to
23 keep reminding myself of this -- oh, see, there's
24 the arrow on the slides. Reg Guide 1.230 is equal
25 to Draft Guide 1299.

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1 So in September 2013, draft guide
2 development begins, and I should credit here my
3 former colleague, Gary Stevens, who, with me, did a
4 lot of this, but he found greener pastures back in
5 industry, not much thanks to Member Riccardella.
6 So that's why I'm alone up here.

7 MEMBER RICCARDELLA: I had nothing to
8 do with it.

9 MR. KIRK: I'm sure you didn't.
10 Anyway, Gary Stevens worked with me a lot on this
11 and a lot of the credit for this goes to him. We
12 had our first briefing with you when Gary was
13 sitting beside me in October 2014. Since that
14 time, in March 2015, we sent out the draft guide
15 and the NUREG for public comments. We received
16 those public comments in May 2015. In another era,
17 sorry. In February 2016. We didn't get
18 concurrence before we received the comments. We
19 got final staff concurrence, I should say from the
20 technical offices. NRR, RES, and NRO have all
21 concurred on the resolution of the public comments.
22 OGC has not. We'll explain this a little more,
23 I'll explain this in a little more detail later.
24 We just ran up against a timing issue here. OGC
25 had some comments about format and needing more

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1 details and responses to certain comments. I don't
2 think they had anything fundamental that they found
3 wrong with it, but we still haven't cycled it back
4 through OGC to get their final approval. We will
5 do that after this meeting.

6 Obviously, May 3, 2016 -- I finally got
7 the year right -- is today's briefing. And then,
8 in the future, we hope to incorporate any
9 recommendations that you have into the reg guide
10 and NUREG, send this and the public, and the
11 resolution to the public comments, through the
12 Office of General Counsel for a no legal objection
13 finding, and then, finally, publish the reg guide
14 and the NUREG on the Federal Register with the most
15 optimistic time frame for doing that, assuming no
16 significant bumps along the way, being about two
17 months from now.

18 MEMBER STETKAR: Mark, I always feel
19 compelled to do this, and you've done it a few
20 times, both on the slides and orally. This is an
21 ACRS Subcommittee, so you're not briefing the ACRS.

22 MR. KIRK: Yes, I'm sorry, I'm sorry.

23 MEMBER STETKAR: Any comments made
24 during this meeting are strictly individual
25 comments, so they have no bearing on an ACRS

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1 opinion. Dr. Powers mentioned that briefly
2 earlier, but you're perpetuating this notion that
3 you're briefing the ACRS. You're not.

4 MR. KIRK: It shows my total ineptitude
5 with --

6 MEMBER STETKAR: Well, it's only
7 important because this is a meeting that's on the
8 public record, and we don't want there to be any
9 confusion about comments that are made by
10 individuals in the meeting versus conveyance of an
11 ACRS opinion on the matter.

12 MR. KIRK: I'll try to remember to
13 correct that before I say it the next time, but I
14 might still get it wrong.

15 Okay. So the regulatory guidance.
16 Criteria regarding data construction, I think we
17 already touched on this. The rule and the related
18 reference temperature screening criteria were based
19 on analysis of three currently operating PWRs, so
20 we got our insights from plants in current
21 operation designed on past editions of the ASME
22 code.

23 We did not assess the effect of new
24 reactor designs and new materials of construction
25 on those screening criteria. Therefore, if a

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1 licensee wanted to use the alternate PTS rule for
2 one of those newer plants, it would be up to them
3 to demonstrate the applicability of this rule to
4 the newer plants.

5 MEMBER POWERS: Would that include
6 experimental data?

7 MR. KIRK: It could. There's no --

8 MEMBER POWERS: What would be the
9 criterion, do you suppose, if the staff would come
10 back and say you've done an admirable job trying to
11 extrapolate from what we have to what you have, but
12 we'd really like to see experimental data to
13 validate this or something like the equivalent of
14 this 60 effective full-power years?

15 MR. KIRK: Well, one thing I've learned
16 in my nearly two decades with the NRC staff is
17 saying that Mark's opinion is a surrogate for all
18 the staff is --

19 MEMBER POWERS: I didn't say --

20 MR. KIRK: However, if it was me and
21 knowing what I think I know, what I would
22 personally be interested in is, quite frankly, more
23 on the reactor operations side than on the
24 materials side. And maybe that reflects too much
25 confidence in my part of the materials side. On

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1 the materials side, we're using basically the same
2 grades of steel, same welding techniques, except we
3 don't have copper. Copper is limited. So the
4 amount of embrittlement is limited, and we've been
5 through this extensively within ASTM and looking at
6 embrittlement trends on high-copper versus low-
7 copper material and we've got trend curves that
8 track all that.

9 So from my perspective and, again, my
10 personal perspective, I think the materials side is
11 well dealt with if we know the composition of the
12 material. Then we can get on to base how well it's
13 done and how well it's demonstrated, and I'll leave
14 that aside.

15 But I think, you know, to me, the
16 bigger, the potential bigger differences between,
17 say, an AP1000, to pick a new design plant, and the
18 three much older plants that we analyzed come in
19 the possible challenge events, the possible
20 transients that could lead to --

21 MEMBER POWERS: Okay. Let me seek more
22 of the Kirk definitive statement of all things done
23 by the staff here. Suppose I told you that my new
24 modern plant is going to be a load following plant?

25 MR. KIRK: A low?

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1 MEMBER POWERS: Load following. That I
2 will follow the load demands, rather than being a
3 baseline plant. How does that change your
4 analysis?

5 MR. KIRK: Well, I mean, obviously, it
6 changes. Obviously. I would think it would change
7 the frequency with which the transients occur or
8 the likelihood that they would occur.

9 MEMBER RICCARDELLA: But on the other
10 hand, you wouldn't accumulate doses rapidly.

11 MR. KIRK: That's true. I think there
12 are a lot of things to consider there, which is
13 why, which is why we didn't want to provide a
14 blanket endorsement of things we hadn't analyzed.

15 MEMBER RICCARDELLA: But is there a
16 similar restriction on using 61, the original PTS
17 rule?

18 MR. KIRK: No, which is a little bit
19 counter -- no, I don't want to use that word. I
20 don't like --

21 MEMBER RICCARDELLA: So anybody, you
22 know, if you build the vessel properly, you're
23 going to be able to operate it under 61 and you
24 wouldn't go here.

25 MR. KIRK: Yes. And it is a little bit

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1 ironic that we haven't put a similar restriction on
2 the use of the older rule for the newer plants, and
3 the only reason for that remaining so is the
4 perception that the older rule was more
5 conservative. So if a licensee chooses to comply
6 with the more conservative rule, from an
7 embrittlement standpoint, it's up to them.

8 MEMBER STETKAR: Well, I mean, some of
9 this is kind of interesting because I don't know
10 anything about materials, but what I do know about
11 newer plants, at least in licensing space, they're
12 going to give you more large LOCAs because they're
13 designed to blow you down, whether it's a
14 pressurized water reactor or whether it's a boiling
15 water reactor. I call it a large LOCA and
16 everybody thinks of a pipe break. I think of de-
17 pressurization valves. They're designed to get you
18 down to low pressure really fast, and, therefore,
19 the frequency of what you're now characterizing as
20 the predominant thermal transient, that being a
21 large primary blow-down, might be different for new
22 plants, despite their materials differences, than
23 the older designs. And that's strictly
24 operational, you know, the way they're designed, at
25 least in licensing space.

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1 CHAIRMAN BALLINGER: And in a load
2 following plant you get more fatigue cycles. I
3 don't know what the accumulated dose would be. It
4 would be lower on average, I suppose; but they'd be
5 operating longer anyway.

6 MEMBER POWERS: Well, everything is
7 cast in effective full-power year, so you take care
8 of the dose issue. You do not take care of the
9 more frequent transient issue.

10 MEMBER RICCARDELLA: Heat cycles.

11 CHAIRMAN BALLINGER: And that's
12 something that's embedded in this rule, and I don't
13 know how you handle that.

14 MEMBER RICCARDELLA: But you still are
15 required to do an NDE every ten years, and so,
16 presumably, if these cracks are growing, you're
17 going to see them in those periodic inspections.

18 CHAIRMAN BALLINGER: The ten-year
19 inspection would characterize the flaw distribution
20 anyway.

21 MEMBER POWERS: Yes, and the trouble is
22 you still have this component of the flaw
23 distribution that counts for your ignorance and
24 blindness.

25 CHAIRMAN BALLINGER: Yes, but they have

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1 to be pretty big before they're problematic, like
2 bigger than we've ever seen.

3 MEMBER RICCARDELLA: Yes, that kind of
4 bigger.

5 CHAIRMAN BALLINGER: But, again, he's
6 going to get to the requirement you have to
7 validate your flaw distribution against your
8 inspection results.

9 MR. KIRK: Right. And in any event, I
10 mean, I think -- and I was going to apologize for
11 not having all the answers, but these are hard
12 questions. I mean, I think these hard questions
13 point out why we included this provision in the
14 rule that, if somebody wants to use this rule to
15 apply to a newer plant, it's up to them to answer
16 all these difficult questions.

17 MEMBER STETKAR: But do we know that 61
18 remains assumedly conservative?

19 MR. KIRK: What I can tell you, which
20 is absolutely correct, is that the 50.61
21 embrittlement limits are more restrictive, more
22 conservative, than the 50.61a limits. Whether
23 that's -- what I can also tell you, which is
24 factually correct, is that a detailed analysis of
25 how much that greater conservatism of embrittlement

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1 would make up for possible increases in load, the
2 staff hasn't done that analysis and I don't want to
3 represent --

4 MEMBER POWERS: I mean, that's the
5 inherent difficulty with 61 is that it's difficult
6 to go in and say if I term the assumptions out how
7 does the outcome change, and that was one of the
8 objectives in "a" is to -- I mean, you never get
9 rid of that problem but to reduce that problem
10 down.

11 MEMBER RICCARDELLA: Presumably, the
12 licensees, like for the AP1000, have done an
13 evaluation on embrittlement before my time, so I
14 haven't looked at them. But I assume that the
15 staff has reviewed their analyses of reactor
16 pressure vessel embrittlement, right?

17 MR. KIRK: I'm sorry. Where did you --

18 MEMBER RICCARDELLA: Well, an AP1000.

19 MR. KIRK: Oh, yes.

20 MEMBER RICCARDELLA: A new licensee
21 come in and --

22 MEMBER POWERS: And I would not presume
23 that things like using it as a load following plant
24 had been examined at all.

25 CHAIRMAN BALLINGER: I think I remember

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1 Gary saying, when I asked him last time how many
2 plants would be forced into 61a for 60 years, and I
3 think the number -- do I remember the number three?

4 MR. KIRK: Well, we'll get to that, but
5 I'm going to have to object to your use of the word
6 "force" because nobody is forced to use 50.61a.

7 MEMBER RICCARDELLA: Which effectively
8 means shut it down.

9 CHAIRMAN BALLINGER: So then the
10 question is what about 80 years?

11 MR. KIRK: Well, that's coming up, if I
12 can get away from the load following plant
13 question.

14 MR. WIDMAYER: Will be at 80 years.
15 Never mind.

16 CHAIRMAN BALLINGER: Remember, just
17 it's made good.

18 MR. KIRK: From the beginning, Dr.
19 Powers is always asking questions that I can't
20 answer, and this is the one for this briefing.
21 Thank you.

22 MEMBER POWERS: You have no idea how
23 much work it takes me to plan these questions.

24 MR. KIRK: No, that's good. I look
25 forward to it. Okay. So I'm going to move on and

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1 try to get out of this.

2 CHAIRMAN BALLINGER: He's going to try
3 to get out of here.

4 MEMBER STETKAR: They're still talking.
5 Yes, that's okay.

6 MEMBER RICCARDELLA: I said the bigger
7 question about load follow would be when existing
8 plants decide to go to load follow because they're
9 the ones that are going to be, you know, some of
10 them might be pretty far out on the embrittlement
11 curve. But, again, I think the ISI is what covers
12 that.

13 MEMBER POWERS: I think it's cumulative
14 you use each factor and certainly get them in
15 trouble on load following.

16 MR. KIRK: Okay. We're going to try to
17 talk about the non-controversial subject of
18 surveillance data. So the goal of the statistical
19 checks that are required by the alternate rule and
20 are described by the reg guide draft guide is to
21 ensure that the surveillance data for the
22 particular plant being assessed is either well or
23 conservatively represented by the embrittlement
24 trend equation that was both used as a module in
25 the probabilistic fracture mechanics calculations

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1 that provided the basis for the reference
2 temperature screening criteria and also that's
3 given in the rule.

4 So just schematically, the statistical
5 tests are looking for three things. They're
6 looking for how well does the embrittlement trend
7 code represent the mean of the data, the slope or
8 better to say the evolution of embrittlement with,
9 I'm sorry, the evolution of transition temperature
10 shift with embrittlement, and it's also looking for
11 outliers in the data set.

12 Plants are required to perform these
13 checks if they have three or more transition
14 temperature shift values, which pretty much boils
15 down to three or more capsules. They are required
16 to consider all belt line plates, welds, and
17 forgings for which data is available, not just for
18 the so-called limiting welds. And they're also
19 required to consider data from sister plants if
20 it's available. And if you're not into the
21 material geek lexicon, sister plant means that,
22 say, Member Riccardella owns a plant that happens
23 to have the same weld wire as my plant, so the data
24 that he gets influences my plant and vice versa.

25 Being regulators, we've construed these

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1 statistical tests only flagged underestimates. If
2 the generic equations overestimate things, well,
3 that's okay with us because an overestimate of
4 transition temperature shift will be conservative.
5 And as I've said, we're essentially doing three
6 consistency checks to see that the plant-specific
7 data here represented schematically by the green
8 dots is well represented by the embrittlement trend
9 curve represented by the red curve.

10 If the plant-specific data fail the
11 test, well, then what next? Well, the general
12 answer is the licensee, the general answer is the
13 licensee needs to make a case to the director of
14 NRR as to what that means and what they need to do
15 about it. There were two cases that we saw to be
16 simple enough that we could provide guidance, sort
17 of a recipe if you will, in the regulatory guide.
18 One is in the case of a mean test failure where the
19 data are systematically above the embrittlement
20 trend curve, one method that's acceptable to the
21 staff is to simply add a factor on to the predicted
22 curve to better represent your data. And the
23 second case which we sometimes see -- excuse me --
24 is, oftentimes with the old surveillance capsule
25 withdrawal schedule, you'll withdraw a capsule

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1 after the first or second operating cycle, so it's
2 got very little dose on it. And in those cases,
3 oftentimes you'll essentially be sampling the
4 inherent material variability and you can see
5 things like uncharacteristically higher low shifts
6 or the often amazing case of increasing your upper
7 shelf energy, not that that's considered here.

8 In any event, the guidance indicates
9 that, if you happen to have an outlier at a very
10 low fluence, less than 10 percent of that of your
11 evaluation fluence, you could eliminate that data
12 point from consideration.

13 If you don't happen to fall in these
14 two categories, you're left doing your own
15 engineering evaluation and trying to convince the
16 NRR staff and director of NRR that you've done a
17 good job.

18 The next regulatory guidance gets to
19 the whole -- oh, sorry.

20 MEMBER RICCARDELLA: Are there any
21 plants that are going to fall in this less than two
22 capsules?

23 MR. KIRK: Yes, there are. I mean --

24 MEMBER RICCARDELLA: Eventually,
25 they're going to get to three capsules, right?

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1 MR. KIRK: Yes, yes. I mean, the --
2 yes, the requirements, the ASTM-E-185 requirements
3 for -- I hesitate to say this a little bit because
4 if you go back far enough in ASTM-E-185, there
5 wasn't a specific number of capsules required.
6 That was back in the 1960s, and I'm not sure that
7 any plants that were originally licensed in the
8 1960s are still operating.

9 If they were licensed to a version of
10 E-185 from the mid-70s and beyond, they would be
11 required to have at least three capsules, and that
12 would be for a low-shift material, if not more. So
13 --

14 MEMBER RICCARDELLA: If you read the
15 rule, it almost seems a little backwards that,
16 well, if you don't have the data, if you don't have
17 the data, then you don't need to evaluate whether
18 the generic trend is applicable or not. I mean,
19 that's kind of what you're saying.

20 MR. KIRK: Yes, that is what the rule
21 says.

22 MEMBER RICCARDELLA: All right. But
23 I'd assume anybody that's out there and approaching
24 --

25 MR. KIRK: I'm not -- all I can say is

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1 I'm not personally aware of any plant -- well,
2 there's only one plant that's used this, and
3 certainly that wasn't the case -- of any plant
4 that's used this or that is considering using it
5 that would fall into the category of not having at
6 least three capsules pulled by the time they're
7 considering using it.

8 MEMBER RICCARDELLA: That's what I
9 would assume.

10 MR. KIRK: It was really a condition
11 put in. And you're right, it doesn't fully make
12 sense, but it was just a condition put in to make
13 sure that everything was covered.

14 Okay. Getting to the regulatory
15 guidance on in-service inspection, the reason for
16 the requirement is quite simply stated. As I said,
17 you know, you go back to the sort of basic fracture
18 mechanics equation that driving force equals stress
19 times square root of pi times crack size. So,
20 obviously, the crack sizes that we have used in the
21 analysis to set the screening limits are really
22 important to what those screen limits wound up
23 being. So we wanted to include a check to make
24 sure that the flaws or the indications that are
25 found in the plant are well represented by that

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1 flaw population that was assumed in making those
2 limits. And that's the intent of what's going on
3 here.

4 So the examination requirements. We
5 require a qualified examination be performed in
6 accordance with ASME Code, Section XI, Mandatory
7 Appendix VIII. And we also require, and this goes
8 beyond as required by the code, a requirement
9 that's, I'll say, unique to this rule is a
10 verification that any axial flaws found at greater
11 than 0.075 inch through-wall extent at the clad
12 interface don't open to the inside RPV service. So
13 what we want to do, the intent of this is the
14 recognition that a surface-breaking flaw to the ID
15 would be significant, so we want the licensees to
16 affirm that they don't exist.

17 An optional thing that licensees could
18 pursue if they want to is they can account for NDE
19 uncertainty. So if you, say if you went through
20 and tried to meet the flaw tables in the rule using
21 your straight-out NDE results from a Section XI,
22 Appendix VIII exam and you didn't meet the
23 requirements, if you go through and account for NDE
24 uncertainty, it may be possible that you then
25 satisfy the tables because the at least now current

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1 NDE techniques tend to oversize smaller flaws,
2 which tends to characterize them more
3 conservatively than they need to be. All I can say
4 is in the one application that's gone through, that
5 being the Palisades application, that optional path
6 did not need to be followed.

7 MEMBER SKILLMAN: Mark, before you
8 change that slide, what change, if any, to the NDE
9 equipment has been obligated by an applicant that
10 would want to use 50.61a?

11 MR. KIRK: Well, there's no change here
12 because there is, as Pete's pointed out already,
13 they're already doing the ASME exam. I could just
14 speak to the one that's done it because I was there
15 watching the exam. In the case of Palisades, they
16 put on their inspection sled also transducers to do
17 any current at the same time as they were doing the
18 regular Section XI, Appendix VIII exam because they
19 knew going in that they were doing, the one point
20 of doing this inspection was to provide input to
21 50.61a. So they knew they would need to verify --
22 what the rule says is that they need to verify that
23 axial flaws that I'll say are close to the
24 cladding, the rule doesn't use that language, but
25 are close to the cladding or not surface connected,

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1 the NDE inspector I talked to said, yes, it's just
2 easier for us, the sled is in the vessel, I have to
3 dose people up to go in and change this out, so
4 we've just put eddy current probes on the sled, as
5 well, and so we're going to eddy current the whole
6 inside. Every indication they found, because, of
7 course, they do the analysis offline later,
8 basically every indication they found they also
9 eddy-currented, if that's the right way to say it,
10 a patch on the ID in the vicinity of that so that
11 they would have the data later that they needed.

12 That's the only plant that's done it.
13 So that's what they did.

14 CHAIRMAN BALLINGER: So that -- I'm
15 trying to remember now. Did that help get rid of
16 these ghost kind of indications that looked like
17 flaws that weren't? If I recall. Maybe I'm just
18 not remembering correctly.

19 MR. KIRK: I don't, I couldn't comment
20 on that. I don't know.

21 MEMBER RICCARDELLA: I think the idea
22 is the flaws are much worse if they penetrate for
23 this analysis than if they penetrate the cladding,
24 and the UT doesn't really inspect the cladding.
25 They inspect the base metal, so, this way, they can

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1 say, well, if I had an indication, I also inspected
2 the ID surface of the cladding and I'm confident
3 that there's no surface breaking flaw there.

4 CHAIRMAN BALLINGER: I thought there
5 were some plants that had indications that turned
6 out not to be indications.

7 MR. KIRK: Oh, I'm sure there are.

8 CHAIRMAN BALLINGER: But it's a problem
9 here because of the flaw size distribution
10 requirement.

11 MR. KIRK: Okay. I think this gets
12 into a little more detail. We're looking for flaws
13 or -- I'm sorry I'm not a good NDE guy.
14 Indications. We're looking for indications in a
15 number of categories, and I'll work up from the
16 bottom from the least risk significant to the most.
17 Embedded indications beyond 3/8t from the ID,
18 embedded between one inch and 3/8t from the ID,
19 embedded within one inch of the inner-diameter and
20 surface connected. And the reason why the risk
21 significance goes as indicated by the arrow is
22 simply that this is a thermally-driven event. So
23 the tensile stresses are nearest the ID, and so you
24 want to be looking for those because they're the
25 ones that are driving the risk.

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1 In terms of the guidance in the
2 regulatory guide and the requirements of the rule
3 for how flaws in these different bins are assessed
4 -- I'm back to flaws again. Sorry. For surface,
5 if you found a surface-connected flaw, a flaw
6 that's surface connected to the ID, you would have
7 to do a plant flaw-specific assessment of the
8 through-wall cracking frequency because that's
9 beyond the scope of what was systematically
10 considered in the tech basis calculations.

11 If they're embedded within an inch of
12 the inner diameter, that's where you use the flaw
13 tables. If they're between an inch and 3/8t,
14 that's where you use ASME Section XII code, and
15 beyond 3/8t, again, you're deferring to the code
16 requirements.

17 So the PTS-specific requirements that
18 go beyond the code really come from in these first
19 two categories of the surface-connected flaw and
20 embedded flaws within one inch of the inner
21 diameter of the vessel. All the rest is the same
22 as for any vessel complying with ASME Section XI.

23 This is probably more detailed than we
24 need here. We recognize that sometimes the
25 language that gets into the Code of Federal

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1 Regulations is a little bit difficult to follow for
2 engineers. It's probably very easy for lawyers.
3 So Gary and I turned that language into a flow
4 chart with references to the different parts, the
5 different invoking languages of the code.

6 But this is essentially walking you
7 through, and this is part of the reg guide now or
8 will be part of the reg guide. You do your ASME
9 Section XI inspection. You're asked do you have
10 surface-connected flaws. You go through the flaw
11 table. You account for NDE uncertainty, and you
12 eventually come to either the conclusion that you
13 need to do a plant-specific assessment, that you
14 can't use directly the provisions of the alternate
15 rule or the alternate rule is applicable for your
16 use. And the reg guide steps you through it.

17 Again, I should just emphasize there's
18 nothing on this flow chart that's in any way
19 different from what's in the rule. The flow chart
20 is in the reg guide, and it's just an attempt to
21 explain more clearly to engineers what the
22 provisions of the rule are.

23 MEMBER SKILLMAN: Mark, if the
24 inspection finds an indication and further NDE
25 demonstrate that there really is a connected crack

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1 of significance, does that automatically trigger a
2 repair?

3 MR. KIRK: No. Well, I have to defer
4 to people that know about the code. I don't think
5 size of indications that we're talking about here
6 you would be forced into a repair by the code, and
7 certainly the alternate PTS rule doesn't force you
8 into a repair. The alternate PTS rule would force
9 you into a plant-specific through-wall cracking
10 frequency evaluation.

11 MEMBER SKILLMAN: Would that enhance
12 the next inspection interval into a five year
13 instead of a ten?

14 MEMBER RICCARDELLA: Yes, what happens
15 is, in the code parlance, these are the standards
16 for evaluation, which are just a set of tables you
17 go and look at. If you exceed those tables, you
18 have the option to repair or do a detailed fracture
19 mechanics evaluation. And if you do do the
20 detailed fracture mechanics evaluation, then you do
21 get kicked into more frequent exams.

22 MEMBER SKILLMAN: Thank you.

23 MR. KIRK: Okay. And also there's a
24 part of the -- excuse me -- there's a part of the
25 alternate rule that talks about alternate

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1 embrittlement screening criteria, meaning alternate
2 to the reference temperature tables in the
3 alternate rule. Too many alternates. Sorry.

4 So why are they needed? Paragraph
5 (c)(3) of 50.61a allows for a plant-specific
6 analysis just by operation if the RT max values
7 exceed the PTS screening criteria. We've provided
8 here one method, there are certainly other ways to
9 do this, that a plant could demonstrate that, and
10 that's simply to say that the reference temperature
11 screening criteria that are in the table are based
12 on bounding curve fits to the PFM results, which
13 you saw earlier.

14 And what you get, as I indicated
15 before, the screening limits are determined by
16 saying -- and the bounds aren't shown here. That's
17 a bad slight on my part. But if you add up the
18 three bounding curves, they should be limited to 10
19 to the minus 6. What that gets you is this three-
20 dimensional surface that's almost a box but not
21 quite. It's a box with rounded edges.

22 In order to easily put that into a
23 table that could be put in a federal regulation, we
24 had to simplify the box somewhat, which meant that
25 we had to say that the reference temperature max

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1 for the circ weld, because we knew that circ welds
2 would hardly ever be limiting, wouldn't go above a
3 certain value. So we essentially set the screening
4 criteria for the circ weld to be 10 to the minus 8
5 just to make the plate and axial weld screening
6 easier in a simple table look-up format. We felt
7 that was a reasonable thing to do simply because we
8 didn't know at the time of any plants that were
9 circ weld limited or would be circ weld limited in
10 the foreseeable future. However, we wanted to
11 provide this alternate means, should a circ weld
12 plant experience high embrittlement, that they
13 could be then held to a 10 to the minus 6 screening
14 criteria, rather than a 10 to the minus 8, which is
15 inherent to the tables. That's really all this is
16 doing. Going through this set of equations is the
17 equivalent to the technical basis information on
18 which the reference temperature values in the table
19 in the alternate rule were based.

20 Now we get to the question I know Ron
21 has been wanting to ask, which is potential future
22 use of 50.61a, and I think I should emphasize here
23 "potential" because foretelling the future is not
24 very easy and if I could do that I would have hit
25 the lotto a long time ago.

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1 MEMBER POWERS: A famous quote,
2 "Prognostication is difficult, especially about the
3 future."

4 MR. KIRK: Yes, it is.

5 CHAIRMAN BALLINGER: That's got to be
6 Yogi Berra.

7 MEMBER POWERS: I think it was Mark
8 Twain.

9 MR. KIRK: I think I should probably
10 quote Yogi Berra in preference to more my style.
11 Anyway, this is just a reminder of what we told you
12 in October 2014, in case you forgot. These were
13 the plants that were then on the list. That's
14 changed somewhat, as I'll reflect here, and we'll
15 just go down it.

16 And now responding to the question that
17 Ron had asked us before the meeting, I talked about
18 potentials 50.61a use both during license renewal,
19 which is NRC code for within 60 years, or during
20 subsequent license renewal, meaning 60 to 80 years.

21 So Beaver Valley Unit 1, the last time
22 we talked, the plate in Beaver Valley Unit 1 had
23 been projected to exceed the 50.61 screening
24 criteria before the end of their license renewal
25 period; and, therefore, they had made an

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1 application to use 50.61a in 2013. However, after
2 they made that application and while the staff was
3 still conducting its review, they found data on
4 their limiting materials that they weren't aware
5 that they had, and that allowed them to both
6 recalculate their embrittlement trends -- they got
7 a new chemistry factor, essentially, using Reg
8 Guide 199 -- and also get a better estimate of
9 their underrated RTNDT. Based on those two
10 improvements to their data, they found out that
11 they were no longer projecting that they would
12 exceed the 50.61 screening criteria and so withdrew
13 the application.

14 So based on a conventional 50.61
15 analysis, Beaver Valley is now showing that it's
16 not projected to exceed those screening limits
17 within license renewal, so use of 50.61a during
18 license renewal is unlikely. It's possible during
19 subsequent license renewal, but I think the thing
20 I'm going to say on the next slide is, right now,
21 the staff is not aware of any plant that has short-
22 term plans to use 50.61a. These are just ones that
23 could be coming up.

24 Diablo Canyon Unit 1, axial weld is
25 projected to exceed the 50.61 screening criteria

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1 before the end of license renewal. And so, you
2 know, definitely possible that they could use it,
3 but there are other things they could do we'll talk
4 about on the next slide.

5 Fort Calhoun. So I'm focusing here on
6 plants that are known to be high embrittlement.
7 Axial weld is projected to have an RTPTS of 268 at
8 end of license renewal, so they'll remain compliant
9 with 50.61 based on current projections by two
10 degrees. Two degrees is important. So they're not
11 going to use it during license renewal. They could
12 possibly use it during subsequent license renewal.

13 Palisades, we already know the answer.
14 They use it during license renewal. I'm not aware
15 that Palisades is pursuing subsequent license
16 renewal, but if they did they might use it again.

17 Point Beach Unit 2 and Three Mile
18 Island I'd like to talk about together. They're
19 both plants that are known to have reference
20 temperatures approaching the RTPTS screening limits
21 of 50.61. However, they're both plants that are
22 covered by the Babcock and Wilcox 2308 approach,
23 which essentially uses master curve data, true
24 fracture toughness data to reset the initial RTNDT.
25 That's an approach that's been pursued for pretty

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1 much all Babcock and Wilcox fabricated plants that
2 had lineated welds. It's used routinely, and
3 that's why those two high-embrittlement plants --
4 by high embrittlement, I mean approaching the 50.61
5 screening criteria -- have not and probably will
6 not use 10 CFR 50.61a because they've got another
7 means that worked well for them.

8 Finally on the list, Salem Unit 1. Its
9 axial weld is projected to have an RTPTS of 267,
10 three degrees less, at the end of license renewal.
11 So they would not be, see no reason why they would
12 use 50.61a during license renewal, but they could
13 possibly use it during subsequent license renewal.

14 MEMBER RICCARDELLA: Did you skip over
15 Indian Point in Unit 3?

16 MR. KIRK: I think I did. Yes, so we
17 see -- sorry about that. We see possible use by
18 Indian Point Unit 3, before the end of license
19 renewal, because they're projected to exceed the,
20 the 50.61 limit before 2025. I didn't mean to skip
21 them.

22 That all said, I mean, the two dates on
23 here are 2025 and 2033, so a decade to a
24 decade-and-a-half from now, which means it might be
25 only my colleague, Matt Gordon, who's left here to

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1 talk about it. I'll be retired.

2 So no licensees have indicated any
3 short-term plans, by short-term, I mean in the, in
4 the next three to five years, to use 50.61a. Just
5 a disclaimer, the list on the previous page may not
6 include all plans that are considering the use,
7 it's a due diligence effort.

8 And also should point out, the plans
9 may elect to use 50.61a, not for compliance
10 reasons, but for economic reasons. Say, somebody
11 was considering buying a new steam generator and
12 wanted to make, wanted to get as many things off
13 the regulatory problem list, as they could, they
14 might decide to use 50.61a and we would have no way
15 of knowing, before they, they brought that case to
16 us, so clearly that's not included.

17 And also, just a reminder, and this
18 right-most column is nothing other than a statement
19 of the facts of our current regulatory structure is
20 that, plants have options, other than 50.61a and
21 other than annealing, to address and manage
22 embrittlement.

23 They have various physical options,
24 fuel management, changing operational
25 characteristics and annealing. They have data

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1 options. They can look more to plant-specific
2 surveillance data, they can get Master Curve data,
3 using the BAW-2308 approach.

4 And, I should also point out that there
5 is now ongoing, within the industry, renewed
6 interest in pursuing Master Curve and direct
7 fracture toughness measurements being pursued by
8 the PWR Owners Group and also going through ASME
9 Code and the guise of a revised version of ASME
10 Code Case N-830.

11 So Master Curve use, in general, beyond
12 the BNW plants, has not been, I'll say, pursued in
13 earnest for about the last decade, but within the
14 last year to two years there's been renewed
15 interest in that, so a number of plants are looking
16 at that, again, no plant-specific applications, but
17 general industry study programs and work within the
18 Code to enable that type of analysis.

19 And, of course, there are always
20 analytical options, meaning plant-specific PRA
21 and/or PFM, like we talked about before, to
22 demonstrate compliance with, to demonstrate vessel
23 safety.

24 MEMBER POWERS: I -- my presumption is
25 that you are relatively confident in the

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1 probabilistic fracture mechanics and you have
2 indicated a confidence in the knowledge and
3 material properties, when a licensee comes to you
4 with a new approach, at what point, in what area
5 would you require experimental validation of his
6 approach?

7 MR. KIRK: I thought I'd gotten rid of
8 that question. Experiment of validation of any
9 aspect, or --

10 MEMBER POWERS: Some aspect. I mean, I
11 get the feeling that you would not require it for
12 the probabilistic fracture mechanics, which in my
13 mind, is little more than witchcraft. Oh that was
14 just for you. And you've indicated a confidence in
15 understanding material properties, so I'm sitting
16 here saying, what, what would provoke into saying,
17 gee, I really need to see some experiments here,
18 to, to give me confidence in this, this alternate
19 approach?

20 MR. KIRK: I mean, I find it, I find it
21 really personally hard to speculate. I mean,
22 getting into any of these reviews, and, you know, I
23 should point out, you know, I'm not, I don't really
24 work for the regulatory part of the agency, I --

25 MEMBER POWERS: And that --

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1 MR. KIRK: -- I work for the research
2 part.

3 MEMBER POWERS: We're just holding you
4 accountable for --

5 MR. KIRK: Thank you.

6 MEMBER POWERS: -- speaking for that
7 person.

8 MR. KIRK: I appreciate it. And the
9 guy that's left up here. I think it really depends
10 on, and I'm -- you know, this is an evasive answer
11 and I'll just label it, as such. It really depends
12 upon the specifics of the case at hand and how
13 strong, strongly the case has been supported.

14 MEMBER POWERS: Well, where would you,
15 where would you look most diligently?

16 MR. KIRK: Well, again, the loads
17 full-size embrittlement. And, and, and, and, I
18 think, also, a lot of us depends on how road
19 full-size embrittlement and that's axiomatic, but
20 it depends on how close somebody is to some
21 perceived regulatory limit.

22 MEMBER POWERS: Well, I mean, we
23 presume that he is --

24 MR. KIRK: Okay, I mean, --

25 MEMBER POWERS: -- comes to you with a

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1 new technique, because he's getting very, very
2 close, if not exceeding, --

3 MR. KIRK: Yes. Well, let's get back
4 to the, if, if you had a plant, if you had a new
5 plant that we hadn't analyzed yet, and there was,
6 you know, concern from staff experienced, you know,
7 in the operational side that the plant operational
8 characteristics wouldn't lead to the same challenge
9 events, as we had analyzed here, I think that would
10 be a, you know, a ripe area for, you know, for
11 study.

12 And, and, you know, I'll throw a stone
13 at materials, while I'm at it. If there was
14 something unusual in the surveillance data, if you
15 had -- okay, I'll give you a good example that,
16 fortunately, is not in this country.

17 The Genkai Power Plant in, in Japan,
18 pulled its four surveillance capsule, some years
19 ago, and while the previous three surveillance
20 capsules had been, pretty much, following the
21 generic trend, it had an out wire, not at the low
22 fluency end, but at the high fluency end, and in
23 the case of Japan, that provoked an extremely
24 detailed study getting into more measurements, more
25 mechanical property measurements, diagnosis of the

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1 mechanical property measurements, more
2 micro-structural property measurements, to try to
3 understand the basis for that one out wire.

4 So I think, you know, you got to, you
5 got to look for something, I'll say, strange,
6 unusual, outside of your experience that doesn't
7 seem quite right, before, as a regulator, or as an
8 advisor to the regulator, you say, and maybe you
9 should bring me something more. I'm struggling,
10 because I'm not good with hypotheticals, so I have
11 to, I have to think of things that have actually
12 happened. So I think those, you know, those would
13 be good categories for, for more, you know, more
14 detailed inquiry.

15 MEMBER POWERS: Oh I understand that
16 what I'm thinking about is the codicil in the
17 guidance that says these are the things that go
18 beyond the scope of our experience, and when you
19 encounter them, please don't, please come talk to
20 us, before you rely on this guidance.

21 MR. KIRK: Yes. Right, but we haven't,
22 and I think that's, that's a prudent thing to say,
23 we haven't then prejudged exactly where that
24 conversation will go.

25 MEMBER POWERS: Yes, and --

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1 MR. KIRK: Yes.

2 MEMBER POWERS: -- but, while I'm
3 interested in where this guidance -- you would not
4 be confident if somebody was using this guidance.

5 MR. KIRK: No. I mean, I think that's,
6 and again, sort of statistics 101 when you get
7 outside of your experience, you start looking for
8 more evidence --

9 MEMBER POWERS: The --

10 MR. KIRK: -- to backup.

11 MEMBER POWERS: -- the trouble is that
12 this guidance will be used by people who use it, as
13 a prescription, and so it's, it's incumbent upon
14 you with a great deal of experience to communicate
15 them, not only how to use it, but when not to use
16 it.

17 MR. KIRK: Yes. And are you
18 suggesting, or asking, if we've done that
19 well-enough to --

20 MEMBER POWERS: I am.

21 MR. KIRK: -- to say when it's not a
22 prescription?

23 MEMBER POWERS: I am.

24 MR. KIRK: I mean, --

25 MEMBER POWERS: I'm asking you to think

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1 about it for a little bit.

2 MR. KIRK: Okay. We should think about
3 that.

4 MEMBER POWERS: I think that's, I think
5 that's going to be increasingly important, as you
6 think about migrating to New Hampshire.

7 CHAIRMAN BALLINGER: You might force
8 him to migrate to New Hampshire early.

9 MR. KIRK: The --

10 MEMBER POWERS: I've tried that for
11 years and failed miserably, so --

12 (Simultaneous speaking.)

13 MR. KIRK: The part of New Hampshire
14 I'm considering migrating to have electric rates
15 that almost doubled when Vermont and Yankee closed.

16 MEMBER POWERS: Yes.

17 MR. KIRK: So --

18 MEMBER POWERS: Very foolish on your
19 part.

20 MR. KIRK: Now I'm getting my exercise
21 cutting wood.

22 MEMBER POWERS: Helping the
23 environment, no doubt.

24 MR. KIRK: No doubt.

25 MEMBER SKILLMAN: Mark, let me ask two

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1 questions. They're similar to what Dana just
2 asked, but in my own work for preparation for
3 today's meeting, I've written them down, so I think
4 this is the best time to ask them.

5 How do you handle the variability in
6 chemistry? And here's why I'm asking the question.
7 Like Dana said, this is a very prescriptive
8 approach. Equations five, six, and seven, guide a
9 user to take action to develop a delta T --

10 MR. KIRK: Right.

11 MEMBER SKILLMAN: -- integer. And the
12 ingredients in those calculations include copper
13 content, effective copper content, nickel content,
14 manganese content and phosphorus content, in the,
15 in the other comments from the public and others,
16 it says, these are the soft metals that's giving us
17 a problem here. How do you handle, or how do you
18 anticipate a licensee is going to handle
19 uncertainties in those --

20 MR. KIRK: Yes.

21 MEMBER SKILLMAN: -- ingredient
22 concentrations in their plates and their foragings?

23 MR. KIRK: Well in that case, we have
24 attempted, and I think done as good a job, as
25 possible, based on the information we've got, to

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1 handle it for them and that the, the uncertainties
2 in those, in the chemistry inputs were sampled, as
3 part of the favor analyses.

4 Because, it's very, it would be very
5 unusual for a licensee to say, have enough
6 measurements of any of these copper, nickel, what
7 have you, to form a statistical distribution.

8 So in the favor analyses, we took the,
9 and that's actually documented in the appendix of
10 NUREG-1807, I think, we went out and looked for
11 data that was available where people had done
12 repeated measurements, developed statistical
13 distributions to represent them, and that was
14 sampled within the PFM analyses that then gave rise
15 to the reference temperature limits.

16 So I would say that that part of the
17 uncertainty is explicitly covered by the reference
18 temperature limits, themselves, and for that
19 reason, we ask the licensees only to come in with
20 so called best estimate values of each of those
21 variables, which would be the same type of input
22 that we look for, for 50.61 applications, for PT
23 limits analysis and, and so on.

24 MEMBER SKILLMAN: Okay. Let me ask
25 another one, similar-type question. And I draw

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1 this from almost 45 years ago, the, those of us who
2 were doing the systems in the ACCS analysis in
3 Babcock were right next to the reactor vessel and
4 the internals people, so we heard them struggling
5 with where to place the surveillance vestment
6 holder, tubes and the geometry and the concerns
7 about the fluency, too, the SSHTs and to the
8 specimens, surveillance specimen holder tubes and
9 the specimens.

10 And this has to do with the uncertainty
11 of the fluency on the specimen. How do you address
12 in this, in this set of equations, the variability,
13 or the uncertainty in the absorbed dose to the
14 specimen, itself?

15 MR. KIRK: Again, that's, that's the
16 same answer. That's an uncertainty that we sampled
17 within the original calculations of -- well, the
18 thought, at the time, much like the chemistry, is
19 it wasn't realistic to ask somebody to do that on a
20 plant-specific basis, so we included that
21 uncertainty in the basis calculation, so it's
22 reflected in the referenced temperature limits.
23 And again, we just look for the input of the best
24 estimate fluency for the location on the ID of the,
25 of the various vessel materials.

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1 MEMBER SKILLMAN: Okay. Final
2 question. In Table 1, which is on Page 6 of the
3 Guide, the terms include neutron fluency and
4 effective neutron fluency and copper content and
5 effective copper content. Could you explain what
6 --

7 MR. KIRK: Yes.

8 MEMBER SKILLMAN: -- effective means,
9 in the --

10 MR. KIRK: Yes, those are, and in, you
11 know, now that I see that, I'm sorry they're there.
12 I mean, those are terms that are used in the, in
13 the embrittlement equations that is Equations five,
14 six, and seven, in the guide and corresponding
15 equations in the Rule, itself.

16 But, be that as it may, those are
17 values that are fitting parameters, if you will, --

18 MEMBER SKILLMAN: I was wondering if
19 they were, they were averages, or means, or --

20 MR. KIRK: No, they're --

21 MEMBER SKILLMAN: -- aggregated --

22 MR. KIRK: -- they're just --

23 MEMBER SKILLMAN: -- aggregated values
24 from some other --

25 MR. KIRK: No they're -- well, in the

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1 case, and maybe the easiest one to explain is --
2 well I can explain them both. Effective copper
3 content reflects the fact that, above a certain
4 limit, copper is ineffective, as an embrittlement
5 element, and so it caps the copper at a, at a
6 copper max value, but that's taken care of in the
7 equation.

8 The effective fluency reflects the fact
9 that, at least, in terms of this embrittlement
10 equation, the neutron flux has a second order
11 effect on the degree of embrittlement, and again
12 that's accounted for in the equation.

13 So those aren't, you know, again,
14 looking at this again, those aren't direct inputs
15 to the equation, they're calculated from other
16 inputs, so I think it would have probably been
17 clearer to, to take them out, but they're not
18 something that's separate, you input copper,
19 nickel, phosphorus, manganese, fluency and
20 temperature and everything else is calculated.

21 MEMBER SKILLMAN: Okay. Mark, thank
22 you.

23 MR. KIRK: Okay. Thank you, sir.

24 MEMBER SKILLMAN: Thanks.

25 CHAIRMAN BALLINGER: Is this a

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1 convenient point we're going to shift to another --

2 MR. KIRK: I think it is, yes.

3 CHAIRMAN BALLINGER: All right. I have
4 one question before we, before we do that and it's
5 probably a dumb one, but on Page 7 --

6 MR. KIRK: Of the Guide?

7 CHAIRMAN BALLINGER: -- of the Guide,
8 Paragraph B-I.

9 MR. KIRK: Yes.

10 CHAIRMAN BALLINGER: Can you tell me
11 what that means?

12 MR. KIRK: Oh no. This seems, to me,
13 to be one of those that we might have revised,
14 because it was unclear.

15 CHAIRMAN BALLINGER: Okay.

16 MR. KIRK: What it's trying to say, we
17 talked about earlier, is that, you need three
18 measurements of Delta T-33 transition temperature
19 shift values at three different fluency values, in
20 order to do the surveillance check. If you don't
21 have, at least, that, you just use the equation.

22 CHAIRMAN BALLINGER: Right. I
23 understand that part.

24 MR. KIRK: It --

25 CHAIRMAN BALLINGER: I understand what

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1 you said and I understand what it --

2 MR. KIRK: Good.

3 CHAIRMAN BALLINGER: -- read before,
4 but for the life of me --

5 MR. KIRK: Yes, well I, I --

6 CHAIRMAN BALLINGER: -- I don't
7 understand what that means.

8 MR. KIRK: Well I have the original,
9 unmarked-up version. I'll have to check. I think
10 that was one where many people made the comment of,
11 what are you trying to say?

12 CHAIRMAN BALLINGER: Okay.

13 MR. KIRK: So hopefully we've clarified
14 that, but I can, I can check that.

15 CHAIRMAN BALLINGER: Okay. Does
16 anybody around the table have any questions? But,
17 I think, we're going to, I'm going to propose that
18 we take a 15-minute break now.

19 MEMBER REMPE: Right now we're going to
20 the closed session.

21 CHAIRMAN BALLINGER: Oh, we're going to
22 a closed session, after this, right?

23 MR. WIDMAYER: Right.

24 CHAIRMAN BALLINGER: Okay, so you're
25 right. Are there any comments from anybody in the

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1 room? Derek, do we need to get the line open?

2 MR. WIDMAYER: There is, yes, we need
3 to get the line open.

4 CHAIRMAN BALLINGER: Can we get the
5 line open?

6 MR. WIDMAYER: It should be one person.

7 CHAIRMAN BALLINGER: One person. Yes,
8 I must have read that, that little paragraph a
9 dozen times, could not figure out --

10 MR. KIRK: Yes.

11 CHAIRMAN BALLINGER: -- what we're
12 saying.

13 MR. WIDMAYER: Okay, it's on, it's
14 open.

15 CHAIRMAN BALLINGER: Yes are there, I
16 don't hear any crackling, or popping, either.

17 MR. WIDMAYER: Try.

18 CHAIRMAN BALLINGER: Try? Is there
19 anybody out there on the line?

20 MR. LEWIS: Marvin Lewis, member of the
21 public.

22 CHAIRMAN BALLINGER: Good afternoon,
23 Marvin.

24 MR. LEWIS: Thank you. Look, I'm just
25 wondering, you know, we've use justifications to

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1 forget about outliers that, sort of, go against the
2 grain, of course outliers go against the grain,
3 that's why they're outliers, right?

4 My problem is this, are you forgetting
5 a lot of experience, not only in the U.S., but
6 outside the United States that might show what
7 you're, show that there's a problem there that
8 you're not looking at, like, for instance, Belgian
9 reactors that has shown a lot of micro cracks.

10 And I'm wondering, you did reference a
11 couple of other ones, and I'm just wondering if
12 there is a trend somewhere that you're missing on,
13 on this toughness subject?

14 I'm, I'm not saying there is, I'm just
15 wondering, because I, you know, you're using
16 justification here, justification there, and I'm
17 just wondering if there is a trend that you're just
18 getting around with justifications? Thank you.

19 CHAIRMAN BALLINGER: Thank you. Are
20 there any other folks out there, who would like to
21 make a comment?

22 (No response.)

23 CHAIRMAN BALLINGER: Hearing none, can
24 we close the line? Okay, so I think we can take
25 now a 15-minute recess, until just before quarter

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1 after.

2 (Whereupon, the meeting in the above-
3 entitled matter was concluded at 2:57 p.m.)
4
5
6
7

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Advisory Committee on Reactor Safeguards Materials Subcommittee Meeting

review of

- Draft Reg Guide (DG-1299 / RG 1.230) ←
- Draft Tech Basis Document (NUREG-2163) ←
- [*both concerning the Alternate PTS Rule (10 CFR 50.61a)*]



Mark Kirk, Senior Materials Engineer

*Office of Nuclear Regulatory Research
Component Integrity Branch*

Tuesday May 3, 2016
NRC Headquarters
Rockville, MD

Presentation Overview

- Alternate PTS rule (10 CFR 50.61a) development & background
- PTS Rule Regulatory Guide
 - Reg guide process development summary & current status
 - Overview of tech basis & reg guide
- Possible future use of 10 CFR 50.61a & RG 1.230
- Public Comments on reg guide and tech basis
 - Summary of responses
 - Summary of changes to RG & NUREG
 - Path forward / next steps
- **NRC staff request of ACRS**
 - **Memo to NRC/RES approving RG & NUREG, or**
 - **Letter to EDO objecting to RG & NUREG**

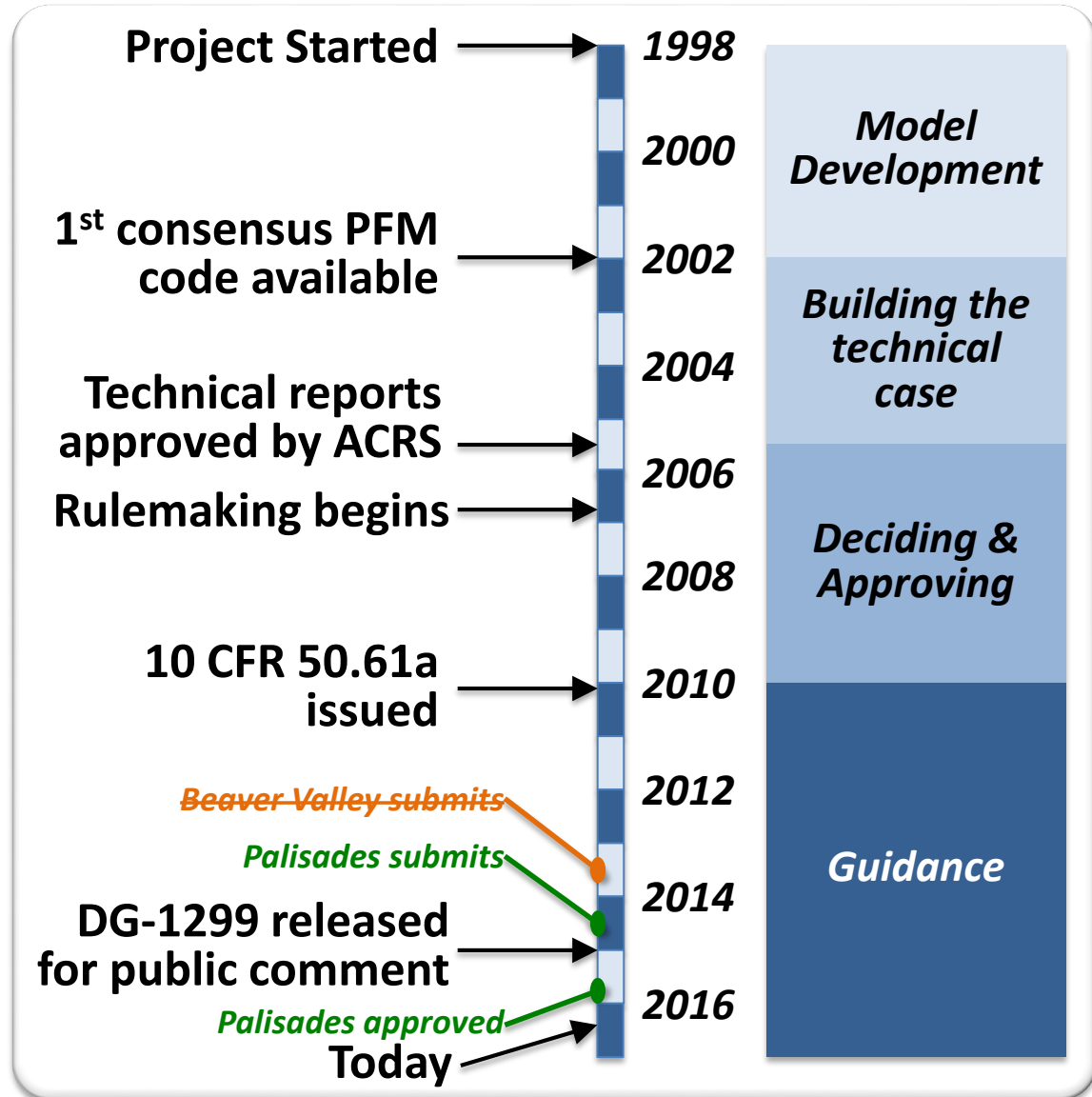
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Overall Alt-PTS Timeline

Simplified

- Development, approval, & current use spans nearly 2 decades
- Includes extensive reviews & opportunities to comment
 - ACRS
 - External review panel
 - Internal NRC
 - Public meetings
 - Public comments
- Current task: issuing regulatory guidance



BACKGROUND

What is 10 CFR 50.61a?

Why was it developed?

(Chapter 1 of NUREG-2163)

The Path to 10 CFR 50.61a

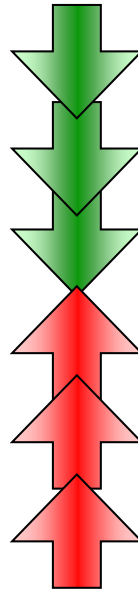
- **Motivations for alternate rule development**
- **Overall approach**
- **Key results**
- **The Alternate PTS Rule (10 CFR 50.61a)**

Technical Motivations

Developments since the 1980s suggested the overall conservatism of the rule

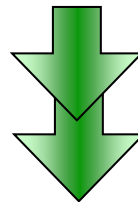
■ PRA

- Use of latest PRA/HRA data
- More refined binning
- Operator action credited
- Acts of commission considered
- External events considered
- Medium and large-break LOCAs considered



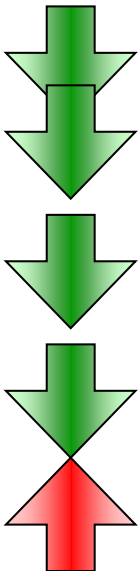
■ TH

- Many more TH sequences modeled
- TH code improved



■ PFM

- Significant conservative bias in toughness model removed
- Spatial variation in fluence recognized
- Most flaws now embedded rather than on the surface, also smaller
- Material region dependent embrittlement props.
- Non-conservatisms in arrest and embrittlement models removed

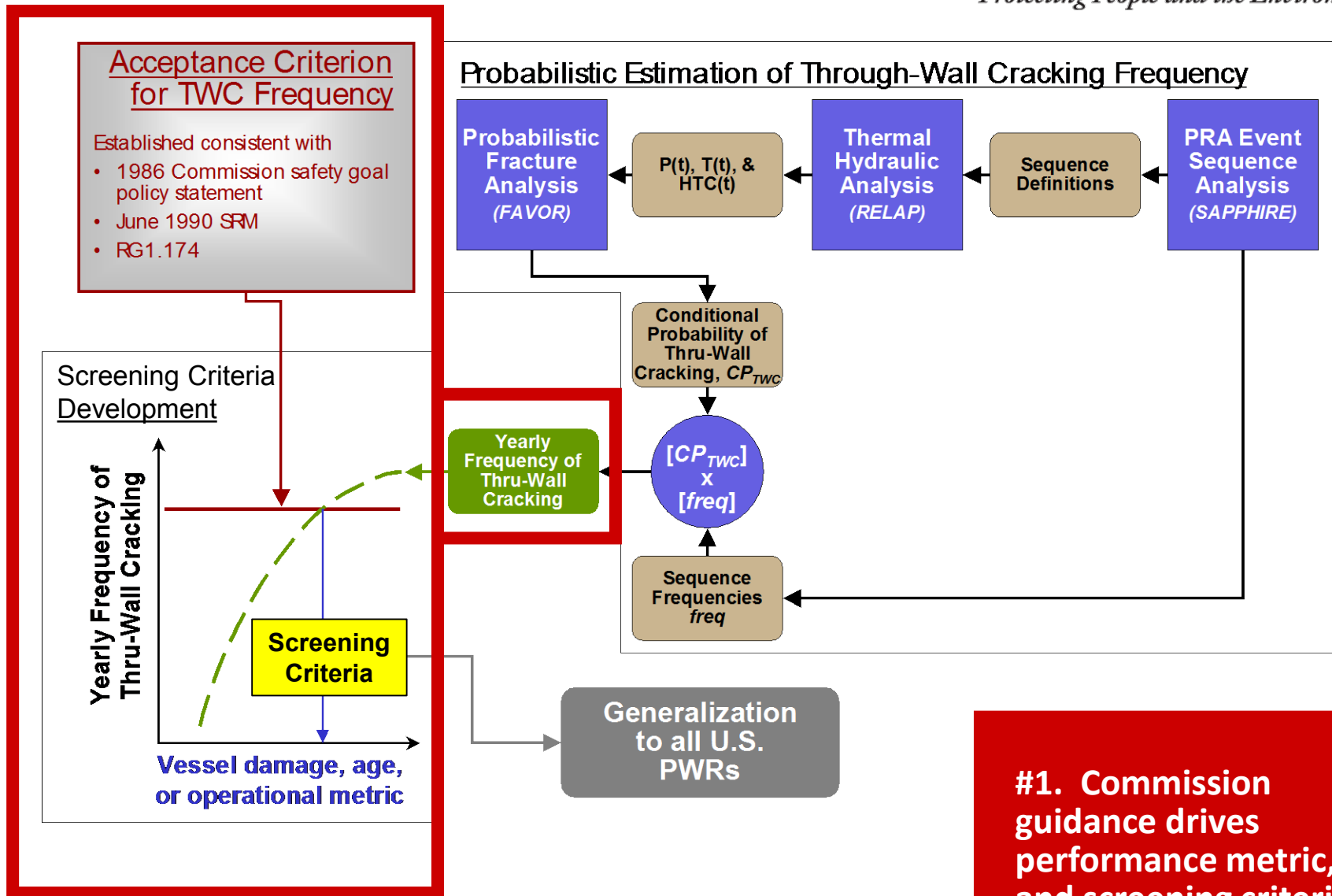


Regulatory Motivations

- **Produces unnecessary burden**
 - Technical improvements suggest strongly that current RT_{NDT} screening criteria of 300 °F and 270 °F are more conservative than needed to maintain safety.
- **Does not necessarily increase overall plant safety**
 - Focus on unnecessarily conservative RT_{NDT} screening criteria can divert resources from other more risk-significant matters.
- **Plant-specific analysis not a practical option**
 - Difficult to perform and review. Completeness and success criteria unclear.
- **Creates an artificial impediment to license renewal**
 - Unnecessarily conservative RT_{NDT} screening criteria alter perception of the safe operational life of a nuclear power plant.

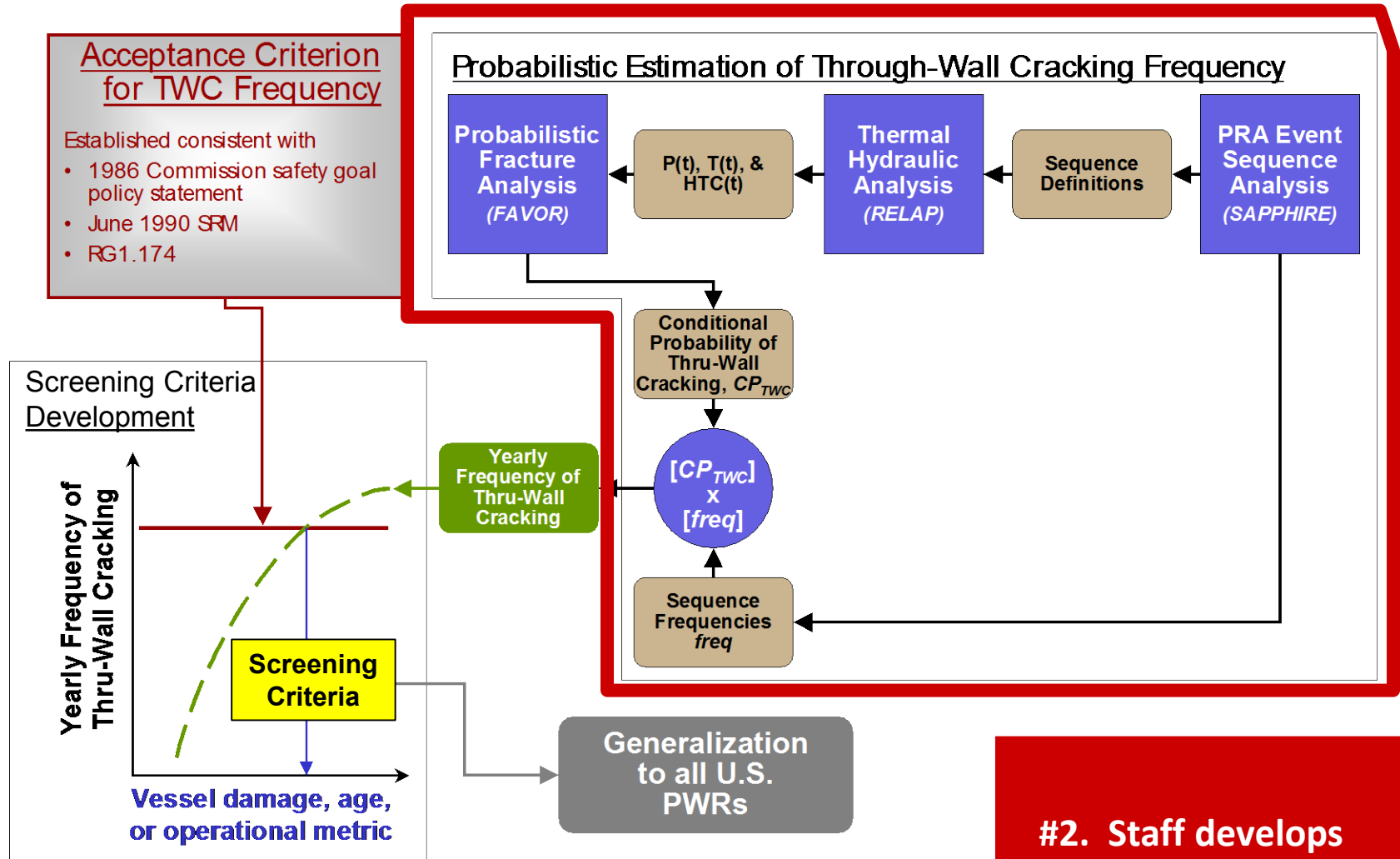
→ Causes work that produces no real benefit ←

PTS Project – Overall Approach



#1. Commission guidance drives performance metric, and screening criteria.

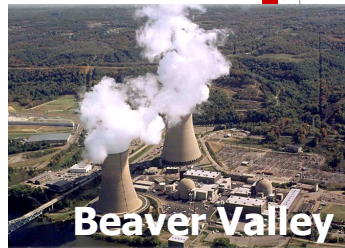
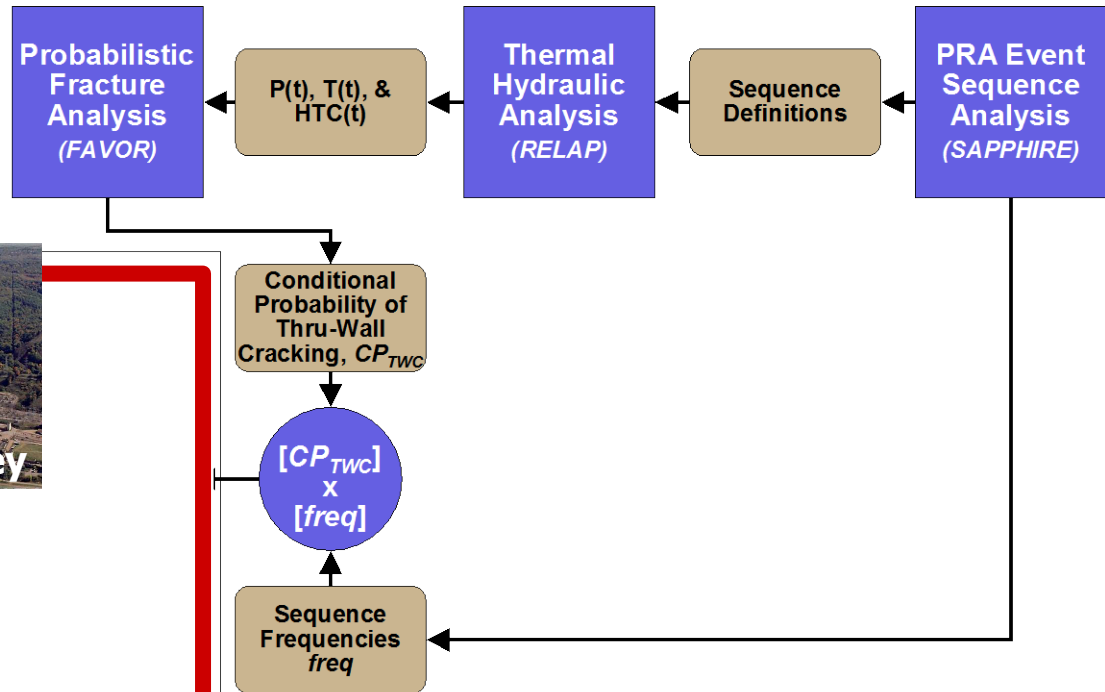
PTS Project – Overall Approach



#2. Staff develops model to estimate performance metric.

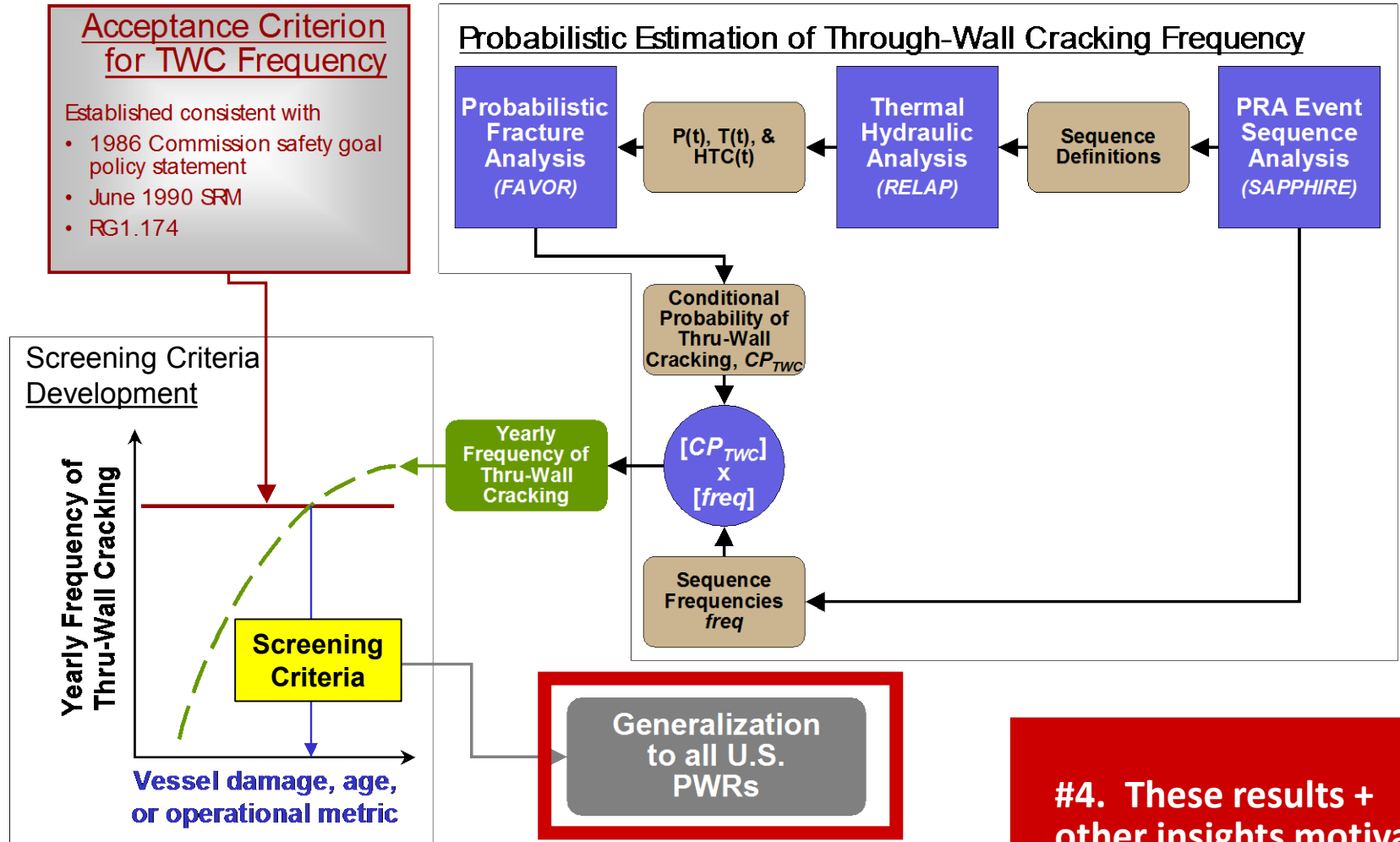
PTS Project – Overall Approach

Probabilistic Estimation of Through-Wall Cracking Frequency



#3. Metric estimated based on detailed analysis of 3 plants.

PTS Project – Overall Approach



#4. These results + other insights motivate generalization to all plants.

Key Results

- **What operational transients most influence PTS risk?**
- **What material features most influence PTS risk?**
- **Are these dominant material features / transients common across the fleet?**
- **New embrittlement screening criteria based on RI calculations**

Transient Classes Modeled

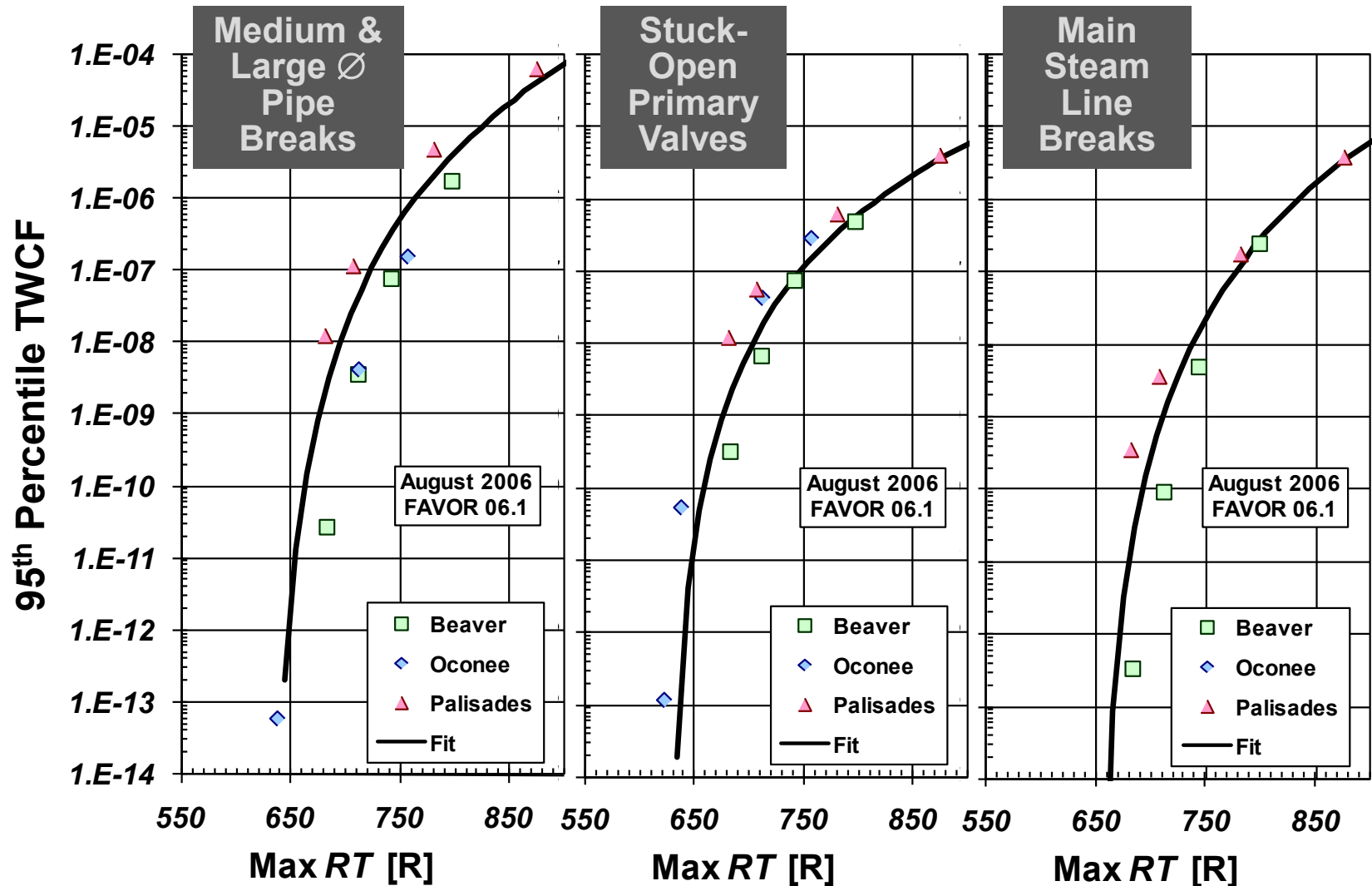
Primary System Faults

- **Pipe breaks**
 - Large
 - Medium
 - Small
- **Stuck open valves that later re-close**
- **Feed and bleed**

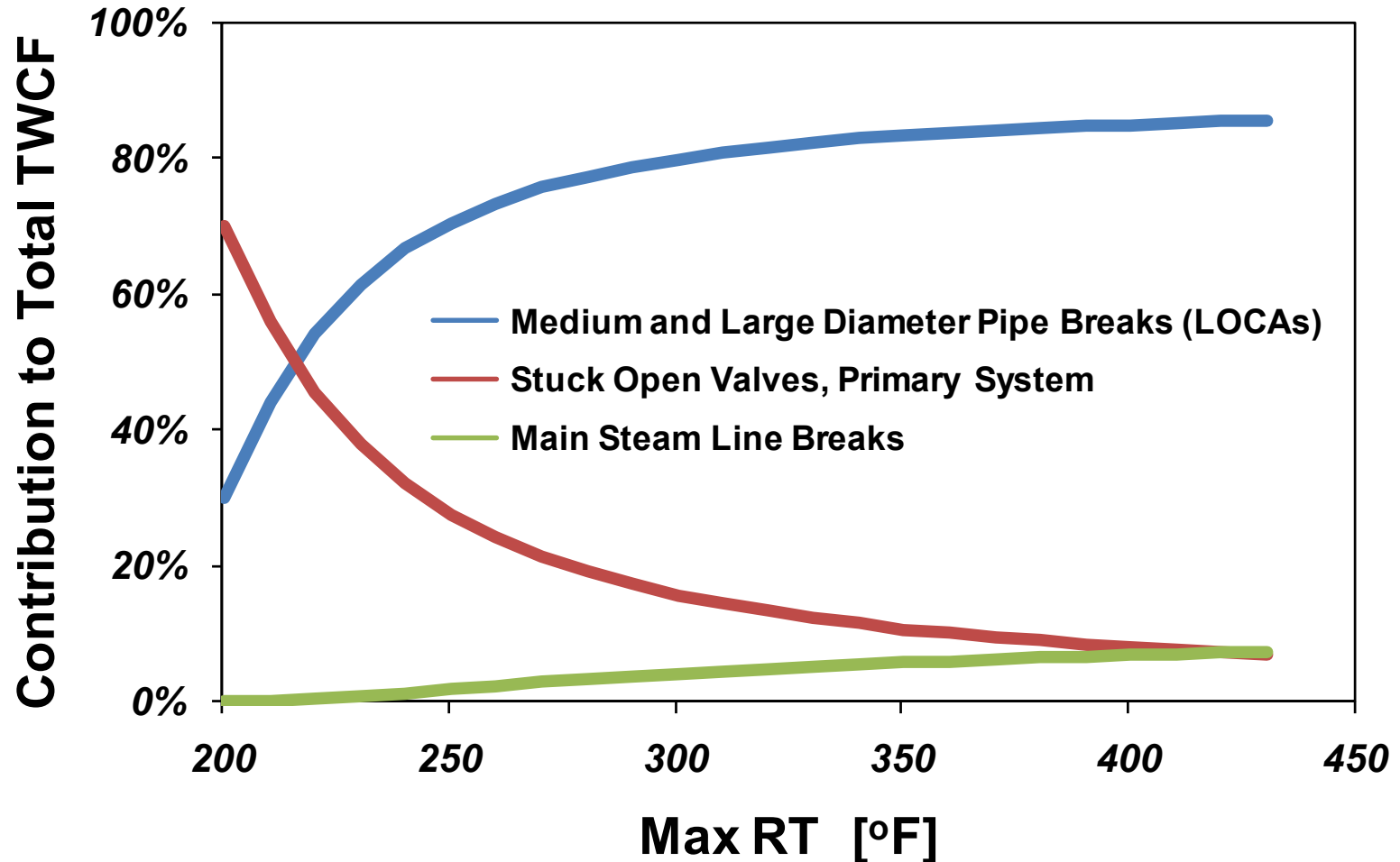
Secondary System Faults

- **Main steam line break**
- **Stuck open valves**
- **Steam generator tube rupture**
- **Pure overfeed**

Important Transient Classes



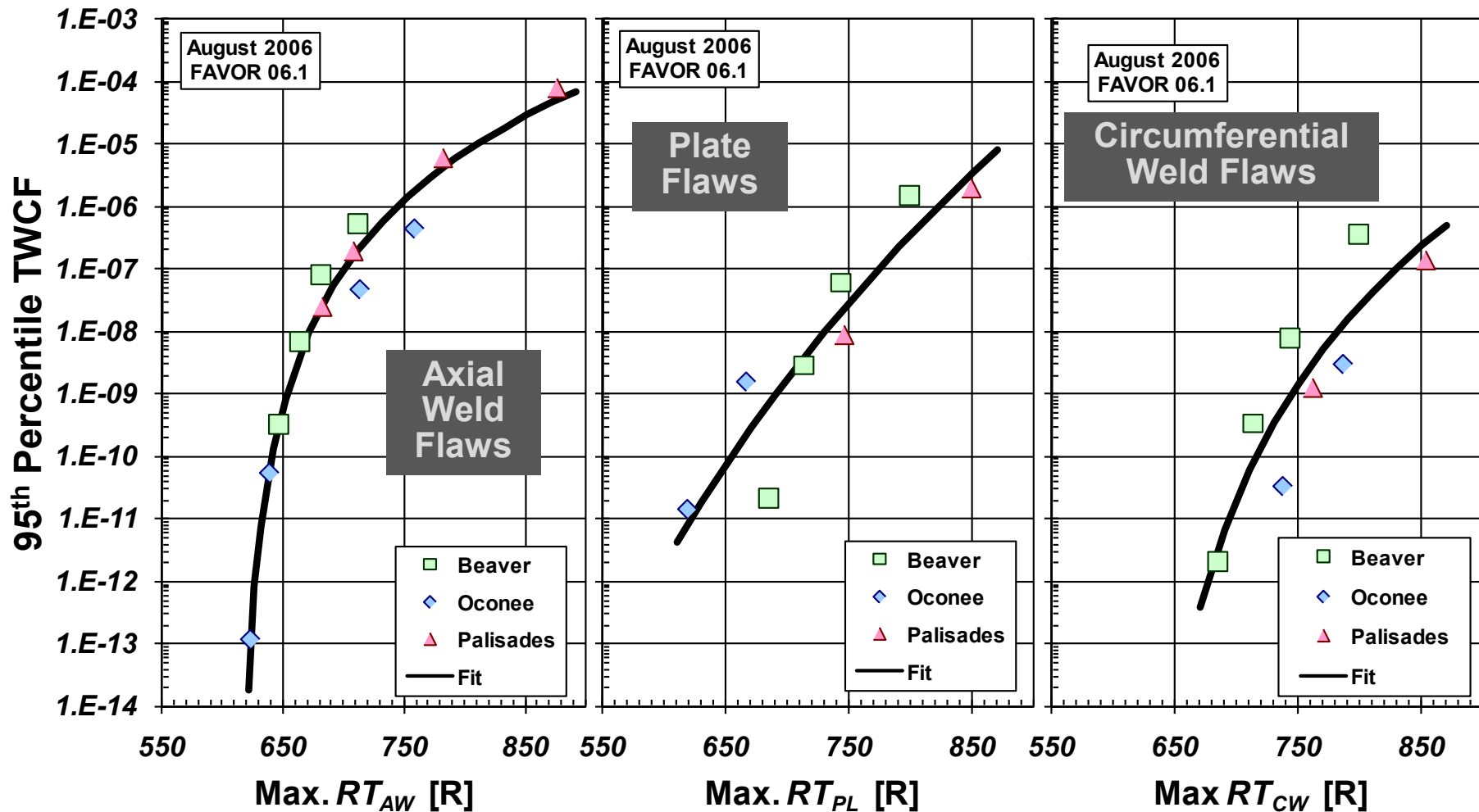
Important Transient Classes



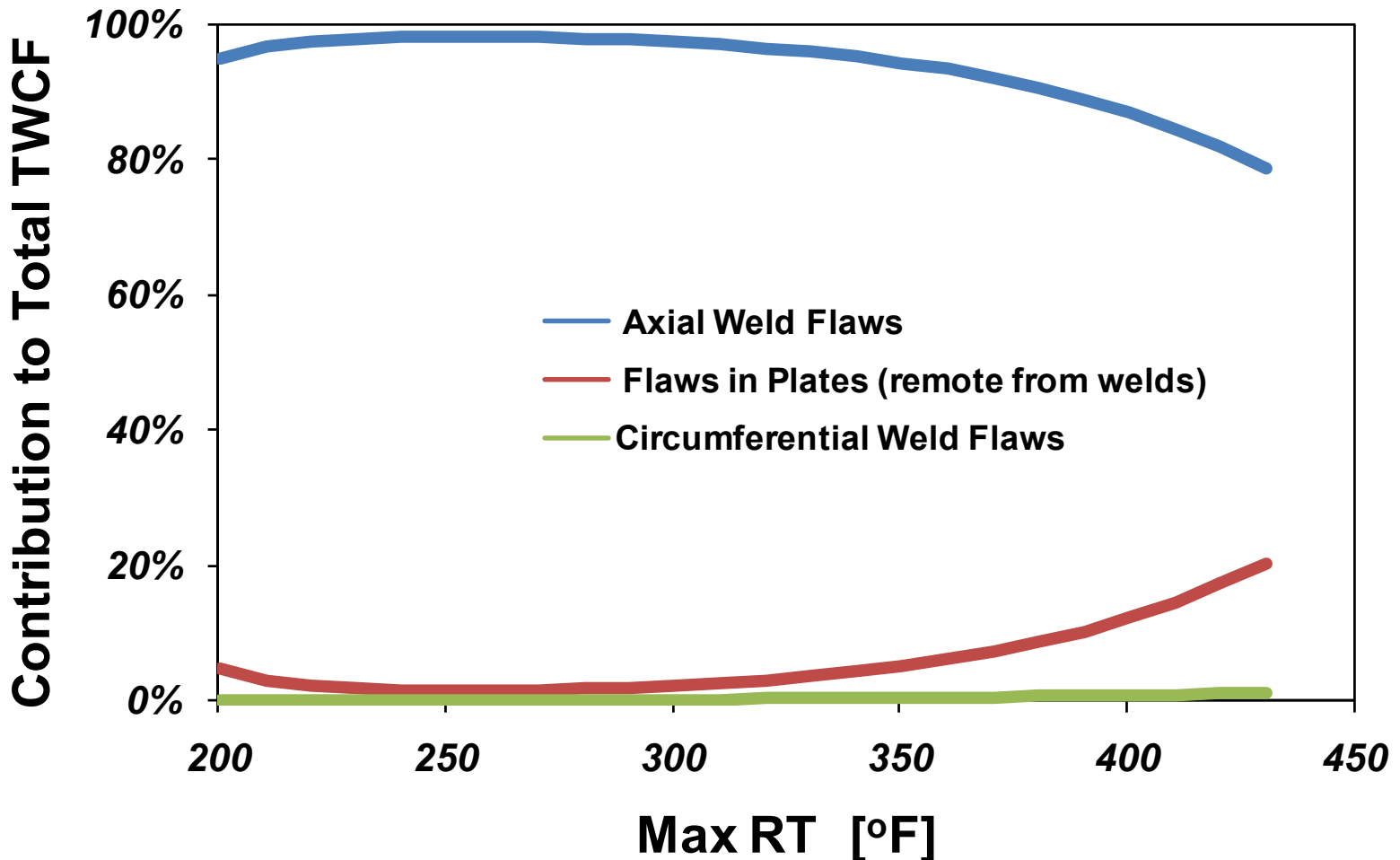
Important Transient Classes

- **Primary side faults dominate risk**
 - Due to low temperature on primary side (35°F)
- **Very severe secondary faults (MSLB) make a minor contribution**
 - Primary side temperature cannot fall below 212 °F, so material still tough even at high embrittlement
- **All other transient classes produce no significant risk**
 - Challenge is low even if transient occurs

Important Material Features



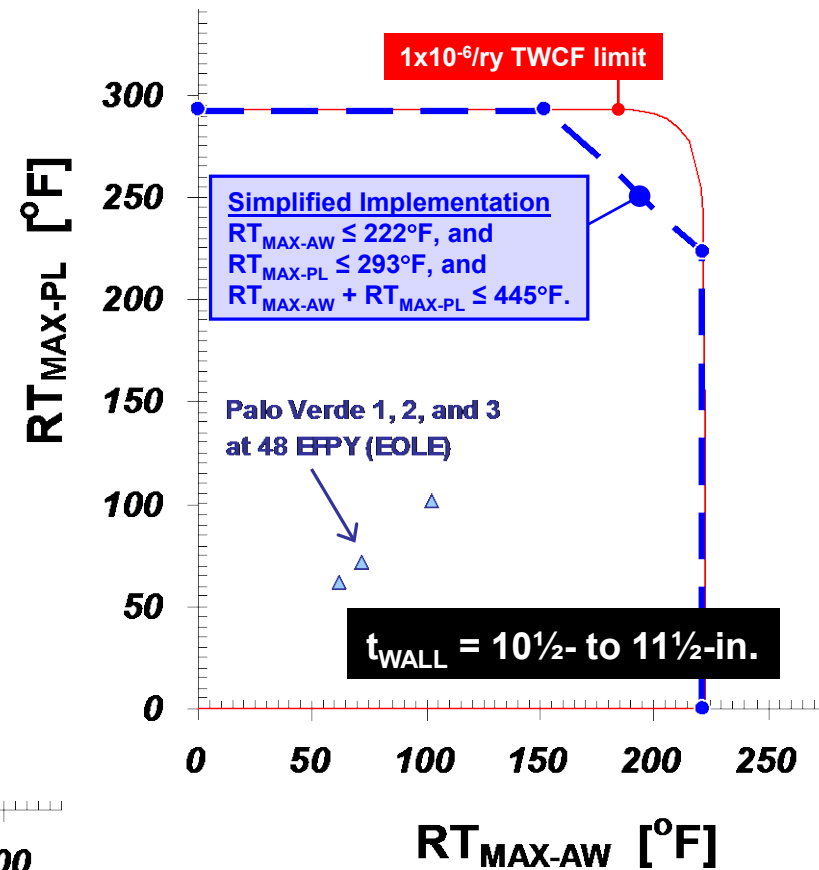
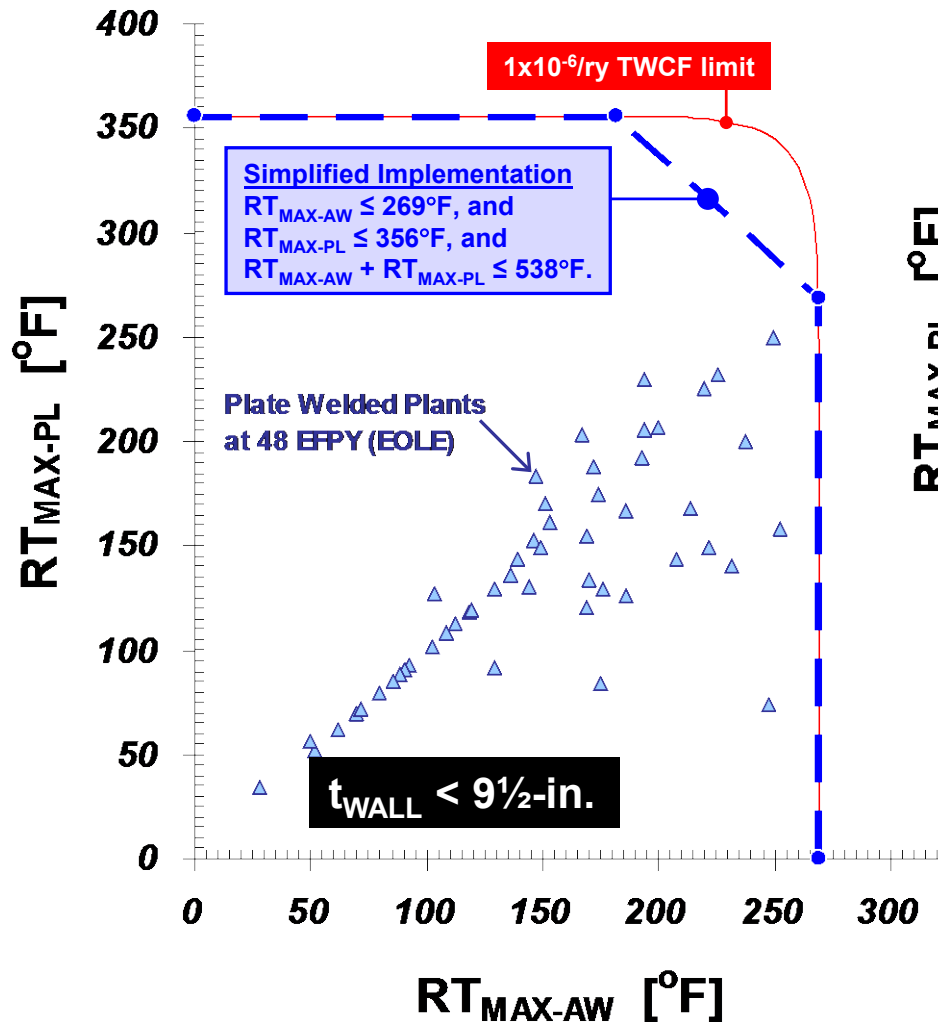
Important Material Features



Important Material Features

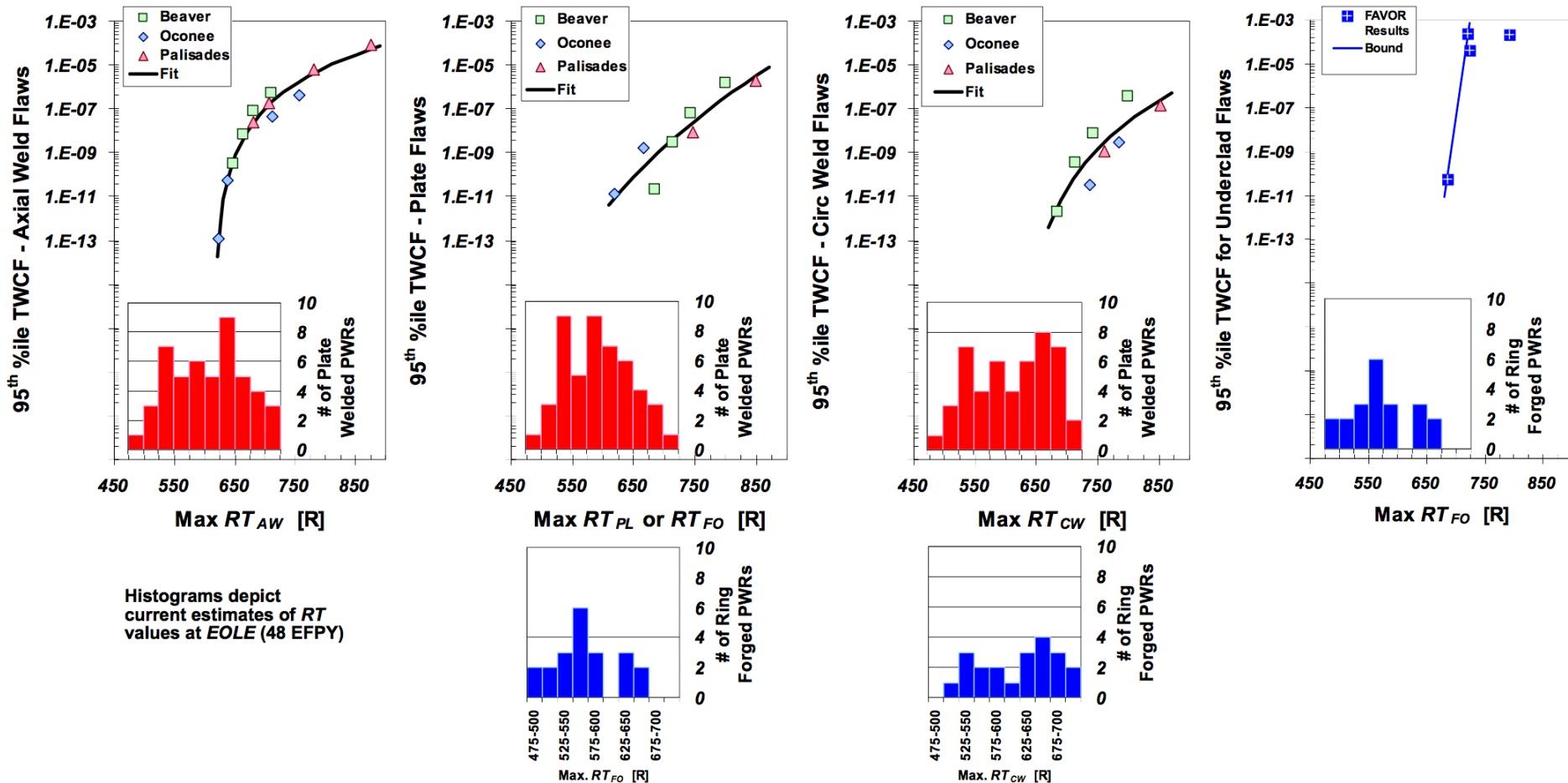
- **Axial cracks dominate risk, circumferential cracks do not**
 - Circ cracks arrest due to vessel geometry
 - Axial cracks are much less likely to arrest
- **Thus, the properties of materials associable with axial flaws dominate**
 - Axial weld properties
 - Plate properties
- **A 3-parameter characterization of RPV embrittlement unifies results across all study plants**
 - Failure probabilities are associated with the responsible material/flaw features

10 CFR 50.61a RT Limits Compared to Plant RT_{NDT} Values



Plant Embrittlement Related to TWCF

Fig 3.12 from NUREG-1874



OVERVIEW OF THE ALTERNATE PTS RULE

(Chapter 2 of NUREG-2163)

Conditions for Use of 10 CFR 50.61a

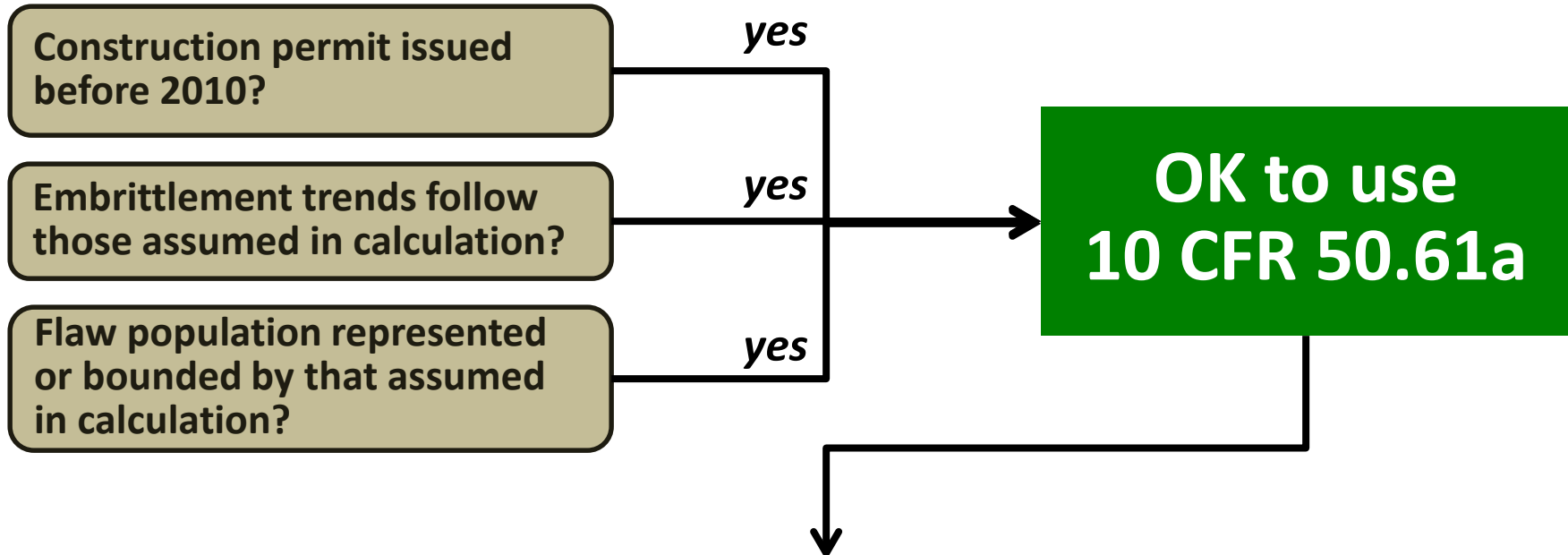


TABLE 1—PTS SCREENING CRITERIA

Product form and RT _{MAX-X} Values	RT _{MAX-X} limits [°F] for different vessel wall thicknesses ⁶ (T _{WALL})		
	T _{WALL} ≤ 9.5 in.	9.5 in. < T _{WALL} ≤ 10.5 in.	10.5 in. < T _{WALL} ≤ 11.5 in.
Axial Weld RT _{MAX-AW}	269	230	222
Plate RT _{MAX-PL}	356	305	293
Forging without underclad cracks RT _{MAX-FO} ⁷	356	305	293
Axial Weld and Plate RT _{MAX-AW} + RT _{MAX-PL}	538	476	445
Circumferential Weld RT _{MAX-CW} ⁸	312	277	269
Forging with underclad cracks RT _{MAX-FO} ⁹ ...	246	241	239

Comparison of 10 CFR 50.61 to 10 CFR 50.61a

Less restrictive reference temperature (embrittlement) screening criteria enable longer operations, but gating criteria must be satisfied to use the alternate rule.

	10 CFR 50.61 <i>REQUIRED</i>	10 CFR 50.61a <i>VOLUNTARY</i>
Reference Temperature Screening Criteria	More restrictive	Better informed, Less restrictive
Plant-specific surveillance data check	Required – 1 test	Required – 3 tests
Plant specific inspection for flaws	Not required	Required

Presentation Overview

- Alternate PTS rule (10 CFR 50.61a) development & background
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DG/RG Development Timeline

DG 1.230 = DG 1299

Date	Event
September 2013	Draft Guide development begins
October 2014	1 st ACRS briefing
March 2015	DG & NUREG sent out for public comments
May 2015	Public comments received
February 2015	Staff concurrence (except for OGC final no-legal objection (NLO) finding) on responses to public comments & revisions of RG complete
May 3, 2016	Today's ACRS Briefing
Future	<ul style="list-style-type: none">• Incorporate ACRS recommendations into RG & NUREG• Send to OGC for NLO• Publish final RG & NUREG on Federal Register (within ≈ 2 months)

REGULATORY GUIDANCE

Criteria Relating to the Date of Construction and Design Requirements
(Chapter 4 of NUREG-2163, Position 1 of DG-1299)

Construction Date

- **Rule & RT screening criteria based on analysis of three currently operating PWRs**
 - Risk-dominant transients
 - Materials of construction
- **The effect of new reactor designs & new materials of construction on these screening criteria have not been assessed**
- **Therefore the applicability of the Alternate PTS Rule restricted to construction permits issued before February 2010**
- **Licensees may choose to demonstrate applicability to specific reactor designs of their interest**

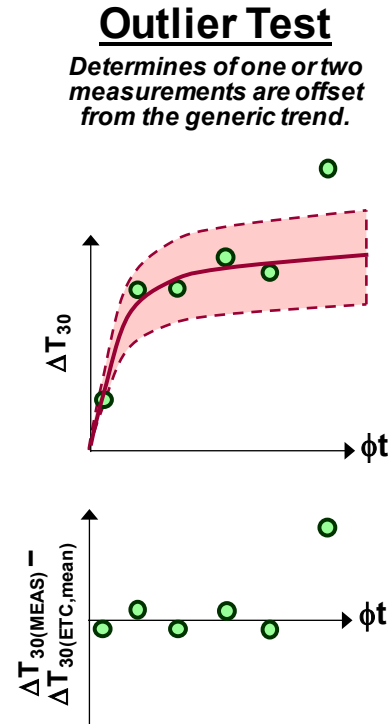
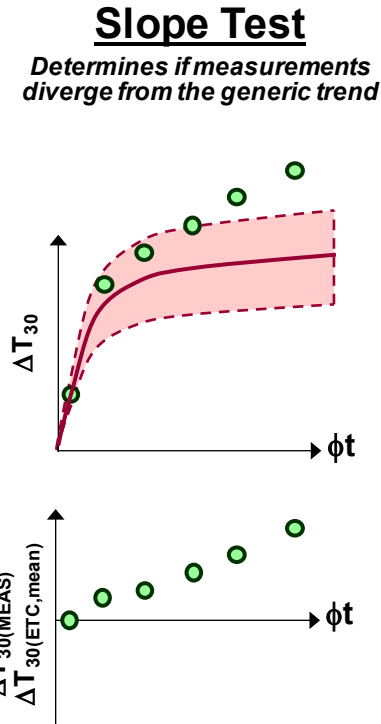
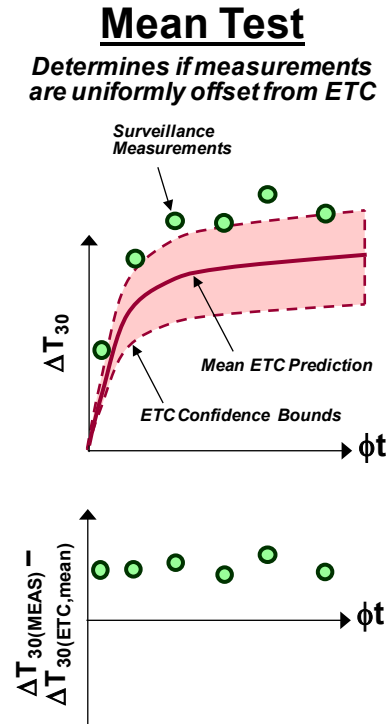
REGULATORY GUIDANCE

Criteria Relating to the Evaluation of Plant-Specific Surveillance Data
(Chapter 5 of NUREG-2163, Position 2 of DG-1299)

Goal

- **Goal**: Ensure that surveillance data for the plant being assessed is well, or conservatively, represented by the embrittlement trend equation
 - Used in the probabilistic fracture mechanics (PFM) calculations that provide the basis for the RT_{MAX-X} screening criteria, and
 - That is given by the Rule

- Must have 3 or more ΔT_{30} values
- Must consider
 - All beltline plates/welds/forgings for which data is available (not just “limiting” data)
 - Data from “sister plants” if available
- Only flags under-estimates
- 3 tests determine different deviations from expected trends

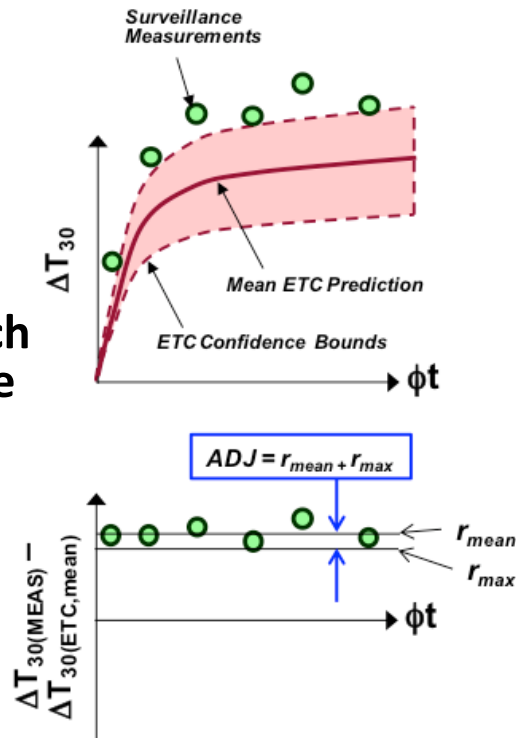


Plant-Specific Surveillance Checks

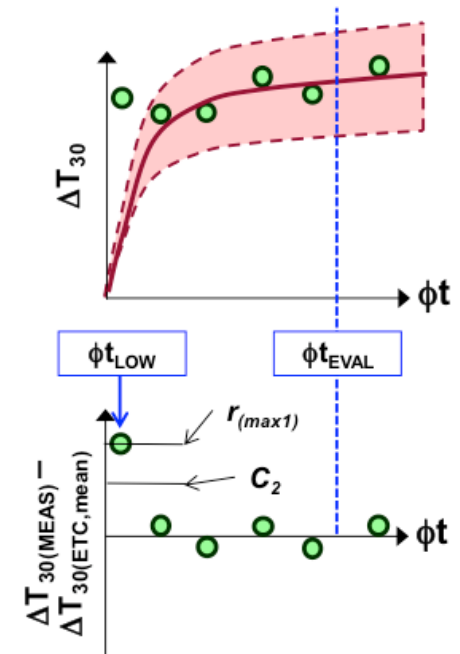
What if the data fail the test?

- Before considering adjustments, consider the accuracy & appropriateness of the input data
 - RT_{NDT(u)}, # of Charpy values, composition & exposure variables, notch orientation, comparative trends analysis

Mean Test Failure



Low Fluence Outlier Test Failure



- Adjustment Procedures
 - Mean test: Add ADJ
 - Slope test: Use greater slope indicated by the surveillance data
 - Outlier test: Can ignore a failure at a fluence < 10% of that for the PTS evaluation provided 3 or more data remain

REGULATORY GUIDANCE

Inservice Inspection (ISI) Data and Nondestructive Examination (NDE)
Requirements

(Chapter 6 of NUREG-2163, Position 3 of DG-1299)

NDE Requirements

Reason for Requirements

TABLE 2—ALLOWABLE NUMBER OF FLAWS IN WELDS

Through-wall extent, TWE [in.]		Maximum number of flaws per 1000-inches of weld length in the inspection volume that are greater than or equal to TWE_{MIN} and less than TWE_{MAX}
TWE_{MIN}	TWE_{MAX}	
0	0.075	No Limit
0.075	0.475	166.70
0.125	0.475	90.80

TABLE 3—ALLOWABLE NUMBER OF FLAWS IN PLATES AND FORGINGS

Through-wall extent, TWE [in.]		Maximum number of flaws per 1000 square-inches of inside surface area in the inspection volume that are greater than or equal to TWE_{MIN} and less than TWE_{MAX} . This flaw density does not include underclad cracks in forgings.
TWE_{MIN}	TWE_{MAX}	
0	0.075	No Limit
0.075	0.375	8.05
0.125	0.375	3.15
0.175	0.375	0.85
0.225	0.375	0.29
0.275	0.375	0.08
0.325	0.375	0.01
0.375	Infinite	0.00

Satisfying the tables ensures that the population of flaws in the vessel is well represented, or bounded, by the population of flaws assumed in the tech-basis calculations.

NDE Requirements

Examination Requirements

REQUIRED	OPTIONAL
Qualified examination in accordance with ASME Code, Section XI, Mandatory Appendix VIII	NDE uncertainty (NDE techniques tend to oversize smaller flaws, thereby distributing detected flaws into larger bins where the allowed number of flaws is smaller)
Verification that axial flaws greater than 0.075" TWE at the clad/base metal interface do not open to the RPV inside surface	

NDE Requirements

How Requirements are Invoked

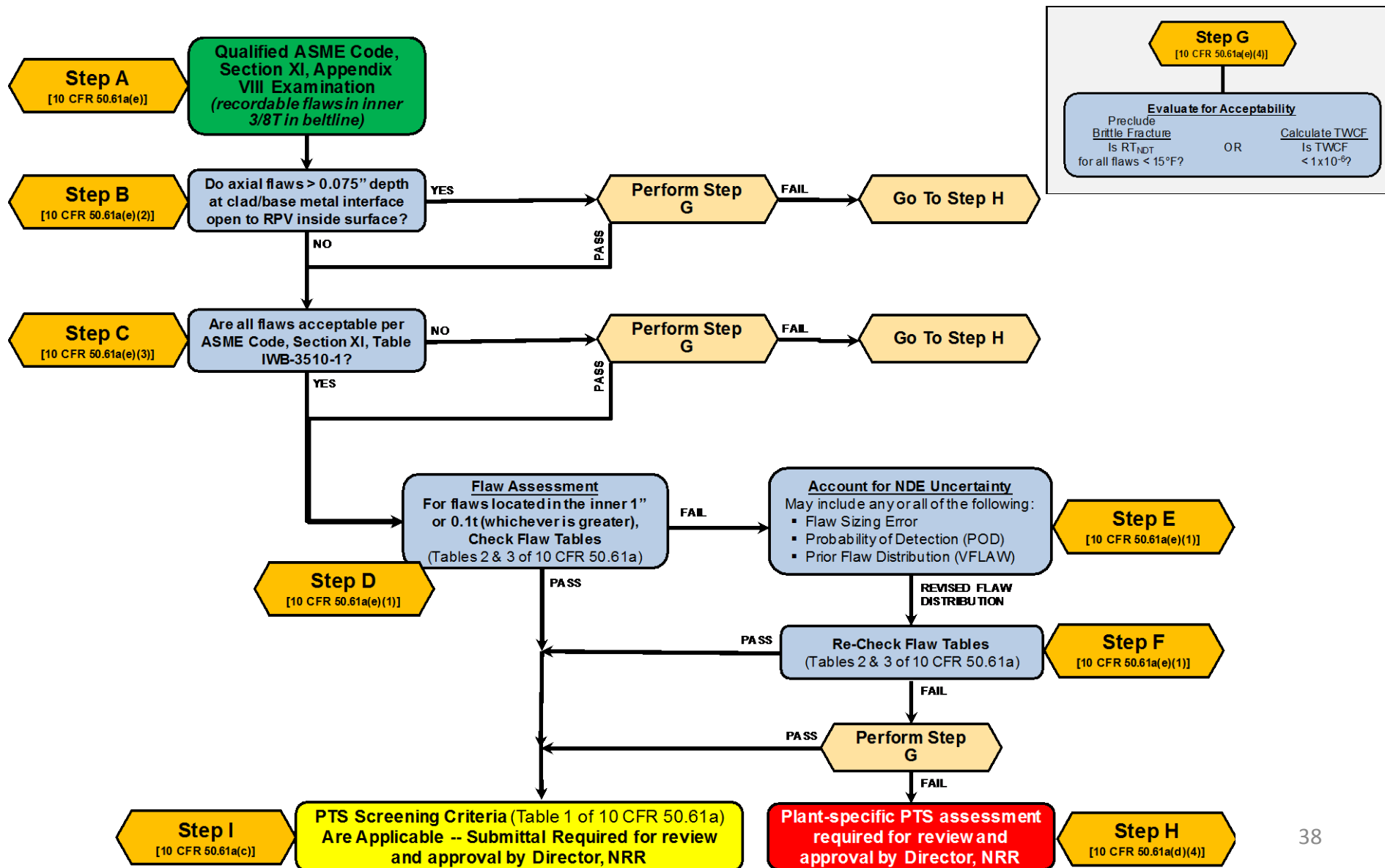


Description of Flaws	How are they Assessed
Surface connected on ID, depth greater than 0.075-in. beyond the cladding	Flaw specific assessment of TWCF contribution
Embedded, within 1-inch of inner-diameter	<ul style="list-style-type: none"> Assess compliance with flaw tables If flaw tables are exceeded assess TWCF contribution
Embedded, between 1-inch and 3/8t from ID	<ul style="list-style-type: none"> Assess to ASME Code, Section XI, Table IWB-3510-1 Assess for TWCF contribution if flaw exceeds Table IWB-3510-1
Embedded, beyond 3/8t from ID	No assessment required if flaw acceptance criteria of ASME Code, Section XI, Table IWB-3510-1 is satisfied.

Thermally-driven stresses produce greater risk-significance for flaws closer to the ID. Assessment requirements are more stringent for these flaws.

NDE Requirements

NDE Results Evaluation Process



REGULATORY GUIDANCE

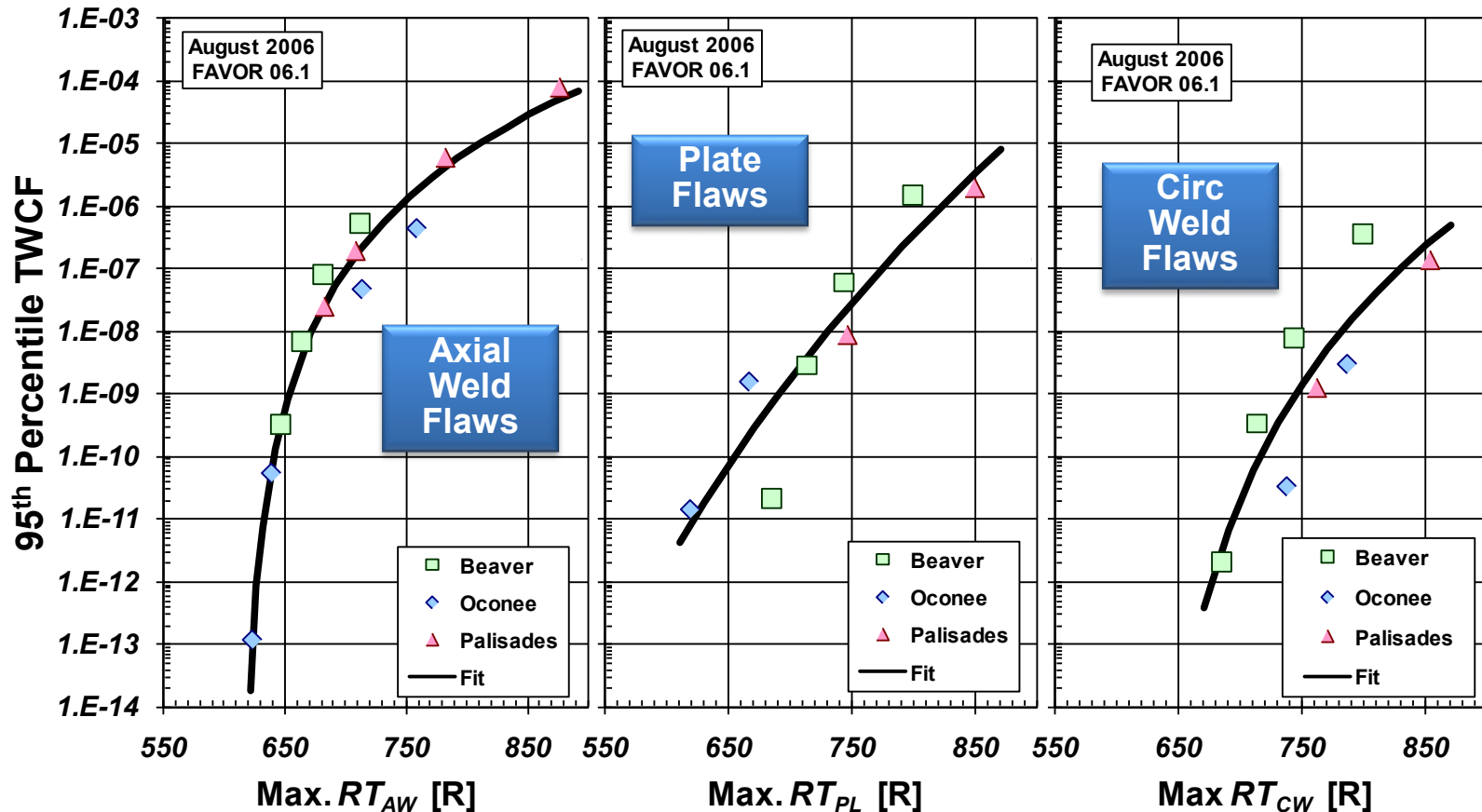
Criteria Relating to Alternate Limits on Embrittlement
(Chapter 7 of NUREG-2163, Position 4 of DG-1299)

Alternate Embrittlement Screening Criteria

Why Are They Needed?

- Paragraph (c)(3) of 10 CFR 50.61a allows for plant-specific analyses to justify operation if projected RT_{MAX-X} values exceed the PTS screening criteria
- NRC staff elected to develop one method of acceptable guidance for meeting this provision
- Similar feedback was provided by stakeholders

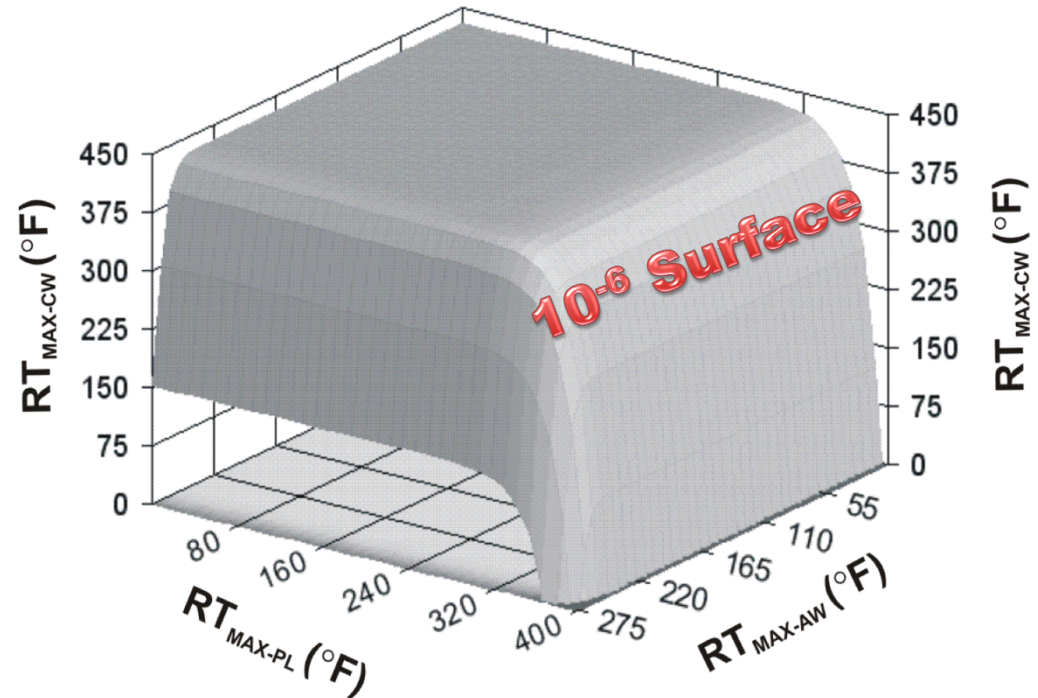
Alternate Screening Criteria on Embrittlement



RT screening criteria based on bounding curve fits to PFM results

Alternate Screening Criteria on Embrittlement

- RT screening criteria table in 10 CFR 50.61a established by inverting this equation
- Simplifications needed to express equation in tabular form
- Licensees can use formula instead of table



$$TWCF \text{ Limit} = 10^{-6} > TWCF_{AWF} + TWCF_{PF} + TWCF_{CWF} + TWCF_{FO}$$

Axial Weld Flaws Plate Flaws Circ Weld Flaws Forging Flaws

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Future Use Perspective

Repeat of status from 10/2014 ACRS Brief

- **Four plants are currently projected to reach 10 CFR 50.61 screening criteria during their 60-year operating periods:**
 - **Beaver Valley 1 (2033)**
 - Submitted July 2013; under staff review
 - **Palisades (2017)**
 - Submitted August 2014; under staff review
 - **Diablo Canyon (2033)**
 - **Indian Point 3 (2025)**
- **Several plants would likely require 10 CFR 50.61a for 80 years of operation**
- **Other plants may elect to use 10 CFR 50.61a for economic reasons**

Future Use Perspective

Updated Status

Plant Name	Notes	10 CFR 50.61a use?	
		During LR	During SLR
Beaver Valley Unit 1	<ul style="list-style-type: none"> Plate projected to exceed 50.61 screening criteria before the end of LR. Made 50.61a application in 2013. Withdrew application in 2015 based on RT_{NDT} recalculation and new surveillance data. 	Unlikely	Possible
Diablo Canyon Unit 1	<ul style="list-style-type: none"> Axial weld projected to exceed 50.61 screening criteria before end of LR. Use of 50.61a possible by 2033 (before end of LR) 	Possible	Possible
Ft. Calhoun	<ul style="list-style-type: none"> Axial weld projected to have $RT_{PTS}=268^{\circ}$ F at end of LR. 	No	Possible
Indian Point Unit 3	<ul style="list-style-type: none"> Plate projected to exceed 50.61 screening criteria before end of LR. Use of 50.61a possible by 2025 (before end of LR) 	Possible	Possible
Palisades	<ul style="list-style-type: none"> Axial weld projected to exceed 50.61 screening criteria before end of LR. Addressed in 2015 using 10CFR50.61a for LR. 	Yes	Possible
Point Beach Unit 2	<ul style="list-style-type: none"> Circ weld projected to exceed 50.61 screening criteria before end of LR. Addressed in 2014 using BAW-2308 approach through LR. 	No	Likely not
Salem Unit 1	<ul style="list-style-type: none"> Axial weld projected to have $RT_{PTS} = 267^{\circ}$ F at end of LR. 	No	Possible
TMI Unit 1	<ul style="list-style-type: none"> Axial weld projected to have $RT_{PTS} = 264^{\circ}$ F at end of LR using BAW-2308 approach. 	No	Likely not

LR = License renewal to 60 years

SLR = Subsequent license renewal to 80 years

Future Use Perspective

Updated Status, Cont.

- No licensees have indicated short term plans to use 50.61a
- List on previous page may not include all plants considering use of 50.61a
- Plants may elect to use 50.61a for economic reasons – NRC cannot anticipate this use
- Plants have options other than 50.61a to address & manage embrittlement:
 - **Physical options**
 - Fuel management
 - Changing operational characteristics (e.g., heating make-up water)
 - Annealing
 - **Data options**
 - Plant-specific surveillance data
 - BAW 2308
 - Master Curve (PWROG project, CC N-830)
 - **Analytical options**
 - Plant-specific PRA &/or PFM

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CLOSURE & DISCUSSION