UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

* * * * * * * * * * * * * * * * * *

Investigation of: *

ENBRIDGE - LINE 6B RUPTURE IN MARSHALL, MICHIGAN * Docket No.: DCA-10-MP-007

* * * * * * * * * * * * * * * * * *

Interview of: SEAN KEANE

Enbridge Headquarters
Edmonton, Alberta
Canada

Wednesday,
December 7, 2011

The above-captioned matter convened, pursuant to notice.

BEFORE: MATTHEW NICHOLSON
Investigator-in-Charge

APPEARANCES:

MATTHEW NICHOLSON, Investigator-in-Charge
Office of Railroad, Pipeline, and
Hazardous Materials Investigations
National Transportation Safety Board
[redacted]

BRIAN PIERZINA, Accident Investigator
Pipeline and Hazardous Materials Safety
Administration (PHMSA)
[redacted]

JAY JOHNSON, Supervisor
Audits and Inspections
Enbridge Pipelines
[redacted]

RAVINDRA CHHATRE
Integrity Management Group Chair
National Transportation Safety Board
[redacted]

MATTHEW FOX
NTSB Materials Lab
National Transportation Safety Board
[redacted]

I N D E X

I N D E X (Cont.)

I N T E R V I E W

MR. NICHOLSON: This is NTSB Pipeline case number DCA-10-MP-007, Enbridge Energy July 2010 crude oil release in Marshall, Michigan. These are the Integrity Management Group interviews being conducted at the Enbridge Headquarters in Edmonton, Alberta, Canada. Today is Wednesday, December 7th, 2011.

This interview is being recorded for transcription at a later date. Copies of the transcripts will be provided to the parties and the witness for review once completed.

For the record, Sean, please state your full name, with spelling, employer name, and job title.

MR. KEANE: Sean Keane. S-e-a-n, K-e-a-n-e. I work for Enbridge Pipelines. My job title is Supervisor Crack Planning.

MR. NICHOLSON: Okay. And, Sean, for the record, please provide a contact phone number and email address that you can be reached at.

MR. KEANE: My phone number is [redacted]. My email address is [redacted].

MR. NICHOLSON: Sean, you're allowed to have one other person of your choice present during this interview. This other person may be an attorney, friend, family member, co-worker or nobody at all. If you would, please indicate whom you have chosen to be present during this interview.

MR. KEANE: Nobody.

MR. NICHOLSON: Okay. We'll go around the room now and have each person introduce themselves for the record.

My name is Matthew Nicholson, M-a-t-t-h-e-w, N-i-c-h-o-l-s-o-n. I'm with the NTSB as the IIC. My phone number is [redacted] [redacted]. My email is [redacted].

MR. FOX: My name is Matt Fox, M-a-t-t, F-o-x, NTSB Materials Lab. Phone number is [redacted]. Email [redacted].

MR. JOHNSON: Jay Johnson, Enbridge Pipelines, [redacted]. Cell [redacted]

MR. PIERZINA: Brian Pierzina, B-r-i-a-n, P-i-e-r-z-i-n-a. I'm with the PHMSA [redacted]. My e-mail is [redacted] and my phone number is [redacted].

MR. CHHATRE: Ravindra Chhatre. I'm Integrity Management Group Chair, NTSB. My email is Ravindra.chhatre -- [redacted]. Telephone is [redacted] [redacted]

INTERVIEW OF SEAN KEANE

BY MR. NICHOLSON:

Q. Okay. Sean, maybe to begin with, actually, it will be probably a good idea before we launch into IMS if you gave us maybe a little background about yourself.

A. Sure.

Q. Education; when you started at Enbridge; positions you've held within Enbridge; and just maybe a little bit about your duties.

A. Okay. I started at Enbridge in 2003. Prior to that, I was -- graduated as a metallurgical engineer and worked as a Failure Consultant to the oil and gas industry for a number of years before joining Enbridge in 2003.

When I joined Enbridge, I began working in the area of -- well, within the Materials Technology Group and working on crack programs. And have progressed through that same group since that timeframe as a -- into a senior engineer. And then in approximately 2008, I believe it was, as a supervisor of the team.

Q. So, you are currently still part of the Materials Technology Group?

A. The Materials Technology Group has -- was renamed just recently into the Crack Planning. So --

Q. How recent was that?

A. That was part of the restructure, the reorganization that occurred.

So, the Material Technology Group has looked after cracking programs, though, since its inception.

Q. Okay. If you'd like, you can go ahead and take us into the pipeline IMS.

A. Yeah.

Q. (Indiscernible) talk a little bit about some of your procedures and maybe just how your program works.

A. Sure. So, the crack management plan is a continuous cycle of plans and actions and monitoring programs to guide it towards prevention of leaks due to axial crack flaws. So, those axial crack flaws include fatigue and SCC. Those are the two primary mechanisms driving crack (indiscernible) from the Enbridge system. It's a series of plans and actions, like I indicated, surrounding susceptibilities, assessment and re-assessment intervals in condition monitoring. It's a continuous cycle. And at several points -- at any point along this cycle, we can trigger the need for a comprehensive threat assessment, such as crack in-line inspection, or a hydrotest, or at times even a DA program. Those are the three types that we've considered historically.

Also, at any point during this process, there's immediate actions to mitigate a threat, so that means pressure restrictions and immediate excavations or planned excavations throughout a phase program.

So, what I'd like to do is we'll just walk through the process documents surrounding these various --

UNIDENTIFIED SPEAKER: (Indiscernible.)

MR. KEANE: Yeah. Okay.

BY MR. NICHOLSON:

Q. And just for the record, these documents you're bringing up, these are PI's that are all discussed under the Crack Management Program? Is that what that is?

A. That's correct. Yeah, this is all under the Crack Management Program.

BY MR. CHHATRE:

Q. Sean, (indiscernible) can you -- before you start, can you tell me where your group fits in under your overall integrity management?

A. Yes.

Q. And then can walk us through?

A. Yeah and I can pull up the slide to walk you through if that's easier; a little bit here.

Q. I think it would be, yes.

A. Yeah. So, one of the first ones here that Scott had. So, under -- so, we're with the -- under the Integrity Planning Teams, so there's the three teams for crack, corrosion, and mechanical deformation teams. And so we are one of the teams within this Integrity Planning group.

So, then we report up through -- Scott Ironside is the Director of the Program Management -- and ultimately then into the VP of Walter Kresick. Sure.

Q. It was the same kind of structure present before the accident or this is post accident?

A. Well, that's correct. That this is the post-accident structure. The structure prior to the accident had -- it was very similar in that I was still reporting up through Scott Ironside. And -- But we had a different -- as you've heard Scott describe, the Infrastructure Management side of this, yeah, group wasn't here before, so these activities were previously completed as parts of the other teams and within Enbridge themselves. So, it's been more formalized and restructured to provide additional focus here. Anything else?

MR. NICHOLSON: You're good. I think you can continue.

Is there anything more, Ravi?

MR. CHHATRE: No, no.

MR. KEANE: All right. So, the Crack Management Program components and process documents and guideline documents are what I'm going to describe. And as you can see here, each of these key components within the program structure have an associated process document or guideline document.

So, the susceptibility assessment, which it's faint in the background here, I've left that original circle here. But so we'll describe this one first. And then I'll go into -- and we'll talk about the comprehensive thread assessment. That is the bulk of what our processes are geared towards. It's a very -- it's a key series of activities for us and you can see that. It's reflective of the number of process documents and guideline documents surrounding it.

And then moving down into -- we'll talk about reassessment interval and then come around to condition monitoring and some of these immediate actions.

MR. NICHOLSON:

Q. Are we looking at these chronologically or -- I mean, is this -- are these as the steps are executed by an analyst?

A. Largely. Right. And that's why I thought we'd approach it this direction because at times -- yeah. We do have to bounce around a little bit during the -- just the reality of when you get information in.

Q. Okay.

A. So, condition monitoring, you continuously have to update your information and update your analysis to ensure that the re-assessment intervals are correct.

Q. Okay.

A. But that condition monitoring, part of that re-assessment interval is understanding it's a susceptibility change. So, this cycle has to occur, but at any point it can trigger these immediate actions and you can -- the reassessment interval might be bumped forward in time as a result of this susceptibility change.

Q. Okay. Just to clarify. Please explain the difference between an EI document and a guideline.

A. So, process documents are those activities that fit within a defined structure. They are very repeatable and they have a rigorous amount of definition surrounding them.

A guideline document has -- it's a little bit more subjective on how to develop them, so there's -- it's -- we have guidelines on what to consider within them but we don't have the definitive, "If you see this, then you have to do that." So, those definitive action-reactions.

So, ultimately a guideline document has evolved into process documents. And that's what we've seen for ourselves, so we can talk about some of those along the ways.

MR. CHHATRE: Is there a difference in what management approval these documents have in addition to being -- what documents and guidelines and process, do they both have management blessing or does one have management blessing and the other doesn't?

MR. KEANE: Both have I would say management's approval, yes. So, you'll see through our process documents and the guideline documents that they're all supervisor approved and they're all -- we have responsibilities identified within them so, yeah. Absolutely.

MR. FOX: This is Matt here; Matt Fox. With the condition monitoring, in some of the earlier documentation that we got, the information requests, the condition monitoring, the process document was PI-41. Is PI-06 a relatively new document or --

MR. KEANE: No. The previous PI-41 document contained the same information that was in here.

MR. FOX: Okay.

MR. KEANE: It also contained the crack inline inspection interval determination.

MR. FOX: Okay.

MR. KEANE: So, we've separated those out along the way.

Again, because while the pressure cycle monitoring, a component of that involves a fatigue style calculation, it's not the crack inline interval determination. Those are separate processes, so we split those out to be more clear.

MR. NICHOLSON: This is Matt Nicholson.

BY MR. NICHOLSON:

Q. Then the question ultimately is, are we seeing what we're seeing today is what was in place July 2010, right?

A. So, what I'm walking you through here is the current version of things.

Q. Okay.

A. We can step back a year and a half to the 2010 -- well, the July 2010 versions. They're largely very, very similar.

Q. Okay.

A. We can track through the manner of change that's occurred since then. There's been I'd say three more notable changes along the way.

Q. Well, maybe you could point them out as we're going through.

A. I think that would be best.

Q. Okay.

A. Is to point them out, so, yeah.

Q. Thank you.

A. As you can imagine, there's been lots of immediate learnings from Marshall. And while we don't know -- we don't know all those learnings yet, we've had to make educated and, you know, speculations on different things. And so as a result, our process documents have changed.

So, the susceptibility assessment is -- it defines initial susceptibility to potential crack growth. And largely this plays two roles. So, the initial susceptibility, if you go back in time, when Enbridge was prioritizing which tool runs to complete first, because the crack ILI technology has -- it's a younger science than metal loss, for example. So, we were in the process of -- well, there was a time when we were running our initial line assessments. And so that initial susceptibility used these indicators, such as failure history and our results from opportunistic excavations.

And what I mean by opportunistic excavations is those excavations completed for other reasons, such as a corrosion dig or even just a maintenance -- any maintenance activity. So, with all those activities, did we find cracking?

So, those types of results provided an understanding of the susceptibility of the line.

We'd also look at operating pressures, so both the MOP of the line as well as the normal operating pressures and additionally, pressure cycling.

Q. So, just to go back. Any opportunistic dig that was performed, would include a (indiscernible) particle inspection?

A. Correct. So, for every excavation completed on -- I don't remember the exact date that it goes back to, but quite some time, Enbridge has required NDE complete M-mag particle, an inspection of all welds; so long seams, girth welds in all areas according despondent and all areas of observable metal loss. So, we've been looking for SCC and cracking in all our digs.

Q. Now, you were talking about operating pressure.

A. Right. So, operating pressure is an indicator of susceptibility. So, depending on what the MOP is, if it's -- we can talk about MOP if you want, but normal operating pressure is something that we've defined as being -- the typical operating pressure to the line is exposed too so it's a maximum of that.

So, while a given line might be licensed to operate up to 72 percent SMYS, if it's only operating at 40 percent SMYS, we want to know that and we want to track that.

So, 99.99 percent of the time we look to see what the maximum operating pressure is. And we want to understand that because within condition monitoring we want to track if that has changed or not because that's also an indicator of something. The susceptibility could change.

Q. So, what do you do? You pull up SCADA data? Is that what you're doing?

A. Yeah. Yeah.

Q. Do you consider when you look at the maximum transients, like line shut downs?

A. Absolutely.

Q. Line stops?

A. Absolutely. Okay. That's all part of it. So, if it's just -- and that's why we put not just the max pressure there, but it is the 99.99 percent of the time what pressure does it see. Yeah.

And then pressure cycling. We're going to have a longer discussion about pressure cycling as part of the condition monitoring -- or fatigue. We can talk about that. But, yeah.

So, those types of indicators form that initial susceptibility assessment. That understanding, combined with the industry knowledge and our own experience surrounding seam type and coding type and pipe vintage and manufacture and environmental conditions, all that got wrapped up --

MR. CHHATRE: Sean.

MR. KEANE: Yeah?

MR. CHHATRE: On your opportunistic excavations, do you do soil assessment?

MR. KEANE: Yes. Enbridge has done soil assessment and corrosion.

MR. CHHATRE: No. I mean, do you know your procedures? Like, I'm not sure if it has it or not, what your procedure describes what to look for in the opportunistic excavations?

MR. KEANE: It's not a requirement currently. It hasn't been a requirement to do that for quite some time. Historically, it was a requirement. And I don't know -- I can't speak to everywhere within the system, but I know back to my experience previous to joining Enbridge in 2003, I worked here for -- out in the field for four months just doing on-site. And we did corrosion sampling at all of those locations and water testing and all of the soil monitoring stuff that you can start thinking about.

And all that work was done to gather that data base to look for trends associated with corrosion conditions and crack conditions of the mainline. And that work largely concluded that this testing is -- are best indicators of conditions is from the ILI tool. And so as a result of that, the at site sampling was reduced to those anomaly type locations.

MR. CHHATRE: So, it's no longer one of the requirements to do soil samples of PH conductivity?

MR. KEANE: Not at all locations, no.

MR. CHHATRE: Now, what you're saying, these opportunistic excavations, which you'll see cracks, which are mag particles --

MR. KEANE: Yeah.

MR. CHHATRE: Does the document say what to do if you do see crack? Not that you would see crack every time.

MR. KEANE: Absolutely. So, our O&MP is -- requires that -- it's our Operation and Maintenance Procedures, have specific items related to crack. So, if you find crack in the field, what do they need to do with that. And in short, we either grind and remove that feature and then assess it as metal loss to ensure that it is safe. And if it can't be ground or removed because it's either too deep or would result in an unsafe condition for the amount of metal loss, then they -- they'll need to sleeve that feature so we don't leave -- we don't recoil cracks.

MR. CHHATRE: Okay. And how would you know doing mag particle, that a crack you're seeing on SCC and not fatigue -- what is that?

MR. KEANE: I mean, you can't. But all you can do there is have the characteristics of the -- of what's presented to you. Of course, you can't tell by looking at a mag particle if the propagation mechanism is fatigue or SCC. But you can tell that it's in a colony and it's characteristic of SCC for you know the number of reasons there.

So, a fatigue mechanism is largely -- it has to have a certain length. And there's all of those components to it.

MR. CHHATRE: Well, I guess what I was getting at is, if you use these opportunistic digs to identify threats to the pipeline --

MR. KEANE: Yes.

MR. CHHATRE: -- how do you know that the SCC is the thread and not fatigue or vice-versa? What do you do in those -- since you do not know, how will you identify?

MR. KEANE: So, our field NDE identifies the cracks as either SCC or just simply linear indication. So, if it's a single linear indication, which is not characteristic of SCC, then it gets documented as that. If it's SCC, then it's called SCC and it's documented as such. So, we separated the two out. And then we assume that either the two could ultimately propagate by fatigue. So, either of the two could propagate that way.

MR. CHHATRE: I guess, then, any time you see cracks you got to -- after you get both SCC and fatigue and just kind of take that approach? Or are you more specific than that?

MR. KEANE: We're more specific in that we do require the field to document what they're seeing. Because it's important for us to understand if it's SCC or -- if it's characteristic of SCC, is it a colony or not? And so if it's just a centerline crack within a weld, then we want to know -- then it's documented and it's just a singular linear indication. But if it's a colony, then, once again, it is documented as an SCC.

MR. CHHATRE: Now, the ND people, are they Enbridge or are they contractors?

MR. KEANE: They're contract employees. There's an ND scope of work that describes their processes that they're required to complete during excavations. And all of that is in line with our O&P procedures.

MR. CHHATRE: What is the level of certification that you have to have?

MR. KEANE: So, in Canada they're required to have --

depending on which work they're completing, but in Canada they're required to have CGSB level 2 or 1, or 3 or higher.

MR. CHHATRE: C?

MR. KEANE: CGSB

MR. CHHATRE: Oh, CGS.

MR. KEANE: Yes.

MR. CHHATRE: What does that stand for?

MR. KEANE: Canadian Government Standards Bureau is my speculation. Something to that effect. I don't know off the top of my head.

MR. CHHATRE: They have a CGSB level 2 or higher?

MR. KEANE: Depending on the type of work. So, it can be level one, right.

MR. CHHATRE: No. I mean for the cracks?

MR. KEANE: Yeah, it can be level 1, depending if they're doing MAG particle. I mean, there's level 2 inspector. And then in the U.S., then, they're required to be ASNT.

MR. CHHATRE: Okay.

MR. KEANE: So --

MR. CHHATRE: Thanks.

MR. PIERZINA: Sean, this is Brian. So, the crack threats susceptibility has been determined for each segment of Enbridge Pipeline?

MR. KEANE: Yes, that's correct.

MR. PIERZINA: Do you -- can you have a pipeline that's had a failure but then determine not to be susceptible to, say, a manufacturing flaw?

MR. KEANE: No. And the reason -- that's the very first bullet here, right -- is the failure history is the strongest leading indicator of susceptibility. That speaks to everything right there.

MR. PIERZINA: So, can you have -- and how far back does the failure history go?

MR. KEANE: That's a great question. When we were originally building and prioritizing our segments for inspection, the failure history went all the way back. And now that we have a -- we're running second, third and fourth inspections on crack ILI for some of their statements, the failure history goes back to a point in time that it's relevant, now.

So, it doesn't necessarily go back just three years or five years, it goes back long enough to ensure that whatever that failure was, that the mechanisms are in place to ensure against it. So, the detection systems.

MR. CHHATRE: What do you mean, all the way back? How far?

MR. KEANE: Well, back to the original ILI tests. Back to the original construction at times. So, if we had failures as part of construction that we felt were still posing a threat, because of the mechanisms present there, then that would still be considered.

Now, at times the construction might have a leak for a non-threat specific purpose, right, it might not be clearly this is not a manufacturing flaw that's going to grow by fatigue, so we wouldn't have captured that as part of the susceptibility.

But if we had certainly any inservice incidents related to fatigue growth, then that's a demonstrated susceptibility towards fatigue.

MR. CHHATRE: All your cracks, are they OD cracks or are some of them ID cracks?

MR. KEANE: They can certainly be ID also, yes. And we know that through both our failure experience and ILI. Inline inspection is able to discern between internal and external so we see both.

MR. CHHATRE: Do you see both at one location, like cracks in the OE or cracks in the ID, or do you see them at different locations but that's only OD; that's only IE?

MR. KEANE: The vast majority of cracks that Enbridge has seen have been either ID or OD. It's not common to have the coincidence.

MR. CHHATRE: No mix?

MR. KEANE: That's right. That's not common.

MR. PIERZINA: So, getting back to the susceptibility, I'm thinking, let's say for instance a pipeline has had a number of failures due to manufacturing defects, maybe early on in its history.

MR. KEANE: Yeah.

MR. PIERZINA: But, say, no failure within the previous 10 or 15 years. Would that then be determined to be non-susceptible to that manufacturing defect?

MR. KEANE: So, if we had a number of manufacture -- I'll just repeat the question.

If we had a number of manufacturing flaws identified during a hydrotest, and then we had a clean operating history, then that might be considered not susceptible because the hydrotest at that point would have done its job and identified things that perhaps the hydrotest was -- you know, if the mill hydrotest was only to 90 percent and our field hydrotest was to 100 percent, you'd almost expect that you'd be finding more manufacturing flaws then what could come out of the gate from the mill. So, that's not necessarily from that point.

Now, if we've had a series of inservice failures along the way, then I would say that that would be -- that's indicative of a growth mechanism and a pipe condition conducive to a certain threat. So, that would certainly be tracked.

MR. PIERZINA: So, if a manufacturing flaw grows to failure through fatigue --

MR. KEANE: Yeah, through inservice conditions.

MR. PIERZINA: -- does that mean that susceptibility is fatigue and not a manufacturing defect?

MR. KEANE: Yeah. There's a subtlety there, right.

MR. PIERINA: Yeah.

MR. KEANE: And I would say that it's susceptible to fatigue growth of a manufacturing flaw. It's one leads the other. So, without the manufacturing flaw, then you wouldn't be subjected to -- or susceptible to that fatigue growth.

So, within our documentation, we would -- depending which individual document, it's either going to say "fatigue" or "manufacturing flaw." But certainly it's the two of them combined. You can't have one without the other.

So, all of those threat susceptibility indicators are wrapped and combined with the consequence locations. And so this is -- this information was multiplied through and literally used to rank how soon and which priority of inspections were going to be completed first.

So, this was prior to us getting our first inspections done, is how this consequence area -- or consequence locations got roped into this.

BY MR. NICHOLSON:

Q.   So, we were asking about -- this is Matt Nicholson.

We were asking last night about some of this and we were a little confused about these susceptibility assessments and what the end result was. So, when you're done with this, I get a number? Is that what this is?

A.   Precisely. So, -- once again, we're speaking about the susceptibility assessment that was in place probably at the time of our 2005 inspection when we're still getting those first inspections done and we're trying to understand, well, which one do we need to get done first.

And so all of this would get wrapped up into a number.

Q. And this was during the baselining?

A. That was during the baselining

Q. Don't you revisit a line segment continually?

A. Absolutely. So, then this is part of that original base-lining portion. And then as we go into our ongoing condition monitoring part, now we know -- now we've base-lined it and we know what the pipe condition is.

MR. CHHATRE: Sean?

MR. KEANE: Yes.

MR. CHHATRE: And I'm believing this is all current process?

MR. KEANE: That's correct.

MR. CHHATRE: What I'm really more interested in, from the integrity management viewpoint, what was this at the time of the accident? What is happening in my mind, and maybe I'm the only person, I'm really confused. Because I'm thinking, this is what was happening at the time of the accident.

MR. KEANE: And you're correct there.

MR. CHHATRE: If that is not the case, then I don't want to listen to that right now. I don't want to listen to that. I want to listen right now to what was present at the time.

MR. KEANE: This was all present at the time.
MR. CHHATRE: Okay, great. I mean, I just wanted to make sure.
MR. KEANE: Yeah, absolutely. And so if I come to a point where something wasn't in place, I will clearly describe it to you.
MR. CHHATRE: Okay. Thank you. Whatever I'm listening to you is at a time of the accident.
MR. KEANE: Absolutely.
BY MR. NICHOLSON:
Q. I don't want to leave this yet, either, because I've heard you talk about failure history and those are all pretty good, but I'm looking at the same document. There's actually a specific SCC susceptibility criteria, right?
A. Correct.
Q. Now, was that in place at the time of Marshall as well, or has that been added?
A. So, at the time of Marshall it was in place. We had an SCC management plan at the time of Marshall.
Q. Okay.
A. And that SCC management plan talked about susceptibility and within it, it described susceptibility's largely a function of coding type.
Q. Well, I'm reading this from the Crack Management plan, though.

A. Yup.
Q. It's in both documents.
A. Yeah, you raise a good point. We should go back to a little bit of history here as to how the management plans evolved through at Enbridge.
The SCC Management plan was developed probably around the '96, in that timeframe.
Q. Why? Why did it get developed?
A. It was originally developed as part of the learnings and -- application of learnings from the -- there was a public hearing into SCC in Canada for the NEB. And so Enbridge developed a management plan around SCC threat specifically.
Over time, as our management plans developed specific to corrosion and crack and geometry, SCC is a subset of crack, of the crack management plan. And so there was a period of time between 2005 and 2010 where those two management plans started to overlap and get integrated into one crack management plan.
So, there is a lot of overlap between the SCC management plan and just of the overall management plan.
Q. In the other case, can we still talk about the SCC susceptibility factors?
A. Yeah.
Q. Because I see here, coding types one; location relative to other lines; soil and drainage conditions and CP performance.
A. Yeah.

Q. Was that -- did 6B have an SCC susceptibility analysis done or is that something we can pull up and look at?
A. It's not a discrete document. It's just a conclusion; is it susceptible to SCC or not. And absolutely it is. And we knew that. We knew it was susceptible to SCC as well as fatigue.
Q. Well, if it's not a discrete document, how do you -- I don't understand. You said it was a number I get.
A. Right. So, we have the number and we can dig that up if you want to see it.
Q. Okay.
A. But the --
Q. Is the number broken down into its core components?
A. Yeah. It's like coding type. Coding type gets a number. 100 --
MR. CHHATRE: The value was obtained.
MR. KEANE: Yeah.
BY MR. NICHOLSON:
Q. Is this like a ranking?
A. Yeah.
Q. Rating?
A. Yeah, it's a ranking. And it a heavy-weighting towards operating history from failure history and coding type. And consequence. So, pipe vintage manufacture, these were the key indicators from it. These were the key things leading into it.
Q. So, soil and drainage conditions weren't considered?

A. No. Because -- and soil and drainage conditions it's hard to rank an entire line based on soil and drainage conditions because probably every line at some point as imperfectly drained soil. And we know, through all of our history, that that is where the SCC is going to occur. It's where you have those seasonal wet-dry cycles. That's -- that's -- that -- that helps out that environment for PHSCC.

Q. But you still need to identify what the points are, is that correct? Or maybe not.

A. Well, you need to know that a line is either susceptible or not. And once you've determined that a line is susceptible to a threat, then that whole entire line gets managed.

Q. The whole line or just the segment?

A. No, the entire line.

Q. Oh, well, the way this section reads, it's by segment. It says, "Susceptibility assessment applies to pipe segments."

A. Umm, sorry. Yeah. Clarification there. So, line segment in that respect is like a trap to trap segment. So, the entire trap to trap segment needs to be managed to the worse susceptibility of that trap to trap segment.

Q. Okay. Right. So, in a trap to trap mini-model, right?

A. Absolutely.

UNIDENTIFIED SPEAKER: And that falls back a little bit to the high consequence area rule, the INT rule, is (indiscernible) to determine segments so our segments are trap to trap.

UNIDENTIFIED SPEAKER: Oh, okay. So, segment here isn't necessarily a joint (indiscernible)

MR. KEANE: Correct.

MR. CHHATRE: Trap to trap means station to business station? What is that?

UNIDENTIFIED SPEAKER: In the beginning you can take a pig out. There's like, what, two segments on 6 feet?

MR. KEANE: That's correct.

MR. CHHATRE: It goes to pig traps?

MR. KEANE: That's correct.

MR. CHHATRE: Oh, I wasn't quite sure. Okay.

MR. KEANE: Oh, okay.

MR. CHHATRE: Pig traps. Okay.

BY MR. NICHOLSON:

Q. That helps. And then the last factor, then, on that list of SCC, CP performance.

A. Right

Q. And then we talked to CP people yesterday and it didn't sound like, until recently, CP was really part of the Integrity Group at all.

A. No. And we have that even within our susceptibility document. I'm just going to check, real quick, to see if that was placed prior to -- I'll check the last update of it.

So, the version I have -- of course, we go through documents and update them all the time. The version I have is an April 2011 update so I don't know if it was changed or existed at --

Q. What version is that?

A. This is the April 2011 version.

Q. Oh, okay. Yeah, I've got that version.

A. But it describes that -- it described CP performance and coding type and the relationship between them in here. And largely we know that for PE tape, that because of the -- we know that if you have good CP applied to a system and it's applied to that pipeline sec -- that little exposed pipe, that the initial PHSCC will want to curve because it will prevent it. So, that's -- think that's largely understood through research.

But with cold tar coding -- pardon me. Not with cold tar. With PE tape that shields it, the CP can't necessarily reach those shielded areas, so therefore the CP applied to a pipe at that particular location isn't necessarily an indicator of its ability or inability at that location.

So, therefore we just back it up one step and say, if you've got PE tape, you're susceptible to SCC.

Q. Regardless?

A. Regardless of CP. You're already susceptible.

MR. CHHATRE: With CP and SCC, who distinguished between SCC and (indiscernible)? How do you distinguish between the two? I'll tell you why I'm asking that is because the CP levels. So, I just want to find out how can we make sure that it's not any (indiscernible) of what I'm seeing because a little bit of CP or SCC. Morphologically the cracks may look very similar but the condition is different.

MR. KEANE: Right. And that's a challenge. It's a challenge, right. Because if hydrogen embrittlements I don't know how you'd know that it existed.   You've have to look for signs of some form of hydrogen evolution. Some sort of --

MR. CHHATRE: Well, hydrogen evolution, you're really a (indiscernible) title here.

MR. KEANE: Absolutely.

MR. CHHATRE: When you have a hydrogen evolution, you already have too much hydrogen coming in.

MR. KEANE: Without question. SCC itself could be considered an embrittlement mechanism. So, we know that that's there. To have excess hydrogen around, you'd be looking for other indications of that hydrogen. And I haven't seen where that's occurred.

MR. CHHATRE: Does the crack through, then, were there some guidelines to not exceed beyond a certain potential because you might be getting hydrogen evolution? How do you track the CP in that respect?

MR. KEANE: So, the CP guidelines that are set forth are managed to industry standards. And we know that -- we recognize that there's limitations for PE tape. So, we don't take --

there's not a need for us to take the CP readings, integrate them with a PE tape and try to find other areas. There's not a learning there, I don't think.

MR. CHHATRE: In talking to CP people yesterday we learned there really is no maximum potential in your guidelines. There's a minimum to meet industry standards, like you said.

MR. KEANE: 850, yeah.

MR. CHHATRE: Right. But there's nothing maximum. And we saw some readings as high as 1.4 off, 1.6 or even 7 on.

MR. KEANE: Yeah.

MR. CHHATRE: Is that a concern to the crack?

MR. KEANE: It's -- I don't know how much of that CP's getting to the pipe. I don't know how that would run through, necessarily, so I haven't seen that posing a threat. I haven't found -- seen correlations historically. Do I don't know.

MR. CHHATRE: The reason I'm asking is for this bonding to have a -- initial this bonding will be exposed and protected by CP. That's -- I mean, that small area that is bonded is currently leaching there.

MR. KEANE: That's right.

MR. CHHATRE: The other bonding is currently not leaching. So, if you have too high a count and you have an evolution taking place at this bonding location, the track then can still run. That's what I was asking you. Do you take any input? Do you look at that or cannot not be an issue?

MR. KEANE: We haven't seen it being an issue. But the coating dis-bonding, you're suggesting that it could be initiated by --

MR. CHHATRE: I'm saying because the coating is bonded, at least initially may, may, expose the metal surface to where the current can see leach. And the current typically does go certain distance.

MR. KEANE: Yeah.

MR. CHHATRE: And then you need the coating an be able to what the guidelines say. It doesn't go all of the distance. I'm just asking because it looks like -- I haven't seen anything that CP told us that they interact with crack. You took the readings in terms of current new problem with CB. That's all I'm really asking.

MR. KEANE: I agree there that we haven't seen those problems.

MR. CHHATRE: Okay.

UNIDENTIFIED SPEAKER: Question, Sean. Do you have pipelines that aren't PE tape coded that you determined to be susceptible to SCC?

MR. KEANE: I believe we do. I can double-check that. But we have seen SCC on other lines, so they would be susceptible to SCC.

UNIDENTIFIED SPEAKER: What is an example of those types of problems?

MR. KEANE: We've found SCC under -- where despondent coal tars exist. And --

UNIDENTIFIED SPEAKER: What else?

MR. KEANE: Coal tar -- between coal tar and PE tape, that's the vast majorities of a system.

UNIDENTIFID SPEAKER: Right.

MR. KEANE: As you can imagine, where we have FBE, it is performing well. I'm not aware of any SCC that we've found there. But I know industry has found occurrences, yes. Once an FBE desponds, then it could occur.

And then I'm also not aware of any that we've had on our -- we have a coating type called HPCC, high performance coating. And we haven't seen anything there.

UNIDENTIFIED SPEAKER: If you find SCC on, for instance, a coal tar coated pipeline, but you haven't had a failure, and you're susceptibility indicators, is that listed as susceptible to SCC or -- I guess environmental cracking is --

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: -- characterize that.

MR. KEANE: We can open up one of our documents and we can thumb through if you want to see. I'm sure that there's -- there's going to be several lines that are like that. So, --

UNIDENTIFIED SPEAKER: Do you think that would be worthwhile?

MR. KEANE: It will just take a moment. It will just take a moment and then you can kind of see. It's --

UNIDENTIFIED SPEAKER: What is the document you're opening?

MR. KEANE: This document is one of the ones that was submitted through our --

UNIDENTIFIED SPEAKER: I was going to ask you to open that document so this is perfect.

MR. KEANE: Perfect.

UNIDENTIFIED SPEAKER: This is the Appendix A?

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: Good.

MR. KEANE: So, this is -- so this is a document -- we're getting a little ahead of ourselves here, but -- so this document is -- was put in place -- it was prior to the failure but not long before. And it's a document that we use to track some of our key susceptibility indicators, some of our condition monitoring. And some of our range impaction intervals.

It's not our -- it's a tracking document as opposed to a -- the results of the assessment go here, kind of document, right? So, at times this document, we see that I have to go prompt the guys to say, hey, you've completed all your assessments, that's great, but now go through that number back into this document so we can track, right.

So, this truly is a working document. And so I'm just going to give you quick walk-throughs in the sections here. But we have -- the first column is our line, subject matter responsibility individual. So, this tracks who is responsible for the various lines. And that's important for us so that they can see that responsibility so that they know that -- what they're responsible for. And so it just prompts who is tracking what, right.

MR. CHHATRE: I'm sorry. Does this document change all the time or is it like they are like delegated to that particular --

MR. KEANE: The line individual?

MR. CHHATRE: Yeah.

MR. KEANE: They do change over time. We find --

UNIDENTIFIED SPEAKER: The "E" there just started basically?

MR. KEANE: That's right, yeah. And it's actually good, we've been finding, it's good to have the guys rotate through, because then you'll end up with all the experience gained online two gets transferred on to line three. If the line two guy comes and looks at line three and says, well, "Where's this or where's that," or, "I don't understand how you got here," describe how this assessment through the engineering assessments, how did this analysis get completed. It's a way to transfer those learnings not just within the -- throughout the system, because those learnings get transferred through our documentations, through our processes and guidelines.

UNIDENTIFIED SPEAKER: How often do you change those?

MR. KEANE: There's not a set cycle for it. They get changed -- they can change for a few reasons. One of them is simply to balance workloads, so if, for instance, one of the guys on here, Louise, he's got all of line three right now, but all of line three is about to get rerun with crack inspections. And that workload will occupy him and a consultant for quite a period of time. So, the responsibilities need to get shifted off of him so that he can allow time to focus on that. So, we need to balance that.

We leverage consultants quite a bit, too, in order for us to keep up with their trending documentations and to help with some of our engineering assessments along the way.

And so while that's really beneficial for us, we still want our team to be intimately knowledgeable about everything that they're seeing in the field and to have the time to think through all of those oddities that come up.

So, we need to -- so we re-juggle lines as a result of that.

MR. CHHATRE: Do you have a minimum time? I mean, it doesn't do this philosophy any good if you use somebody line today and transfer him in less of here, to a line I just worked too.

MR. KEANE: No. We don't have a stated minimum time, but that wouldn't benefit us or them to transfer them out so quickly, so we don't juggle that fast. Yeah.

UNIDENTIFIED SPEAKER: So, you're just shifting as the workloads change?

MR. KEANE: We shift with workloads.

UNIDENTIFIED SPEAKER: It's just resource management, really.

MR. KEANE: And also with the types of -- the threats that we find. So, where we find -- so, for instance, Steven Bott, he's on 6B right now. Steven comes to us with a good history and he comes from the Pipe Mill and they've worked within our corrosion team for a long time and then into the Crack team. So, he understands a lot of the mechanisms and he's got a good background into management systems and everything and so --

UNIDENTIFIED SPEAKER: But Steven Bott would be what level?

MR. KEANE: And Steven Bott is "off the record, but on the record," so he's just coming up to be a senior engineer here.

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: So, he'll be a senior engineer in January.

UNIDENTIFIED SPEAKER: Oh okay, I see. And then, for instance --

MR. CHHATRE: We won't put it in the document.

MR. KEANE: Yeah, yeah. And he's getting a raise.

(Laughter)

UNIDENTIFIED SPEAKER: So, someone like Saheed (ph.), then, I'm just curious the range of experience. Saheed would be?

What level is Saheed?
MR. KEANE: So, Saheed is -- actually has quite a good experience. So, he's got his masters in engineering and you spoke with him yesterday.
UNIDENTIFIED SPEAKER: Right.
MR. KEANE: And -- But he is still learning through the Crack program themselves right now. So, he has line two and he's been working very closely with myself and some other senior individuals in D&V, learning all of the crack program side of things.
UNIDENTIFIED SPEAKER: He's considered junior level --
MR. KEANE: No.
UNIDENTIFIED SPEAKER: -- midlevel or senior?
MR. KEANE: He is on the upper end of midlevel.
UNIDENTIFIED SPEAKER: Okay.
MR. KEANE: Yeah. So, yeah.
UNIDENTIFIED SPEAKER: And who had 6B at the time of the incident?
MR. KEANE: Steven Bott had just taken it over just a few months prior to that. The individual prior to Steven Bott was Ivan Houvaire (ph.).
UNIDENTIFIED SPEAKER: Oh, okay. Would he be the one that analyzed the 2005 crack run?
MR. KEANE: I did the 2005 crack run, so I'm very familiar with that. Yeah.

UNIDENTIFIED SPEAKER: Great. Good.

MR. KEANE: Yeah. So, right. So, we're walking through this NXA a little bit. And we're going into the next column of data here is the pipe section properties. And these truly are intended to just be very high level types of properties that we track. It's certainly not all inclusive. So, it's just a few key things that our team looks at and just keeps an eye on.

So, we have nominal wall thickness, diameter, section length, trap to trap sections.

You can imagine -- you can see that there's lots of items on here that, well, where's your CVN toughness; where's your grade. This isn't the document for that. Okay.

UNIDENTIFIED SPEAKER: Although I would ask, wall thickness, where you're getting those numbers from?

MR. KEANE: These are the nominal wall thickness.

UNIDENTIFIED SPEAKER: Oh, just from the API spec?

MR. KEANE: Right. No. From our construction specifications, so how we built the pipeline.

MR. CHHATRE: So, with your nominal log, that's the minimum -- take this. The pipe mill has to provide you?

MR. KEANE: Well, not necessarily. These are the specified thickness groupings. So -- Now, the pipe mill can provide plus or minus 12.5 percent or 8 percent depending on the diameter range and everything, right?

MR. CHHATRE: Okay. I do not know what your specs are, so that's why I was asking you.

MR. KEANE: Oh, okay.

MR. CHHATRE: So, nominal plus minus, did you say 12.5 percent?

MR. KEANE: It's a function of diameter. Those are out of the API (indiscernible) specifications largely.

MR. CHHATRE: Okay. Good.

Yeah. Now, and this wall thickness and diameter are important because when we're thinking about mitigation -- or, pardon me, comprehensive thread assessment, can we run an ILI tool? Well, I can't run an ILI tool if I've got a 6-inch line. Okay. I can't -- I don't want to run an ILI tool if my wall thickness is too thin to accurately detect cracking because there's limitations to the technology.

So, that's why this is important to understand the range that exists so that you can ensure that you've selected the right tool.

(Indiscernible.)

MR CHHATRE: 281 is inches (indiscernible)?

MR. KEANE: Yeah. These are in inches. And so, on this particular line that we're looking at here, line one down in (indiscernible) Edmonton, it's 281 wall all the way up through 625 wall. So, there might only be one –

MR. CHHATRE: Schedule differences?

MR. KEANE: Pardon?

MR. CHHATRE: Schedule differences.

MR. KEANE: That's correct. Pipe schedule. Yeah. Yeah, and so there might only be one joint of 625 wall, but that's the entire range.

UNIDENTIFIED SPEAKER: How about for line 6B, what's our range there?

MR. KEANE: A quarter to half inch.

UNIDENTIFIED SPEAKER: To a half inch?

MR. KEANE: Yeah.

MR. CHHATRE: Now, for each pipe joint, the nominal wall would have been (indiscernible) in that range? Pipe joint meaning a particle could go on or whatever.

MR. KEANE: Yeah.

MR. CHHATRE: Okay.

MR. KEANE: Sorry (indiscernible). So, a pipe joint would be specified as quarter-inch for 6 feet. And then it won't come out of the mill at exactly quarter-inch necessarily.

MR. CHHATRE: Right. Right.

MR. KEANE: Yeah, yeah. So, then the next area in here is this crack susceptibly threat indicators that we've been talking about. And so it's not all of them necessarily, but it has quite a few of them. And so we --

MR. CHHATRE: Listen, can we just do this with 6B? So, then I can get(indiscernible) --

MR. NICHOLSON: Actually, the question he was answering was --

MR. KEANE: Here, let me jump right to this one, then. You can see here PE tape. Here's one, coal-tar mummy wrap. You got SCC. So, and -- You can see we have a lot of PE tape. So, --

UNIDENTIFIED SPEAKER: But I thought you said susceptibility results in a number?

MR. KEANE: No. That number was for the original prioritization.

UNIDENTIFIED SPEAKER: Oh, okay.

MR. KEANE: Right. Gotcha. Yeah. And so, now that we've moved beyond that, now that susceptibility is something that we track to make sure it hasn't changed so that we can understand if we need to change our condition monitoring. So, jump to 6B?

MR. PIERZINA: So, is this different than your threat susceptibility matrix? This information?

MR. KEANE: No. In some ways, yes, Brian, because the threat susceptibility matrix has the -- that's based upon if that threat exists, then if we don't do anything to mitigate that threat, do we think it would fail within the next ten years. And if we think it could fail within the next ten years, because if we don't take actions, then it's susceptible. And so, that matrix has that within it. So, it's this, one step further.

MR. PIERZINA: So, it's totally different. That's -- and that's probably where I'm confused because I think you see in that matrix a lot of not susceptible.

MR. KEANE: Right.

MR. PIERZINA: But it's an identified threat.

MR. KEANE: The threat might still be identified and I think we have that in the matrix. But is it, "oh, we had to take it out."

UNIDENTIFIED SPEAKER: Yeah. If we're talking about the threat matrix we saw yesterday with Ryan.

MR. KEANE: Oh, did he show you that?

UNIDENTIFIED SPEAKER: Well, we looked at it.

MR. KEANE: Good.

UNIDENTIFIED SPEAKER: I thought that was only corrosion. Does it include --

UNIDENTIFIED SPEAKER: No, it had crack too. It had basically all the threats.

MR. KEANE: It had all the threats in it. Yeah. So, it has corrosion and cracking and --

UNIDENTIFIED SPEAKER: So, why don't you just describe -- I thought I heard you say, "no." Were you referring to threats susceptibility versus threats?

MR. KEANE: So, the question that Brian asked was, is the threat susceptibility matrix that we've provided that indicates is it susceptible to failure, if we don't mitigate any -- if we don't take any additional actions, could it fail within the next ten years using our conservative assessments.

MR. PIERZINA: That's what's on the -- that's on the threat matrix.

MR. KEANE: That's in that threat matrix.

MR. PIERZINA: Okay.

MR. KEANE: Yeah. Because --

MR. PIERZINA: So, it's a ten-year window.

MR. KEANE: It has a ten-year window and that helps govern where things fall within re-inspection intervals and -- so that's a little bit different, yeah

MR. PIERZINA: But this plays into that?

MR. KEANE: It plays into it but, so for instance, here we have manufacturing, right? So, we know that we have manufacturing flaws on this -- I'll try to pick a good one here -- on this particular pipeline. So, back at Edmonton, we know that we have manufacturing flaws. But is it going to -- are those manufacturing flaws, could they fail in the next ten years? Well, if the line's not cycling at all and if we've never had any problems but we know that because of the ERWC, that that seam contains flaws. Well, we've tracked that. It contains flaws. So, we need to keep an eye on that; on those flaws.

So, this is truly just a less -- these are the even ahead of those leading indicators for those threats of the matrix that we're talking about. These are in front of that. These aren't the results of the growth.

MR. PIERZINA: Right.

MR. KEANE: These are just, is it present.

MR. PIERZINA: But, again, these are for a very long segment.

MR. KEANE: Yeah, that's right.

MR. PIERZINA: So, they're very broad terms.

MR. KEANE: They're very broad terms.

MR. PIERZINA: You can see that so many of these say, “fatigue, SCC.”

MR. KEANE: Right.

MR. PIERZINA: It's almost meaningless. I mean, it doesn't really tell you where.

MR. KEANE: Well, it's somewhere on that trap to trap section so if you're trying to manage that trap to trap from an ILI perspective you've got to run the entire trap to trap. One joint might be managing it. So, well, hold on. If it's just one joint, go and replace that joint of pipe or go and repair that joint of pipe and now has susceptibility changed.

MR. PIERZINA: So, it's like an analysis. Don't you have one to add something that really drills down into where the SCC is

MR. KEANE: Absolutely. That's not the intent of this spreadsheet though, right. So, this is simply a tracking sheet for us.

There was a question on 6B to show that. Do you want to look --

MR. CHHATRE: 6B is an example. Might there be an example on 6B rather than 1?

MR. KEANE: Now, this is a working document so it will be updated to show our how it sits currently. So, within our threat susceptibility indicators, so seam type, main line coating type, a girth weld coating type, is also important for us. Pressure cycling --

MR. CHHATRE: Oh, sorry. Saw and what is EF?

MR. KEANE: Electric flash weld.

Pressure cycling severity, light, moderate.

UNIDENTIFIED SPEAKER: How do you -- where are the -- I think someone mentioned bins yesterday. How do you classify light?

MR. KEANE: Yeah. So, why don't we talk about this right now. This is part of condition monitoring. But I don't mind talking about that right now if that's good for you guys. It's an important component for us.

UNIDENTIFIED SPEAKER: I think that's the way because we could get pretty --

UNIDENTIFIED SPEAKER: Yeah, that's getting away from us.

MR. KEANE: Okay. Then now here's our normal operating pressure. So, 65 percent; 58 percent. And we tracked the appropriateness of the previous crack assessment interval because if run a crack tool and we find features that are below MOP based on the crack results, well, we didn't run the tool in appropriate fashion. That's a problem for us. That's leading -- that's a lagging indicator or a leading indicator if it didn't fail that something went wrong and we need to fix something. So, we tracked it in here.

If we ran it and we didn't find anything significant, then it would be, well, okay, that's fine. That's where we predicted it to be.

So, right now we -- you can see. Of course, this one just says, “We had a rupture,” so that was a problem.

Or threats, so we have fatigue and SCC both in the baseline. And that's -- right in here is just the identified threats. And this is -- it all boils down to just, is it susceptible to having that threat present or not. It's not the severity of the threat. It doesn't say fatigue's a big threat or SCC's a huge threat, it just says, no, fatigue can occur and SCC can occur on those lines. It has the indicators. It has these leading indicators to it.

The next portion of this spreadsheet is geared towards the condition monitoring sites, so it's three assessment interval assumptions in the condition monitoring indicators.

So, these are items that we track and we compare against them. We're making sure that -- we'll walk through a few of them, for example.

So, we'll start with this one right here, so the pressure cycle monitoring used in the reassess interval. When we calculate SCC growth rates, and we'll talk about that now, and that's new since post Marshall. That's new post-Marshall. But pre-Marshall we did calculate fatigue growth rates.

But the pressure cycling data that we use to calculate those growth rates, so the fatigue assessment, the dataset used is important that it's representative of the cycling of the current operations.

So, if the cycling has become more cyclical in nature with larger amplitudes, we need to know that. And so when we track that all along over time and that if at any point if it becomes more aggressive or less aggressive, the we can adjust that. And so this is where it tracks what pressure spectrum was used within that assessment.

MR. CHHATRE: What is your information?

MR. KEANE: This one?

MR. CHHATRE: Pressure cycle?

MR. KEANE: So, the pressure cycling is information that our group calculates. We have a dedicated engineer to calculate -- the engineer pulls the pie data, the raw pie data, and then goes through a cleaning process to remove all the erroneous data, the zeros and the r-tops, the specs and the text and stuff. And then we calculate. We do assessments of that pressure data to capture the normal operating pressures and the -- the maximum operating pressures, the pressures -- do rain flow analysis on that data.

And all of those types of analysis fall under those.

MR. CHHATRE: Suppose like we went in and we find interval for class (indiscernible) special reading.

MR. KEANE: Yeah. We can open up some files.

MR. CHHATRE: No, just telling me of that process is fine.

MR. KEANE: They can be seconds apart and at times they can be minutes.

Now, the time interval is determined by this data programming logic. And it's based upon the need for pressure to change and communication limitations along the way, too.

But what we largely see is that the vast majority can be seconds apart where you have the pressure changes.

Now, if the pressure's sitting stable at 500 pounds for five minutes, then sometimes you only get one reading in a five-minute interval because it gives us the reading before and after, like, after it starts to fluctuate again. So, they're very quick.

MR. CHHATRE: So, cycling, did you say like line cycles would be two-minute cycle, five-minute cycle. Your data is continuous from what you're telling me.

MR. KEANE: Yes.

MR. CHHATRE: So, what is a cycle for you?

MR. KEANE: A cycle is determined through a rain flow analysis. So, there's a --

UNIDENTIFIED SPEAKER: What is rain? I saw it in your document. I was going to ask you. What's rain flow accounting methods? Can you just go over that?

MR. KEANE: Sure. High level, so it's an ASDM method. And we can get into the very specifics, but essentially if you took our pressure data and plotted it out pressure on the “y” access and time on the “X” access, and then just flipped the graph sideways on you, rotated it 90 degrees, and just drop some rain, just drop some water from the top and every time that water would fall off, so the pressure comes down here and then it slowly falls down, so it identifies the largest cycles and the smaller cycles along the way.

And so it's just a scientific approach to calculating and determining your peaks and valleys and counting your cycles all along the way.

So, it's a nice, simple algorithm that can be applied to pressure data. It's specific to fatigue assessments.

UNIDENTIFIED SPEAKER: And is this the right time to talk about the bends and the cycling, because --

MR. KEANE: Yeah. We're getting into it here.

UNIDENTIFIED SPEAKER: So, have you done a sensitivity analysis to determine the effect of using smaller pressure pins versus larger pressure pins on the fatigue life of various defects?

MR. KEANE: Well, absolutely that's -- it's a key parameter coming into everything. Can I just ask, so that I don't jump ahead, but would it be useful to get right into Paris law equations and why that isn't important for us?

UNIDENTIFIED SPEAKER: Yeah.

MR. KEANE: What I can do is I can --

UNIDENTIFIED SPEAKER: We're together so let's -- yeah, let's get it out.

MR. KEANE: I can do it through our management system, actually.

MR. FOX: I guess before we leave this one, particular spreadsheet.

This is Matt Fox here.

I was just going to ask, we didn't have what appears to be a similar document provided as part of our information requests. And for -- at the time it looked like line 6B was, you know, broken out by pump station or at least had a number of pump stations within the trap section.

MR. KEANE: Correct.

MR. FOX: So, I guess now you consolidated it to this -- by trap section.

MR. KEANE: Precisely. So, once again, this is -- the intent of the document is not to track a specific station but to track the worst amongst them. So, it's bringing it back to the intent and making sure that the individuals -- the line responsibility and the guys are using the document appropriately. So, there's a period of time there where they were trying to use this as their assessment sheet. And, no, no, no, no, no. This isn't your assessment sheet. Your assessment sheets are elsewhere. This is not that detailed. This is high level tracking. Yeah.

So, that's correct. That change has occurred.

MR. FOX: And looking at that, what was in place at the time, the downstream at the Marshall Station, the maximum depth of unmitigated crack, that was one of the features within the route you're showing?

MR. KEANE: That's correct. And you can understand the relevance of why we were tracking that one because it was one of the features. And so it had an associated, how did we assess it, what's the operating pressure, what was the maximum depth. It had all those things on it, because that's what we were tracking.

So, this is meant to bring it back up a level.

UNIDENTIFIED SPEAKER: Right. Right. So, if we've got the crack depth but there's, I guess -- is there a maximum rupture pressure value that you could be tracking as well in this to get, maybe the detail of the defect isn't your most critical, or maybe you're looking for the most critical feature.

MR. KEANE: Right. So, what we do currently is we've been able to use the power of computer a little bit more and now calculate fatigue lives for every single feature.

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: And so it's the -- so as such, it's the worst of those features gets tracked into here.

UNIDENTIFIED SPEAKER: So, the feature with the lowest fatigue life?

MR. KEANE: Right. And so what we did before is we tracked the deepest and we tracked the longest. Well, can be get more precise? We can. We tracked each one, and not necessarily combined the two worst things together.

UNIDENTIFIED SPEAKER: So, now we have --

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: So, just a new column in this that wasn't in '94 and the reassessment interval we had max depth of unmitigated crack and now you do have the additional column there, fatigue life, as you indicated.

MR. KEANE: Right. I think you saw through, and this was another document that you have to open up here, but we had submitted this one previously also. Just a small little document.

This was our assessment of every single feature. And you can see it through this document also that every single feature was assessed for fitness or purpose. But also fatigue life.

So, we were just literally rolling all those things out. We had it all for 6 feet. Of course, we had it for the vast majority of things already. But process documents were just inches away.

UNIDENTIFIED SPEAKER: So, now for margin of fatigue --

remaining fatigue life, what is considered an acceptable margin, you know, allowance, from the reassessment interval to the calculated fatigue life?

MR. KEANE: And we'll discuss all of that additionally to this conversation when we get into those process documents, if you want.

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: But what we've been doing is applying a safety factor of two based on time and reassure that we assess that feature prior to that safety factor being issued out there. So, that's how we plan our re-inspection intervals.

MR. CHHATRE: Sean?

MR. KEANE: Yeah.

MR. CHHATRE: (Indiscernible) re-coating segments. I know you're looking at stress coating cracking, but I don't see a coding for D in there. In life can be different. Have you seen any coating bleeding in your pipeline?

MR. KEANE: So, what we have is we've had fatigue failures historically. And on line three there's been PE tape coating and there's been an environmental component to the failure. So, while they're -- the failure analysis have largely concluded that fatigue is the mechanism, but the environment exists. So, we have considered corrosion fatigue along the way as such.

Our C&N values that we choose for modeling fatigue, are the two standards removed from the API5's and the recommended values. So, 8.6 times ten to the minus 19 PSI range, et cetera. Those values, when we look back through our system, have -- are conservative in comparison to our failures. And as such capture whatever environmental component may have existed because through the failure analysis, it hasn't been concluded that the environmental mechanism was corrosion fatigue with something well and beyond.

So, we've assumed that there's a component there and accounted for it with those higher C&N values.

MR. CHHATRE: In lay calculations, what does that mean?

MR. KEANE: So, corrosion fatigue is still modeled as a -- within the Paris law equations. And you can still use C&N values to model them. So, we've just selected C&N values that are representative of both our failure history, which should be -- those are the fastest growing things, because that's why they failed. So, that's how we've captured those.

UNIDENTIFIED SPEAKER: Did you say -- now, I guess I've been under the impression that Enbridge is currently using the recommended C&N values from NPI. I thought I heard you say something a little different than that.

MR. KEANE: The recommended values for screening purposes are those that are two standard deviations removed from average. So, those screening values are the 8.61s. And that's with API. So, that value with an API, that is that value. And that's the one that we use.

UNIDENTIFIED SPEAKER: And how long have you been using that value?

MR. KEANE: So, we've been using that value across our system since -- you probably know better than I here, but it would be approximately 2008. I'd have to double-check. It might be 2007 or 2009. Somewhere in that range. I think it's '08, though.

UNIDENTIFIED SPEAKER: So, for line 6B of the 2005 crack tour run, it seems like the calculations would have been done initially on -- using what type of values?

MR. KEANE: Oh, good question. The initial values for that particular line, I'd have to go back in 2005 and confirm what they were. But without question, they've been redone in 2000 -- oh, I don't remember the exact time frame. But they were all -- the entire system is -- absolutely -- the current processes have been in place for quite some time regarding that C&N value. And all the numbers throughout the system were recalculated with that.

UNIDENTIFIED SPEAKER: Is that something you can bring up? Can't you get to the 2005 analysis?

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: The spreadsheet?

MR. KEANE: Oh, absolutely. Yeah, we can dig it up. But I just don't have it off the top of my head. So, yeah.

UNIDENTIFIED SPEAKER: Or if you want to bring it up here.

MR. KEANE: Sure. I --

UNIDENTIFIED SPEAKER: All the assumptions,(indiscernible) --

MR. KEANE: Yeah. Let me just see. Sorry, I brought some hardcopies of some of the documents that I've got. Might get questions. Let's see if that one's in here.

I think we submitted this document to you also. I'm just looking at our Crack Line Inspection Program Summary for Line 6B. Yeah.

UNIDENTIFIED SPEAKER: I think -- read it again, what is it?

MR. KEANE: It's titled, "Crack Inline Inspection Program Summary, Line 6B, 34-inch, Griffith to Sarnia." This particular version was updated October 2011, so that's more recent, but --

UNIDENTIFIED SPEAKER: What was that? I'm sorry.

MR. KEANE: It's a program summary document, for 6B. So, it outlines the original data or selection criteria that was in place at the time and it outlines all the different programs along the way.

UNIDENTIFIED SPEAKER: Okay. You wouldn't by any chance have an IR number? We only got like 250 of them.

MR. KEANE: Yeah, I know. I tried to go through all the IRs to track them, but I didn't see that one in the IRs. But I was certain that it had been provided. So, maybe if that's something that I can dig up on our break there. That way I don't take up the time to do it.

(Indiscernible)

UNIDENTIFIED SPEAKER: Sure.

MR. KEANE: Yeah.

MR. CHHATRE: Are we going to do a five minute break before we go to the bins? I think we're still going to go to the bins, right?

MR. KEANE: Yeah. We're going to talk about fatigue assessment and how we -- why we choose a bin size of 5PSI and why don't we use 250 pounds or another number.

MR. CHHATRE: Who (indiscernible)?

MR. NICHOLSON: Okay. Why don't we stop the interview at this point. We'll go off the record and take a break.

(Whereupon, a brief recess was taken.)

MR. NICHOLSON: Okay. Back on the record. Part two of Sean Keane. Go ahead, Sean.

MR. KEANE: Okay.

MR. NICHOLSON: I forgot where we left off. I think pressure cycling, is that where we're at?

MR. KEANE: Precisely. There was a question from Brian Pierzina asking about the bin size that we use to group our pressure cycles. So, that leads into the discussion of how do we calculate -- how do we use the results from our rain flow analysis and how do we use those results to calculate fatigue assessment and moving forward with that.

So, I went into our IMS here. And all I've done is linked into our process document PI41 Crack ILI interval determination. And so we can scroll down through here. And this document itself identifies purpose, scope, responsibilities, both for the line -- the materials technology engineer and the individual actually conducting the analysis itself. And authorities related to myself to the supervisor of materials.

MR. NICHOLSON: Well, let's go back. I have questions about this.

MR. KEANE: Sure. Can you just describe, who are these people, materials technology engineers?

MR. KEANE: So, the materials technology engineer, coma line, SME. So, these are the individuals responsible for each pipeline. So, it's referenced also here in our Appendix A document. So, the example I've given is line 6B. You can see that the line subject matter expert is Steven Bott.

And then the other materials technology engineer is responsible for conducting the growth analysis. His name is Aaron Sutton. And his job is to pull the pressure data, to clean it all up, and to use our Flaw Check software to calculate the fatigue analysis and then give those -- the materials. This individual, the line SME, gives all the input parameters to this one individual and then he runs it through the software and gets the results back to the line.

UNIDENTIFIED SPEAKER: And this software is flaw check?

MR. KEANE: That's correct. So, BOT --

UNIDENTIFIED SPEAKER: What about CorLAS? I thought CorLAS was your software?

MR. KEANE: We use CorLAS for determining critical flaw dimensions. So, our crit -- at a given pressure using a defined flaw profile, rectangular or semi-elliptical, what are the critical flaw dimensions at MOP, a hydrotest. Are all the different pressures that we might want to consider.

UNIDENTIFIED SPEAKER: So, it's back solving from a pressure?

MR. KEANE: Exactly. So, he simply grows it. So, this individual uses the software to grow the flaw. And then he puts a stop point for a depth length domination that comes out of CorLAS. So, we feed that into CorLAS.

UNIDENTIFIED SPEAKER: Okay. So, what you're getting from this guy goes into CorLAS? Is that what you're saying

MR. KEANE: The other way around. The results from CorLAS, you also feed it that into here. So, if we think about it from a perspective of we use -- if we're talking fatigue, let's just focus on fatigue for a moment here, the software uses stress concentration factors pertaining to -- let's even back up one step. We assess the pressure data using methods described in BS7910 or API579, and that's rain flow analysis.

And then we calculate the flaw growth over time using stress concentration factors in K equations related to API 579 or BS7910 again.

So, we still use those same methodologies for the flaw growth.

UNIDENTIFIED SPEAKER: Okay. So, you're using 579. Is that a level one, two, three? What is this considered?

MR. KEANE: It's probably simpler to think of it from BS9 and 10 to simply relate the fact that we use the delta -- the K solution, the delta K solution.

UNIDENTIFIED SPEAKER: Okay.

MR. KEAN: So, out of 579 are BS9 and 10. They're the same. And then the critical -- at some point you're growing the crack over time. It reaches a point of critical dimensions. We use flaw check. We use CorLAS to determine those critical dimensions. So, we stop the fatigue growth using CorLAS.

UNIDENTIFIED SPEAKER: And then those dimensions?

MR. KEANE: The initial dimensions, the final dimensions, are all provided to this materials tech engineer who calculates everything. And so he uses that and actually calculates the fatigue life.

UNIDENTIFIED SPEAKER: It's a life?

MR. KEANE: He gets a life.

MR. CHHATRE: That is where the crack is going to go to critical size.

MR. KEANE: That's correct.

MR. CHHATRE: And just would affect --
MR. KEANE: Precisely, yes.
MR. CHHATRE: Right?
MR. KEANE: Yes. And so then that's for a fatigue analysis.
Now, there's lots of different kinds of analysis. We do use a fatigue growth models. And so whether we decide whether that model stops the flaw at a critical dimension or maybe that model grows it all the way up to through wall, or all the way up to 95 percent through wall, it depends on what type of analysis we're doing.
But if we're talking fatigue life calculations, and we stop it at a critical depth at MOP.
UNIDENTIFIED SPEAKER: And for SCC, what?
MR. KEANE: We'll talk about that. That's a different model altogether.
So, coming back -- so our document describes -- the PI41 document does describe how we do rain flow and how we do the actual growth of the model, you know, DADN, C delta KM.
Like I indicated, we use BS9 and 10 to calculate the stress intensity factor, delta K. And now the question -- let's all back up one moment.
So, DADN is incremental crack growth in depth per cycle. And then where C and M are material constants --
UNIDENTIFIED SPEAKER: Sean, this procedure looks

different. This is the new procedure then, right?

MR. KEANE: Right. So, this one is updated since -- the portions that are updated is the background data to it. So, the calculations themselves are the same. The text surrounding it has been added for context. So --

UNIDENTIFIED SPEAKER: All right. I'm sorry, go ahead.

MR. KEANE: Oh, okay. Yeah.

MR. CHHATRE: Are these constant dependent on the C&M change (indiscernible)?

MR. KEANE: So, once again the C&M that we are using are the upper bound values, the 8.61, that Enbridge has seen as being representative of our fatigue failures, our failures in our system, which have had an environmental component.

MR. CHHATRE: Okay. It's a more conservative number you're using?

MR. KEANE: Yes.

MR. CHHATRE: You need a short life with this.

MR. KEANE: Precisely, yeah.

MR. FOX: Maybe I missed it. This is Matt Fox, here.

For calculating your -- the values that you plug into the CorLAS model for your failure criteria, how do you determine the length, depth ratio?

MR. KEANE: Sorry. So, the question is, how do we determine the final depth length of fatigue flow?

MR. FOX: Yeah. The aspect ratio that you can apply for, you know, that failure criteria; that you're going to grow the fatigue flaw to.

MR. KEANE: And so that's a good question. What we do is the initial -- so there's been work done throughout industry to understand that a fatigue flow will -- if -- the entire length of the fatigue flow won't grow -- pardon me -- if a flaw won't grow by fatigue, so it will be a portion of that overall length that will grow back. And that's been done through work with Kiefner and others also and documented in TGO5. It says two times the square root of DT. As a guidance, right.

And so what we do when we're growing a flaw, is we'll take that initial dimension, length and depth, and we'll truncate the length to two times the square root of DT. We'll grow it by fatigue mechanism and then -- but to determine the final depth criteria, we come back to the original flaw length.

So, if that flaw length, in the case of Marshall was 51 inches, or thereabouts, so we determine a critical depth at 51 inches.

MR. FOX: So, the length is determined from the ILI data?

MR. KEANE: That's correct. Short answer, yeah.

MR. FOX: And the depth comes from whatever the critical value is that is 2DT?

MR. KEANE: Correct. No. No. The depth is critical at the total length of the flaw. We grow it by fatigue mechanism for the shorter length that industry has shown is that's what's growing by fatigue. But we still want to account for the -- maybe two portions of that are growing by fatigue.

So, the time -- how fast it grows over time is -- it's loosely a function of length. So, we don't want to discount it. But from the critical dimensions, we assume that the entire thing moved upwards from that length.

Does that make sense, Matt?

MR. FOX: I think so. I think -- guess a little bit of that is discussed in CorLAS procedures as well?

MR. KEANE: Yeah. That's correct.

Matt Fox, did you have a question, too?

MR. NICHOLSON: I'm Nicholson. No.

MR. KEANE: I'm sorry.

MR. NICHOLSON: It's all right.

MR. KEANE: That's my wandering eye.

So, that's probably the lead into the Paris Law equation. And now the question is, when you're calculating this growth -- when you're doing your in flow analysis and bin your pressure rate to figure out your delta K at each cycle, do you use -- we use a five PSI bin. Kiefner has previously done assessments to show a 250 PSI bin or other numbers. So, there's lots of numbers out there. And why did we use 5 PSI?

So, I've put a little schematic on the board behind you that shows pressure over time of hypothetical pressure data. And also a -- I guess the corresponding pressure spectrum that would be characterized using rain flow.

So, I'm going to walk up and point. So, obviously, just hypothetical data, just to speak to it here, but -- so we're showing pressure over time with just a few small cycles, sort of cycling between about ten pounds and then a few more cycles sort of between 70 and 100, so 30 pound cycles. And then a few more around the 50 pounds, you know, 100 to 50.

So, within rain flow analysis, what will happen is, you know, this will be called a cycle and all the way through. And then you'll end up with these little guys getting called out for cycles. And then these little guys will be called out. And then the next step is to figure out to take all that data and put it into bins of Delta P, so you can then figure out, well, how many times do you want to grow your DADN equation by Delta P.

So, you can put it all into, for example, 0 to 50 bin and say anything between 0 and 50 bin, just count it all up. So, that would give you, in this case, 9. So, you would line up saying that when you're calculating this out, so Delta K is proportional to Delta P, so each of these cycles gets applied as if it was 50 pounds. But they weren't 50 pounds. Some of them were ten pounds. Some of them were 30 pounds. Some of them were 50 pounds.

So, historically, rain flow was done by hand. It was literally done by they get a chart out of their pressure data, maybe a print off, and people would go through and circle and apply their rain flow algorithm and figure out when it was. Well, we got computers now. We can apply the algorithms so we can be very detailed and precise on how we do things.

If you go back to the way that all of these equations are built, they were built with lab tests of this or this. And so the equations themselves were more specific than just saying, group it all vague.

So, we use a smaller value. I go 5 pounds. And the intent is to be more precise within the calculation and then apply a known safety factor at the end.

When you do this, you'll end up with some non-precise calculation. You bring in more, potentially more uncertainty, but not necessarily, because if the pipeline was actually operating at only these larger cycles, well, now you're as precise as this one. So, you don't -- you lose your ability to measure precision because you're applying an unknown factor uncertainty within equations.

So, we try and get the calculation down to be precise and then apply a known safety factor at the end of it.

UNIDENTIFIED SPEAKER: So, that's more conservative, though, isn't it, your 0 to 50?

MR. KEANE: It's not more conservative.

UNIDENTIFIED SPEAKER: Isn't it?

MR. KEANE: Nope. Well, if it was 0 to 50 and all of your swings were 100 to 50, but it's not more conservative. It's exactly as precise as this one.

UNIDENTIFIED SPEAKER: Okay. I see what you're saying. Right.

MR. KEANE: So, you lose your ability to -- so you could have easily binned 0 to 100, right. Okay. Now you still have 9. So, you truly start losing your ability to understand -- what you're losing is precision.

And at some point it will be come conservative, but at what point, I don't know. So, why would you add unknown uncertainty, I would wonder, to this?

So, we work closely with industry experts in this area. We have in house training for our individuals. We just finished the empty fleet come through.

MR. CHHATRE: Sean, can I ask you a question?

MR. KEANE: Sure.

MR. CHHATRE: This is a very small group. What happens in real life? I may be getting those 50 shift between two, PSI shifts. This is very symmetrical. I could be getting more than 100.

MR. KEANE: Right. Is that what you mean?

MR. CHHATRE: What I meant was, I can have something like this and it can go down like this. And then I can have something like this, something like this. Again, I might be doing something. I mean, this is real life. This is not real life.

So, how does this confidence level translate into this?

MR. KEANE: So, it's exactly the same concept. What you're drawing here, Ravi, is --

UNIDENTIFIED SPEAKER: Put your name on the right.

MR. KEANE: I did. So, what you're drawing is that -- more typical of real world. And rain flow counting, rain flow is exactly how that gets accounted for. So, once again in your example, so this, this, all these little portions, still get added into here.

MR. CHHATRE: Okay.

MR. KEANE: And then how you group that up, is up to you. So, once again, you could simply count, how many -- a delta P of whatever this access is, and you might land up with 15 or 30, whatever it is, 0 to 100s. Or you could land up with a distribution through here. It's the same thing. It's exactly the same concept.

MR. CHHATRE: So, if you take this one and line cycles of 15 cycles, going from 75 PSI to 35 --

MR. KEANE: Yeah.

MR. CHHATRE: Compared to break out like this. My intuitive way of thinking, this will give you more conservative, because I'm cycling my pipe to a much larger degree of much longer cycles. And I am with smaller cycles of diluting --

MR. KEANE: Can I just -- I just want to restate.

So, you're saying that if you are to use a bin size, if we put some numbers to your chart of 150, again, if we said that use a bin size of 50, so all of these cycles occur within 50 bin, would that give you a shorter fatigue life than if you accounted for a five PSI bin size?

MR. CHHATRE: Right.

MR. KEANE: Sure. Which one's more precise, though?

MR. CHHATRE: (Indiscernible) You're looking at the (indiscernible).

MR. KEANE: No. We're looking for precise so we can put a known factor safety on it.

UNIDENTIFIED SPEAKER: Because you're putting the factor safety on afterwards? We're building it upfront and you're --

MR. KEANE: But you're building in -- what are you building in?

UNIDENTIFIED SPEAKER: It's an unknown

MR. KEANE: It's an unknown. You're building in an unknown source. That's the problem.

UNIDENTIFIED SPEAKER: Or building conservative. Because you're talking about precision with the Paris Law Equation like that is a material property. And it really isn't, especially when we're looking at the end of the defect leg where Paris Law might not even be the appropriate model to use.

MR. CHHATRE: What I wanted to ask you, Sean, is without going through this diagram I drew, I'm opening my crack and then I'm going back.

MR. KEANE: Yeah.

MR. CHHATRE: In your case, you're assuming my crack is full because your cycles shown a steady increase in magnitude.

UNIDENTIFIED SPEAKER: His was just an example.

MR. CHHATRE: Okay.

UNIDENTIFIED SPEAKER: He didn't mean to apply the line operates like that.

MR. NICHOLSON: In actuality, what the question was, was, has Enbridge done a sensitivity analysis to demonstrate what the effect is for, say, using 5 PSI bins versus -- I don't know, Flaw Check has a default bin value of something, right.

MR. KEANE: So, the default setting within flaw check is, it's literally the maximum -- the minimum divided by ten, or something to that effect.

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: So, it's meaningless. And the guys at the VMT Fleet --

UNIDENTIFIED SPEAKER: It's not meaningless, though.

MR. KEANE: Well, it's a starting point for something. Is it the right value? The guys at VMT Fleet will say, no, you should be doing this. Because if you're trying to understand more precisely what's going on, you need to model it as such. So --

MR. CHHATRE: (Indiscernible.) I'm not saying this is right and that is wrong. I'm just trying to figure it out which one is going to give you more conservative.

MR. KEANE: Oh, absolutely. If we bin 0 to 1,000, that would be more conservative. If we bin 0 to 350, that would be -- that would give you still a shorter life. At what point --

UNIDENTIFIED SPEAKER: So, if we say the range is 0 to 500 divided by ten, these 50 pound bins, have you done a sensitivity analysis to show what the change in fatigue life calculations would be on the 5 PSI bin versus the 50 PSI bin?

MR. KEANE: Well, I can't think of a specific example of one, but, I mean, it would be short to do. The problem is, I don't know what it would mean. Because coming back to the way that that all of the -- these equations and the tests and the C&Ns were developed, they weren't developed with uncertainty to them. They were developed with cycle it, apply that bad calculate from your pressure cycling with your known flaw growth, develop your K values and work it through so you can actually translate and calculate it.

MR. CHHATRE: Are you writing any background safety afterwards, after you go through this calculations?

MR. KEANE: Absolutely, yeah.

MR. CHHATRE: So, how is that any different than this one?

MR. KEANE: Because when we add our factor of safety, we apply it to time. So, if we have a time and if you're starting flaw size was, for instance, at this point, and if your critical dimension's here, then we put a factor safety of two on time. So, therefore all this flaw growth from here to here, is not, right. All that comes off. So, by putting the factor safety of two on time for fatigue, because of the shape of the equation, right, there's not a lot of growth occur from that perspective.

And that's why we're trying to be precise, not non-conservative, but precise. So, that we can be known conservative.

UNIDENTIFIED SPEAKER: I'm not real familiar with all these equations. The DA over DN, is that what that is?

MR. CHHATRE: Growth.

UNIDENTIFIED SPEAKER: That's calculated for each of those bins?

MR. KEANE: Correct. Yeah. So, maybe what I can do then is delta K equals -- I should have to look this up, it's a geometry factor --

UNIDENTIFIED SPEAKER: Okay. I know where you're going.

MR. KEANE: The delta stress, and stress is a function of PR over fatigue. Right. But the point being that your Delta K, its a juncture factor, comes out of the PSI 579 or PSI 7910. Flaw size for a given point in time and then your delta -- sorry, my writing is messy on the board here -- delta stress, which is a function of Delta P. So, Delta P comes from your bin size. And you're applying your maximum bin size, so now you have to grow it for that.

So, if you apply this Delta P of --

UNIDENTIFIED SPEAKER: And then you've got the negative one

MR. KEANE: Oh, over here.

So, yeah, so that's where everything comes in from there. That's why it's - -

UNIDENTIFIED SPEAKER: Thank you

MR. KEANE: You're welcome.

UNIDENTIFIED SPEAKER: So, you said that's not a difficult thing to do, to show what the difference would be?

MR. KEANE: It wouldn't be difficult but I don't know what it would mean, is the problem. So, you could do it, but if you land up with a curve here and another curve here, I don't know what that shows.

UNIDENTIFIED SPEAKER: Changing your bins?

UNIDENTIFIED SPEAKER: Let's do it and look at it and then we can --

MR. KEANE: But the only question is, would you rather understand the conservatism from that perspective or would you rather correct maybe the “c” values wrong? Or maybe, right? Or maybe the N value's wrong? Because that's coming back to the science of how this was developed.

UNIDENTIFED SPEAKER: Right.

MR. KEANE: So, that's my only -- you know, I wouldn't want to suggest that we're going to chase this one down because I truly don't believe that that would be --

MR. CHHATRE: See, where I was coming from --

MR. KEANE: But I would do that, of course.

MR. CHHATRE: I was taking it like if you look at the graph down, my -- because my cycles are down, my crack length, now interior should increase. In the second step, in here, my crack length should increase then without using this cycles in that equation, your crack length is getting even smaller as the bin is big. So, that should really give you a little bit different number.

MR. KEANE: Are we talking --

MR. CHHATRE: You are using this equation for each of these bins, right?

MR. KEANE: That's correct.

MR. CHHATRE: Did you built in crack depth in the equation? Is it not?

MR. KEANE: No. The crack depth is a point in time each cycle.

MR. CHHATRE: But each of these bins you are doing that. So, when you are using this, your crack length is not as deep for this particular bin whereas in here, when you come here, my crack length is deeper because this opened up my crack.

MR. KEANE: So, now you're asking -- you're asking a question about the -- about can we calculate along the length. And so -- and that's a really important part of how to determine fatigue calculations, so if you look at that flaw check, this is something that's -- this is a very good, important point here.

So, over time if you're to zoom in on a little portion like this, from a graph and flaw check, what you would see is this. So, what it does is it's calculating, whichever example, but it goes one bin, two bin, three bins, and runs its way down. And calculates, it goes all the way through that entire spectrum, right. So, this pertains to a portion of time.

All right, so this many cycles over a time equals one year, or whatever it is. So, it applies that growth over, right, over a period of time. It grows the flaws to that point.

MR. CHHATRE: A is depth, right?

MR. KEANE: A is depth. That's right. Sorry.

UNIDENTIFED SPEAKER: Is that what you were asking?

MR. CHHATRE: To me, that's what I'm asking. I'm saying, in this equation, you are calculating your growth based on a certain flaw size, right?

MR. KEANE: That's right. And you're repeating that spectrum over time.

MR. CHHATRE: Right. But in this kind of smaller bin size, each of -- in this particular case, when you calculate growth, different crack growth, you're using a flaw size which is smaller because it's amplitude is going to give you a very smaller flaw. What I'm looking at here is, I started with a flaw of one inch, it goes to 1.2 inches. When you do the calculation here, your flaw size is not 1.18 or a half inch.

MR. KEANE: That's right.

MR. CHHATRE: So, the numbers might change.

MR. KEANE: I see what you're saying. So, just to repeat it for everybody else, but you're saying that when you go through your -- if this is your actual pressure spectrum over time, that all of this and this fits into the same five PSI bin, whatever. And then it goes into here, or here. And then you calculate it. You go through this cycle and you start calculating through. And you grow your crack, you know, this point, this point. Each of these bins goes up.

Flaw Check makes sure -- that's an important thing, right? Is that this time -- if you line up ground flaw like this, and only run it through the spectrum once, and Flaw Check says, you haven't randomized enough. You haven't -- you applied this one at the early point. And because of the way rain flow accounts, like it all gets into a bin, so you need to -- you need to randomize this. And so you can actually randomize how it always gets applied. So, it might apply this one first and then it will go to this one and then this one.

Or the smarter way, or a different way to do it, which Flaw Check always does, is it will take -- it will do a quick calculation to figure out how many times it applies this spectrum of pressure data. And then divide that time period by a factor so that it will -- each of these pertains to application of one spectrum. So, it will apply that spectrum at least it's a set amount of times, as a minimum. So, that you don't land up with this, you land up with this. So, it reapplies that spectrum.

UNIDENTIFED SPEAKER: If you did it Ravi's way, you wouldn't end up with a nice --

MR. KEANE: Right.

UNIDENTIFED SPEAKER: -- trend. Is that the problem?

MR. KEANE: Well, no, you might end up saying that -- you wouldn't want to grow a crack like this and then try and figure out, well, at this point in time, how deep is it. Is it here or is it here?

UNIDENTIFED SPEAKER: The drawing that you show there is applying it from the smallest bin first and then the largest and largest --

MR. KEANE: Right.

UNIDENTIFED SPEAKER: If you do it the opposite way, you'd get a scallop going the opposite.

MR. KEANE: Yeah. And it's not necessarily -- do you grow -- do you apply all your small cycles first because you know that growth for the small stuff doesn't apply much and then get to the big ones, because those are going to be giving your biggest growth?

Well, not necessarily, you might have 100,000 of these in one of these. So, this might account for loss. So, therefore divide all this -- if this is over a year, you can divide this by set amount and normalize it all out, shrink the time period, apply it, instead of this you apply it and smooths it all out. And that's important. That's a really important concept. And Flaw Check does that standard.

But then that's a whole different topic than the bin size. But that's part of it I suppose, right? Because it's how --

MR. CHHATRE: Then you have to decide when your next ILI cycle is going to be.

MR. KEANE: That's very important.

MR. CHHATRE: And you will (indiscernible) concept will change your cycles.

MR. KEANE: Right.

MR CHHATRE: You could maybe be too optimistic.

MR. KEANE: Yeah.

UNIDENTIFED SPEAKER: So, why is it meaningless, now that we understand your model, to change -- why couldn't we change the resolution on your Delta P? Because it's smaller bin sizes --

MR. KEANE: You could go to smaller.

UNIDENTIFED SPEAKER: Smaller?

MR. CHHATRE: That's the original question, right?

MR. KEANE: Well, the question was, can you go larger.

MR. CHHATRE: Oh, larger.

UNIDENTIFED SPEAKER: Oh, larger bins. I thought you said smaller.

UNIDENTIFED SPEAKER: Going larger would add a degree of conservatism to the calculations.

MR. KEANE: Right. So, could you do this? Could you do that? And that's where I agree it will give you a different number, it will grow it -- you're applying 100 -- you're applying the same number of bins, or number of cycles, but you're applying them in a much larger -- because you apply the largest one. You don't want to apply the average of them.

So, yeah, it would grow it faster, but which one is more correct? Because if you -- if, in this case, the difference between these two, if, well, you know, -- if you land up with a lot of bins being close to the top of it, versus a lot of stuff down here, you really lose sight of the precision and the differences between what's going on. That's all.

UNIDENTIFED SPEAKER: Maybe the question is better, you know, addressed towards the end of the defects life. I'm not sure if you're involved in the Enbridge internal draft report but it discusses, you know, the Paris Law and how that works well during the mid-life of a structure, but not very well at the end when the defect growth is much more related to the stress amplitude ratio.

MR. KEANE: Yeah.

UNIDENTIFED SPEAKER: Did you have involvement in that? If you're not the right guy to ask --

MR. KEANE: Well, I'm not familiar with it but I can describe the concepts because I understand that.

UNIDENTIFED SPEAKER: That's kind of recognizing that --

MR. CHHATRE: Is it “x” axis?

MR. KEANE: Pardon?

MR. CHHATRE: The “x” axis there?

MR. KEANE: Well --

MR. CHHATRE: To me, it looks like a “T” but then you have DA by DN.

MR. KEANE: No, it's not “T.” Well, let's just pull that up.

MR. NICHOLSON: Are you moving back over here?

MR. KEANE: To be fair, you probably want to erase that because I got the wrong number signs on it.

So, I'm just going to try and find that graph here.

UNIDENTIFED SPEAKER: You're going to be coming up with some IRs on this.

MR. KEANE: I'd rather speak to them.

UNIDENTIFED SPEAKER: Oh, sure. Absolutely. I might not observe it all.

MR. KEANE: That's okay. We can always follow it up, too, right.

MR. CHHATRE: You're more confident than I am. I know I will not follow it.

(Laughter)

MR. KEANE: This is the TT05 paper, the OPS. So, here's the title of it, right here. It's “OPSTT05 Low Frequency ERW.”

UNIDENTIFED SPEAKER: Mr. Keane?

MR. KEANE: Yes.

UNIDENTIFED SPEAKER: Is this an LPS document?

UNIDENTIFED SPEAKER: It's a public document.

MR. KEANE: I'm just looking to see -- I thought we had some susceptibility stuff in here.

Sorry. I was looking for that one curve. We can sit here and sort through documents and try and find it, but as the defect reaches the end -- reaches a depth point, it no longer fits to the Paris Law de-linear portion of a Paris Law equation. So, DADN C delta KN, that pertains to that zone two of the -

UNIDENTIFED SPEAKER: Of the crack growth?

MR. KEANE: That's right. Of the crack growth.

So, as it approaches the end of its life, that, I think -- I think that's the question, right.

UNIDENTIFED SPEAKER: Correct.

MR. KEANE: It doesn't apply, necessarily, and -- but those portions of time are short. And they're the upper ends of where the failures are going to occur.

Oh, from a depth perspective on a fatigue curve. They're way on the downside of it.

UNIDENTIFED SPEAKER: They're on the end.

MR. KEANE: Yeah.

UNIDENTIFED SPEAKER: So, you're saying this equation doesn't hold true for CN values?

MR. KEANE: No, no. I'm saying that we stopped the curve -- the example on the board, we stopped the curve before it ends. Right.

UNIDENTIFED SPEAKER: On your times?

MR. KEANE: Yeah. Yeah.

UNIDENTIFED SPEAKER: Okay. I see. Oh, by taking your factor of two --

MR. KEANE: Even ahead of that. A critical depth is ahead of where that flaw growth is no longer predicted by Paris Law. Yeah.

MR. CHHATRE: (Indiscernible) by taking it a percent?

MR. KEANE: Right.

MR. CHHATRE: You're saying it's built in from the very beginning?

UNIDENTIFED SPEAKER: Part of the issue is, Paris Law is am empirical formula. It's not a material property, necessarily, so --

MR. CHHATRE: (Indiscernible) to a certain extent, right?

UNIDENTIFED SPEAKER: Sure.

MR. CHHATRE: Even 50 percent, empirical.

UNIDENTIFED SPEAKER: Sure. So, the value of adding precision versus adding the measure of conservatism is debatable, I think, you know, obviously.

MR. KEANE: Yeah. I mean, the intention isn't to -- the intention is to not add unquantifiable conservatism.

UNIDENTIFED SPEAKER: So, at this point, you know, the

Enbridge approach of using the precise pressure value and dividing the fatigue life by two, that's a method of adding conservatism and using, say, a 50 pound pressure bin gives you a T-line. Now, does that --

MR. KEANE: How would it compare?

UNIDENTIFIED SPEAKER: Is that going to be more or less than a different approach.

MR. KEANE: Sure. Okay.

UNIDENTIFED SPEAKER: And that's what we don't have any type of feel for right now.

MR. KEANE: Do you know what? I think I'm understanding your question a little bit more.

What you're trying to do is compare our time failure by two approach, well, what if you just accounted for 100 pound bin, or what if you just use a 200 pound bin. At what point would those two numbers come to commonality.

UNIDENTIFED SPEAKER: No. Not to commonality, just, say, you know a 50 pound bin --

MR. KEANE: Yes.

UNIDENTIFED SPEAKER: If you got some of these larger diameter pipelines and then it's a 0 to 500 pound range, divided by ten, you know, that's what Flaw Check says to start out. How does that compare to using precise values?

MR. KEANE: Once again, I just don't know how you draw a conclusion out of it other than just simply the comparison. I think that's your point is, well, what is that comparison.

MR. CHHATRE: My thinking was, as long as we look at this one, and as long as we reevaluation timing, is not likely beyond rupture as before, which is an alternative approach. I was going to predict this, this is only to find out this. An alternative approach.

MR. KEANE: Okay.

MR. CHHATRE: That's where I'm coming from.

MR. KEANE: So, we can --

MR. CHHATRE: We can do it the other way.

MR. KEANE: Is there something you want to bring up? Is that what you were suggesting earlier?

UNIDENTIFED SPEAKER: No, not for our purposes. It's something that we've asked for previously, I think, is the sensitivity analysis of the Flaw Check calculations based on varying bin sizes.

MR. KEANE: Okay.

UNIDENTIFED SPEAKER: That's still requested.

MR. KEANE: Okay.

MR. CHHATRE: I didn't mean to take that much time but I didn't understand.

MR. KEANE: No, that's good.

MR. CHHATRE: I understand now that you are taking the 50 percent.

UNIDENTIFED SPEAKER: You know, and it's important because, the Enbridge internal draft report acknowledges that it really doesn't -- you know, within --

UNIDENTIFIED SPEAKER: Well, it's pretty well documented, too, right?

UNIDENTIFED SPEAKER: I don't know. There's no -- they're not using an alternative yet, as far as I know. Or is that what you were trying to pull up, right?

MR. KEANE: Well, I think context needs to be brought into that part of the report that you're referencing where there's -- and I don't have the report, but the end of -- as you increase depth on the fatigue curve, at some point the fatigue calculation's no longer valid because that one last cycle to fail, all right, you're not there, right. That precision was not intended to be there, but you still need to try and model it somehow. The curve goes S and topic, right? It goes straight up and down towards the end.

So, yeah, when the amount of time in that area is very, very small and all of that gets truncated off by safety factor approach.

UNIDENTIFED SPEAKER: Provided detect the size correctly.

MR. KEANE: Sure. Sure. But from the calculation method itself, yeah.

I think this discussion leads into some of the ways we use the pressure data. I know we're starting to jump around outside of that -- our normal process flow but it's probably a relevant point to branch off and talk about our condition monitoring and how we do this pressure cycle monitoring and what is it.

So, if you guys want to talk about that now then we can go there, or if you'd rather go back to workflow, we can do that too.

MR. CHHATRE: Yeah. I would go with work flow.

UNIDENTIFED SPEAKER: Work flow?

MR. CHHATRE: Yeah. Because I think we are just drifting way too far away.

MR. KEANE: Well, the one point, though, Ravi, is if we go back to this right here --

MR. CHHATRE: Okay. Let's go ahead and finish this and then go back and work off of that.

MR. KEANE: Yeah. Because, you know, we've been talking about these --

MR. CHHATRE: The pressure.

MR. KEANE: Yeah, the pressure cycling re-inspection interval a little bit. We can talk about this pressure cycle monitoring and then we can come back.

UNIDENTIFED SPEAKER: Let's go back and then forward.

MR. KEANE: Yeah.

UNIDENTIFED SPEAKER: We're leaving fatigue analysis for now?

MR. KEANE: Well, I can follow fatigue -- I can take fatigue to the end point, though, and then talk about our SCC -- what we're doing now for SCC.

UNIDENTIFED SPEAKER: You know, I guess the questioning parts fatigue, fatigue analysis, have there been any changes in how the analysis is done now versus what was done for the 2005 crash analysis?

MR. KEANE: So, there have been modifications and enhancements to the processes along the way. If we go all the way back from 2005 to the current date in 2011.

So, those modifications include always using 8.61 so our C&N values; 8.61 times 10 to the minus 19.

We added in along the way tool tolerance into the fatigue life calculations. So, we'll talk about that as we go through our outlier analysis and trending documents.

And, yeah, those are the largest two from a fatigue calculation perspective.

UNIDENTIFED SPEAKER: I guess I'm looking at the data from the 2005 analysis on the ruptured joint. There were -- the data analysis was done on those at the time. And were -- the features that were found on that joint were fatigue life was 21 years and 35 years. Has there been any additional analysis of that? Do those numbers still apply using today's analysis?

MR. KEANE: So, let's talk about those a little bit, then.

UNIDENTIFED SPEAKER: Wait. So, now we're in to the 2005.

MR. KEANE: Right. So, this was submitted as part of the IRI response.

I don't know the document title it was submitted under. My file is, "Line 6B 2005, USCB Program NDE results included."

MR. KEANE: I'm just going to set this document up so we can -- I'm just going to lock down some cells here.

So, I've just highlighted girth weld 217720 in that document and just froze the top row so we can see them as we come across.

So, this would be the feature failed, I believe. And so you can see in our fatigue assessment how we treated it. So, we have the 51.6 inch length was used. A depth of 71,000 was used. And we had a fatigue life of 35 years. And that fatigue life -- so let's just zoom in on this one guy, I guess.

So, if we were to -- I've included tool bias, so we've gone back and we've double-checked everything along the way. This one clearly indicates no bias.

That results in a -- what would it be? This long. It's greater than 15 years by re-inspection like -- their earlier predictive re-inspection interval for that one would have been mid 2012, still.

UNIDENTIFED SPEAKER: So, if you include a bias?

MR. KEANE: Yeah. Correct. So, if we would have shown that column within here, it would have been mid 2012.

UNIDENTIFED SPEAKER: The 2005?

MR. KEANE: Yeah.

MR. CHHATRE: What is bias?

MR. KEANE: So, bias is something that Enbridge started adding into our re-inspection intervals a number of years -- some time ago, I don't remember when. What it is, is it's the minimum of tool reported bias, so they could be off by one millimeter -- a half millimeter, sorry.

So, the ally tool reports things in depth bins, so 12 and a half to 25 for the feature in question. And then it also says that within a certain confidence interval and range, that they could be off plus or minus point five millimeters. And so we add that.

Or the deepest of all of our trending -- non-conservative trending points for that depth, then. So, that's what bias is for us. We look at our field --

MR. CHHATRE: It's about safety, then, essentially?

MR. KEANE: Well, it's not necessarily a factor of safety. It's inclusion of any observed uncertainty or potential uncertainty with the crack depth sizing.

So, observed from our field ILI trends or observed -- or presumed uncertainties so it's to do with the ILI tool. So, we add that depth on to the initial flaw depth.

So, the tool reports the depth within a bin of 12 and a half to 25 in this case. And then we would add 25 percent plus the -- when you look at all the data prior to the Marshall release, the maximums are bias for that 12 and a half to 25 percent bin was approximately nine percent. So, if we add that additional nine percent onto that starting flaw depth, you're still going to have results in a re-inspection interval well beyond 2012. Fatigue life's beyond that, well beyond that.

UNIDENTIFED SPEAKER: 2012 is including the factor of safety?

MR. KEANE: That's correct, yes. Including the factor of safety

UNIDENTIFED SPEAKER: So, fatigue life no bias, is there another column that includes the bias?

MR. KEANE: No. That wasn't provided, so --

UNIDENTIFED SPEAKER: So, it wasn't used because you didn't have it?

MR. KEANE: It wasn't -- we were just in the process of formally implementing that throughout the systems.

UNIDENTIFED SPEAKER: Oh, so there was no --

MR. KEANE: Right.

UNIDENTIFED SPEAKER: -- process in place?

MR. KEANE: Right. But even if that -- even though we were in the process of implementing, it was already -- like, we already had the columns, right? So, you can even see, fatigue life, no bias. And that's why it's shown on there.

UNIDENTIFED SPEAKER: So, if there was a fatigue life with bias we would expect that to be around 2015, so that's about 7 and a half years?

MR. KEANE: Yeah. And I can show you that. I suppose, I don't know, Jay, how we deal with -- I don't think this is something that's been submitted to them before.

MR. JOHNSON: If they want a copy of it, we've made a copy of it.

MR. KEANE: I think it's relevant.

UNIDENTIFED SPEAKER: Who produced these calculations?

MR. KEANE: This is internal. Enbridge produced this.

UNIDENTIFED SPEAKER: But who within Enbridge. You said you didn't do any work on these.

MR. KEANE: This is Steven Bott. So, Steven calculated this.

But we've certainly done similar work with consultants to third party, close your eyes, tell me what you guys see. And then so we've talked about that too, right.

But that's -- so here is the -- so you can see once again on the file there, starting at the 71,000.

UNIDENTIFIED SPEAKER: Oh, okay. Starting depth.

MR. KEANE: So, 71,000, so right here. But if you look at the shape -- sorry, there's two curves on this chart.

There's one using the worst -- the most aggressive quarter over time. And then there's one that we just went back and did the entire spectrum because the cycle life changes over time, right. There's periods where it's operated with less severity and periods where it's, well, this was the most severe cycle, right there.

So, if you take that most severe one and apply it, then this is the curve. If you take the double overall period of time, apply it then, it extends everything up.

But let's just, for sake of discussion, just talk about the -- just

UNIDENTIFED SPEAKER: The worst case?

MR. KEANE: Yeah. The worst case scenario.

So, you take this blue curve and if you extrapolate it, you can imagine how far you'd have to drive it back, drive it this direction, to hit this point. So, that was the -- that's the original numbers. But when you include the bias, it bumps it all the way up to here for starting so you know the “X” axis is 2,005. If you bump it up, then you just, yeah --

UNIDENTIFED SPEAKER: It makes sense.

MR. KEANE: And that's our current processes for doing our re-inspection report.

UNIDENTIFED SPEAKER: So, the chart that you showed before where you were showing fatigue life for line 6B that would include the bias?

MR. KEANE: That's correct. Exactly.

UNIDENTIFED SPEAKER: But it said six years, didn't it?

UNIDENTIFED SPEAKER: Six years and then -- but this would -- the analysis wouldn't have been --

MR. KEANE: This is based on the 2005 data that we had.

UNIDENTIFIED SPEAKER: Oh, was that on the 2005

MR. KEANE: No. The one -- sorry. Dependent's A chart, the current version is updated with most --

UNIDENTIFED SPEAKER: 2010?

MR. KEANE: That's correct. This is based on 2000. This is for that specific nature.

UNIDENTIFED SPEAKER: So, now since then -- the thought process here is that the reported depth was off on the tool? I'm trying to take away --

UNIDENTIFIED SPEAKER: Not necessarily. I mean, there's that -- it's an uncertainty factor essentially.

MR. KEANE: But one that we've been accounting for within our re-inspection intervals. So, it's not only that but the tool itself -- so this is the maximum depth of the bin. But it was reported to us shallower than that still, right.

UNIDENTIFED SPEAKER: Oh, this is the maximum depth?

MR. KEANE: That's the maximum depth of the bin.

UNIDENTIFED SPEAKER: Oh, okay.

MR. KEANE: And it's 25 percent --

UNIDENTIFED SPEAKER: That's the actual of the 285?

MR. KEANE: And it's 25 percent of 285, which is even a bigger number than 25 percent of a quarter-inch.

MR. CHHATRE: What's the question again? You're extending this graph right here.

UNIDENTIFED SPEAKER: As far as D over T.

UNIDENTIFIED SPEAKER: He'd be much farther back in time if you had to extend this back. You'd be pre-2005.

MR. KEANE: You'd be looking at 35 years, basically.

UNIDENTIFED SPEAKER: Exactly.

MR. KEANE: Well, exactly.

So, if that's our critical depth and that doesn't change. If our tool reports a depth of here, then you'd be growing it starting here and growing it at this point. But in reality what we want to do is, we add the toolbars to it.

MR. CHHATRE: Toolbars --

UNIDENTIFIED SPEAKER: Thank you, sir.

(Indiscernible.)

MR. KEANE: And so you track -- you lose -- you take that much off (indiscernible). This tied to it.

MR. CHHATRE: What about this one (indiscernible)?

MR. KEANE: Well, because the graph that we're showing only starts here, right. And so, I'm just trying to illustrate that. You'd have to go backwards on this plot to go back.

UNIDENTIFIED SPEAKER: Okay. Yeah, you might have a delta T coming backwards here.

MR. KEANE: Yeah. So --

MR. CHHATRE: It appears then your crack is much smaller (indiscernible). Yeah. The inspection becomes almost --

MR KEANE: Yeah. So, if you got a very, very subtle crack, then it's not going to grow over time for all these different reasons. And you know, pipeline industry knows that for fact because there's been pipelines have -- they all have flaws.

MR. CHHATRE: Do you have any data that the crack depth remains the same and the length increases?

MR. KEANE: What do you mean the length increases?

MR. CHHATRE: Your flaw identified by –

MR. KEANE: No. We do grow it -- the flaw does grow in length over time, but compared to depth, like when we're talking –- so in a quarter-inch wall, it'll grow in depth

MR. CHHATRE: --much faster then -- a

MR. KEANE: -- then in length. It's not growing by inches. It's growing by thousands of an inch.

So, fatigue growth and even -- it's, you know, we're just looking at IDOE.

So, you might have this initiating flaw down here and it might be long, but it's going to just -- it's going to grow down.

UNIDENTIFED SPEAKER: Is that 9 of the wall thickness?

MR. KEANE: No. Now that's the measured -- that's more trending. And it's 9 percent --

UNIDENTIFIED SPEAKER: So, this is from trending, the 9 percent? From the manufacture?

MR. KEANE: Yeah, that one's from trending.

UNIDENTIFIED SPEAKER: Oh.

MR. KEANE: Now --

UNIDENTIFIED SPEAKER: I'm just curious, .026 is -- was that about nine percent of the wall thickness?

MR. KEANE: This one is. So, 9 percent or .026.

UNIDENTIFIED SPEAKER: Nine percent of the 285 or is it 9 percent of --

UNIDENTIFIED SPEAKER: I think -- well, it's got to be the 289.

MR. KEANE: So, the -- now, some of the changes that have occurred over time is historically that the crack ILI allows us to report in percent bins, 12 and a half percent to 25 percent. And in order to remove that whole discussion that you just asked about, is that percent or is that different, was we'd ask GE a number of years ago, no more percents. Tell us in absolutes. So, 40 to 80 thousand, please, so that way we know what we're dealing with.

UNIDENTIFED SPEAKER: On depth?

MR. KEANE: On depth. And so you'll see that through the 2010 reports now, that they come through with the 40, 80 thousand. And I don't know the exact year when that shift occurred but that was one of the reasons why we asked for that was to avoid that conversation of a percent of a percent of what.

UNIDENTIFED SPEAKER: Sean, do you know where the 285 wall thickness came from in that report?

MR. KEANE: Yeah. The 285 wall thickness is the wall thickness reported to us from the USV vendor. And so this wall thickness, you can see, this is straight out of the USV report here. So, there it is there, 285.

UNIDENTIFED SPEAKER: So, that's a measure wall thickness off the tool?

MR. KEANE: That's correct. So, the USCD tool has a number of straight beam ultrasonic sensors around its circumference. And they use that -- the same algorithms that they use for wall -- WMW tool, the wall thickness measurement tools, they apply that to these sensors. And they use -- they produce an average wall thickness for that pipe joint. And they use that wall thickness to translate back for the percentages and for their own analysis and determination of is it internal or external.

So, I don't know how familiar you are with the functioning of the CD tool but an important component for them is understanding where those -- where the ultrasound is reflected in time and being able to relate that back to internal or external surfaces. And that's how they use that wall thickness. And that wall thickness that we used. So, we would use -- and this is one the process changes that has been made in result to this Marshall failure. Is we use 285 wall thickness multiplied by 20 percent -pardon me, 25 percent, to initiate our calculations, which we use in discrete absolute values.

UNIDENTIFIED SPEAKER: Was the 25 accurate?

MR. KEANE: I think Matt would be best to answer that. Matt Fox.

MR. FOX: I didn't get any 285 measurements, at least on the section that we had -- that we measured.

I guess -- well, I guess we could ask the GE guy, or do you know exactly, you know, how that -- or where it takes that measurement to get the 285? Is it near the girth weld or where does it get that measurement? Because its the same across the joint It's certainly a variant to some extent.

MR. KEANE: It's along the length of the joint. Again, so they sample it along the length of the pipe and then --

UNIDENTIFED SPEAKER: And take an average?

MR. KEANE: And take an average, yeah. I'm not sure if it's an average or a mean -- or the most common; the most repeated.

MR. PIERZINA: Let's assume that it's inaccurate and the average is closer to 250. So, with the 285, that then back there contemplate the values in crack depth calculations that they're providing.

MR. KEANE: That's a good question. So, while GE's answer would be important to hear. I'd like to speculate. I can only speculate because I'm not GE, right. But I'm going to say, no, and the reason being is they don't use that value to adjust their amplitudes. They have an amplitude sizing curve where mount to sound bouncing back is proportional to a crack depth. And that curve is not specific to 280 -- does not adjust between 285 and 250.

So, therefore the sound, they would have put it in the same depth. If it was a quarter-inch or if it was 285 inch. That's -- that would be my speculation.

MR. PIERZINA: The crack depth would show the same, but maybe not as a percentage?

MR. KEANE: Well, knowing that -- maybe not as a percentage.

MR. PIERZINA: So, if the crack depth is the same, but 250 versus 285, maybe it falls into a different bin?

MR. KEANE: I haven't heard GE say that, Brian. I couldn't imagine why they wouldn't say that to me but once again I don't believe that to be the case.

MR. PIERZINA: Okay.

MR. KEANE: My understanding of the way that the analysis processes at GE work, don't suggest that to me.

And it wasn't at the top of the bin either when GE -- subsequent to the failure, GE did provide a what would the maximum depth of that one crack be, tell us a crack profile. And I flipped through my notes here. And I brought that. That was provided in the IR request. I can reference that here for you. The actual profile along the length of the flaw.

UNIDENTIFIED SPEAKER: Yeah. I think I've seen that, too.

UNIDENTIFIED SPEAKER: 19 percent was the max depth.

MR. KEANE: Oh, you have it there? 19 percent?

So, would it be enough to bump beds from 19 - yeah.

UNIDENTIFIED SPEAKER: Before I forget, I would very much be interested in seeing what the fatigue life calculations were for these PPECS, you know, from the 2005 using the C&N values that you guys --

MR. KEANE: Sure. And I'm not sure if we used them on ILI. I'll have to double-check.

UNIDENTIFIED SPEAKER: That would have been -- you would have been using something else when you initially received this report and then subsequently around 2008 recalculated those numbers, right?

MR. KEANE: Yeah. We were still going through a phase of getting our initial inspections done back in 2005. Right? So, we were still getting those -- that was the first tool -- first crack runs done. So, our processes have evolved -- developed in response to the data that we have and our abilities have -- the data type that we had has changed over the years. So, I'm not sure if we even had -- if we used a different value along the way. We might have just gone off the bat to 8161.

UNIDENTIFIED SPEAKER: You said that there was a different C&N value back in 2005 and then it changed in 2008?

UNIDENTIFIED SPEAKER: Well, in 2008 they went to using the 8.61, if I'm understanding.

MR. KEANE: That's when we standardized our C&N values for our entire system.

UNIDENTIFIED SPEAKER: And that's what's in the document I've got.

MR. KEANE: That's correct.

UNIDENTIFED SPEAKER: And you're saying prior to that it was something else.

UNIDENTIFIED SPEAKER: Part of that wasn't standardized.

UNIDENTIFIED SPEAKER: For instance for line three, it was like 2.5, right. Or something in that range.

MR. KEANE: Yeah. And so -- the determination of C&N values and you can walk -- TTO5 as an example of the document, but they're -- you can use a screening value but if you have something better to base your fatigue constants -- material – your fatigue constants on, then you should consider that and use that. When you looked at our other numbers, they were lower. But we didn't have values for all the other lines. So, that's what I'm saying. We might have just used that screen value back because 6B didn't have a failure history behind it. So, I'm not sure. I don't know the value that we would have used.

UNIDENTIFIED SPEAKER: I guess so (indiscernible) I would like to know what was used and what those (indiscernible) values?

MR. KEANE: Sure. Yeah. But once again, though, the initial value might have been 8.61.

UNIDENTIFIED SPEAKER: You mean, the fatigue life for this defect?

UNIDENTIFIED SPEAKER: Yeah. I guess specifically for those defects.

UNIDENTIFIED SPEAKER: Before we leave this sheet here, though, can you just walk us through to this column, for those of us that aren't familiar with -- like there was a length -- the length and width over in columns L and M. Some of that. What is that used for?

MR. KEANE: Sure. Excuse me, should we start at the beginning?

UNIDENTIFIED SPEAKER: Yeah. Would you? I think that -- I mean, some of this I know.

MR. KEANE: So, the first one is the CorLAS number. And back in the day there -- we had to calculate for every single feature a CorLAS calculation to determine this. So, there wasn't an Excel version of CorLAS. There was a DOS version. And there wasn't a vast input version to CorLAS.

So, when you see 7,000 plus CorLAS calculations, that's because there were 7,000 plus calculations done. And so when you -- it was a lot of work. Obviously, we had to develop methods to do this, because the -- the opportunity for human error to enter into that would be obvious. So, therefore, what we did is we had developed a script to use Excel spreadsheets and enter data into

CorLAS software and then run CorLAS and then every single file was saved with a naming convention and all being controlled by this mastermind software, I guess, sitting above CorLAS. And so it was running CorLAS and saving all the results for us. And then going back into all the results and stripping out all the data that we wanted out of it and saving everything along the way.

So, that's what the CorLAS number is, is those are the original thickness for purpose calculation values. I think we provided all those to you so you probably landed up with a multi-thousand page PDF version of that. It would have been literally thousands of pages.

UNIDENTIFIED SPEAKER: I don't think I saw the print-outs.

MR. KEANE: Yeah. But we provided each of those to you. And I do have part of it as part of an IR response. I only printed the one page pertaining to feature. But -- So, that's what that CorLAS number is.

And then the number is the -- it's just simply a number provided by within the feature listing for GE. And we don't use that. The fact that it's the same as the CorLAS number is a coincidence. We start our numbering from the top and go down and apparently so did they.

UNIDENTIFIED SPEAKER: But you do need it if you go back to GE to get a profile?

MR. KEANE: We always use the area number because the area number is unique identifier for GE. And so that's another number that's important to know for us.

The girth weld number is important, of course. Some of them are obvious, so I'm not going to describe them.

Mount post is something that Enbridge calculates for every single feature.

UNIDENTIFIED SPEAKER: Where's the start? Is that something off this?

MR, KEANE: That's correct.

And then we have the long seam in orientation followed by the wall thickness followed by the distance from the downstream creek flow and those two are -- the two numbers themselves are also important because that tells us the joint length, which otherwise isn't stated.

And then this column's not used by us necessarily. It's used by other groups within Enbridge to determine where along the joint -- or where along the pipeline is this feature located, so it's --

UNIDENTIFIED SPEAKER: It's absolute from head to --

MR. KEANE: No. This particular one is absolute from the trap.

UNIDENTIFIED SPEAKER: Oh, it's feet?

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: And then this one is the feature orientation in degrees. So, for this feature it's at 100 degrees, which is just 4 degrees below the long seam. And then length. So, that's total length, the box feature. Width has no meaning for crack feature. It's just a function of how they boxed the features. It truly is. When I say “boxed,” do you know what that means?

UNIDENTIFIED SPEAKER: It's where they analyze?

MR KEANE: That's correct. So, when GE does their analysis they have a series of algorithms to pre-identify reflectors that potentially meet their -- any of their reporting criteria.

So, it pre-identifies tons and tons and tons of features and boxes them out to say, I want the analyst to look at each of these things. So, each of those boxes is what pertains to this width and the length.

UNIDENTIFIED SPEAKER: Everything will have a box?

MR. KEANE: Everything gets a box. Now the analysts, then, can go in and they can tighten and adjust the boxes when they're doing their analysis process but the box shape itself doesn't have a meaning for crack.

UNIDENTIFIED SPEAKER: Even when we're talking crack field versus crack life?

MR. KEANE: Crack field, it does, because crack field now that that width pertains to circumferential distance.

UNIDENTIFIED SPEAKER: But the mere present of a number in that column wouldn't indicate that you should question the characterization?

MR. KEANE: That's right. And we can walk through a number of other features just to see how that looks. The estimated depth, according to this, 25 percent. Interacting length, our longest indication, is -- are you familiar with that?

The way the crack tool works is they use -- there's sensors. Maybe the best way to describe it is, they integrate all the results from the sheer way sensors, the multiple sheer way sensors coming along the circumference of the pipe. And they integrate the circumference plus the length and they do a C-scan. So, basically unwraps the pipe.

And then when you look at that C-scan along the length of the pipe, the crack field has -- they look for the longest, continuous crack within an SCC colony. And then that's really important for us. Right. And so that -- that longest indication is not necessarily related to a crack that could -- like you wouldn't use that value for a failure analysis calculation or -- pardon me -- a predictive failure pressure calculation. Right? Because that's not the necessarily interacting length that you use. It's just the limitation of what the tool can see. The tool themselves, if they can see a break of -- it's approximately a half inch or an inch, somewhere in that range, where the ultrasonic sensors aren't seeing anything, then therefore they just say that it's not -- they can see that space. So, therefore they know that that little blip and this little blip aren't connected together. But if all those little ultrasonic reflectors are connected, then they report that as their longest crack length.

That one's easier to describe with a photo, so if you want to come back to it, I'll bring up the C-scan.

UNIDENTIFED SPEAKER: But it's only relevant if it's a crack field?

MR. KEANE: Right. It's only relevant if it's a crack field, yeah. And we have criteria built around the use of that information, too.

The relative position. Yeah. The proximity, it's relative to the long seam itself, so in 2005 they classified things as being either in weld or out weld or adjacent to weld; so IW, AW.

External or internal flaws created for the regular positions. Type of feature so crack-like -- crack field much like et cetera, et cetera.

Comment is important for Enbridge also because this was -- this has evolved over time but this is where the analysts can put in there their other observations and Enbridge would use those types of observations.

So, if they would put in comments such as, “Associated with metal loss” or “Associated with dent,” they've done that before. So, we look through those comments to see what they're seeing so that we can find out is there anything unusual about that feature, because it's simply a place for the analyst to provide an additional level of commenting to us. So, we look through all of those and we calibrate based on what they're seeing. So, there's lots of observations related to that.

This document is prepared by Enbridge but everything -- all the columns in blue, except for this mount post -- sorry -- and you can see at the top here, these ones, so everything in here, this is all reported to us by the vendor. So, when I say "analyst," I'm referring to the GE analyst.

MR. CHHATRE: Okay. That's what I was wondering.

UNIDENTIFIED SPEAKER: This is GE's data.

MR. KEANE: This is GE's data right up to the blue. Yeah. Right up to this column that I'm on here is GE's data.

UNIDENTIFIED SPEAKER: Oh, oh, right.

MR. KEANE: So, all this, everything with this blue header row.

UNIDENTIFIED SPEAKER: Oh, I see.

MR. KEANE: And then if we -- there's one. Where we ask for additional information from GE, such as depth profile, or maximum depth profile, then we'd provide it in here.

UNIDENTIFED SPEAKER: What is section?

MR. KEANE: That is the way for GE to track which tool run portion that was in. So, that number has meaning for them but doesn't mean anything to us. So, the tool -- this particular tool run was completed in two passes, so they have EDS -- hang on. I lost my place here but - both 305 and 205. So, that's what that means to them is it's just for them to track.

And then the next series of columns, this is the light purple, is Enbridge's assessment of that feature. And this is a summary of our assessment that we provided for you guys.

And you can't see the row numbers. I don't think I'm missing any rows at the top, but -- so you can see that predictive failure pressure was based on a “J” value equivalent to approximately 20 foot pounds. And -- yeah. And this sub point here is calculated for ILI features trended to be a potential crack.

So, in other words, we wouldn't calculate a fatigue life for a feature that's not a crack feature. So, if it's a geometry feature, we're not going to calculate fatigue life because it doesn't make any sense. It's a geometry feature.

So, anything that's supposed to be a crack, we calculate stuff for it.

UNIDENTIFED SPEAKER: So, is it notch-like? Is notch-like considered a crack?

MR. KEANE: Yeah. So, notch-like -- precisely. So, Enbridge has considered notch-like, crack-like, crack fields. Anything that's got a depth with it, assume that it's growing and model it up.

So, this is the high level inputs used in to our calculations so fitness or purpose length; fitness for purpose depth. And the -- this should be MOP, not AWP.

Hydra-test pressure at that location and CorLAS predicted failure pressure as using the maximum depth total length. So, maximum depth of the depth bin and total length of the feature.

And then the CorLAS predicted failure pressure if we look at their feature profile. And then the fatigue life, using no bias, as we discussed earlier.

UNIDENTIFIED SPEAKER: Hold on.

MR. KEANE: Sorry.

UNIDENTIFIED SPEAKER: A CorLAS predicted feature for?

UNIDENTIFIED SPEAKER: Depth profile supplier.

MR. KEANE: Correct. So, --

UNIDENTIFED SPEAKER: That's where you've actually asked for the profile.

MR. KEANE: Precisely.

UNIDENTIFED SPEAKER: Oh, okay. And the other one uses the maximum over the bin. Is that the difference?

MR. KEANE: Precisely.

UNIDENTIIED SPEAKER: Okay. I got it.

MR. KEANE: And then or each feature a summary of did we investigate it as part of our phase one excavation or as part of our 2008 -- we did some more digs in 2008. Did some more --

UNIDENTIFED SPEAKER: Oh, those are all digs. Okay.

MR. KEANE: Exactly. These are all different programs now. That way you could see what we've dug along the way. So, this is a summary of that.

And like indicated, the results from all the other excavations feed into our programs also and we track and trend that. So, it's just -- we just titled, “Opportunistic,” here.

UNIDENTIFIED SPEAKER: So, what goes in these fields? A number?

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: I guess it's a number.

MR. KEANE: It would simply just be a “one.” Just -- let me -- yeah. “One” for a yes and a “zero” for a no. So, we went with the binary system. Yeah. So, “zeros” and “ones.” That's it.

UNIDENTIFED SPEAKER: That would just tell you it got looked at under one of those programs?

MR. KEANE: Exactly.

UNIDENTIFIED SPEAKER: So, you would go -- you can go pull up the report.

MR. KEANE: Precisely.

UNIDENTIFED SPEAKER: Okay.

MR. KEANE: And then you could look at the trending. And then we up -- I think you requested that we update this sheet with some of the excavation results themselves, so we tied all that into it also. We put in the excavation date, the length, the depth, the feature type itself. So, if it was crack-like, if it was an SCC, you can see here -- so was it crack-like, was it SCC, was it more notch-like, so more of a manufacturing, more of a groove-like feature.

Actually metal loss and some sort of an inclusion feature. Like a stringer, lamination type features. Or some sort of geometric reflection off of a weld cap or something to that effect. Or was nothing found.

And then the repair method. So, was it ground, was it re-coded or was it sleeved.

So --

UNIDENTIFED SPEAKER: Does the field identify the defect that wasn't reported? Would those be lines inserted in a spreadsheet like this or something totally different?

MR. KEANE: No. So, if false -- we call those false negatives, yeah. And if there was a false negative feature, they wouldn't show up in the spreadsheet because this spreadsheet was intended to be derived from the USCD program itself; like it was focused on the features. We absolutely track those false negative features and I'm sure we've provided trending that we can talk about all that stuff. So, if I have trending here, we can certainly talk to that.

UNIDENTIFIED SPEAKER: Speaking of the unit plot?

MR. KEANE: Yeah. Precisely. Like a depth unit plot. Found something in the field that the tool should have reported to you, where did it fit and how did it look, yeah.

Additional commenting, so, you know, corrosion at the weld toe with intimate and shallow cracking and whatever the more specifics of the features themselves.

And then based on --

UNIDENTIFIED SPEAKER: Is this filled in by the analyst? All these columns? So, he'd have to go to a general report.

MR. KEANE: Yeah. Precisely. So, all of this information is filled in by Enbridge engineers who have gone through and pulled all of this information out of the end-of-year reports. And that's our process. That's what we do.

UNIDENTIFIED SPEAKER: But is the person in the crack department, not logistics?

MR. KEANE: That's correct. That's correct. And we also hire consultants to do this work. There's a large volume of work so where we've used consultants, it's been groups with -- with vast experience in defect assessments so we've used D&V. And at times we've used HM Pipelines. So, that's it.

MR. CHHATRE: Some are green, why?

MR. KEANE: Absolutely. Yeah.

MR. CHHATRE: Different requirements?

MR. KEANE: Yeah. We have very strict requirements on how that trending work is completed and the observations related to it. And for a number of years now we've actually hired D&V to come in and do a two-day defect assessment training for us because

D&V has a vast experience in defect analysis fitness for purpose calculations.

So, they come in and they train us. And then whenever we get them to do trending for one of our programs, then we make sure that they're using our templates and our spreadsheets and we talk about everything that they see. Yeah.

Because the trending for crack programs requires expertise. It requires individuals to look at not just what the analysts are -- pardon me -- not just what the technician reported, but to look at the photos and to look at all the information because you can't distill crack just down to length and depth, necessarily. Sometimes it's the length and it's a depth. And it's centerline. There's a whole bunch of stuff going on. So, you need to make sure that you're not missing pieces of the puzzle.

We found that D&V's been really good for that. But, so -- I know that the training that they've been providing us, oh, for a number of years now, the defect assessment training, has been valuable for us so -- And then --

UNIDENTIFIED SPEAKER: Column AM, I didn't hear. CorLAS predicted failure pressure.

MR. KEANE: Yeah. So, --

UNIDENTIFIED SPEAKER: This is based on field data.

MR. KEANE: That's exactly what that is. So, it's using the field information to calculate a predicted failure pressure.

And there's the sub-text to it that says, “Best available field data.” That's not really necessary to say that, but the intention is there that they don't necessarily -- we try and obtain precise field information, as precise as possible, so if ideally we want to understand what that crack morphologically is all along the length of that fault if possible. And so if they can obtain that within ultrasonic sensors, then they document and we'll use that profile within our determination of CorLAS -- of fitness for purpose.

UNIDENTIFIED SPEAKER: Is that then brought in at a reassessment interval?

MR. KEANE: Absolutely. It does. For sure. Yeah because --

UNIDENTIFED SPEAKER: It trumps all the other (indiscernible).

MR. KEANE: Yeah. Because if you develop the unity plots and that unity plot says that, well, based on all these observations, these features were deeper in the field than what ILI said, then that's the bias and that bias comes right back into the fatigue analysis.

UNIDENTIFED SPEAKER: Well, now it does. It wasn't then, though.

MR. KEANE: Now. That's right. Yeah.

UNIDENTIFED SPEAKER: Yeah. But back then --

MR. KEANE: And so our -- we've recently gone through documents to even add that into our dig criteria so to even dig more. But that's now.

UNIDENTIFED SPEAKER: Right. That's all now.

MR. KEANE: Yeah, so -- But we know looking at the -- that all the trending of all the data -- and there was 120 plus digs done on this dataset, so very, very large number, a good number of digs, that the worse bias we observed for this depth bin was -- was it nine percent. And then when we add that to the fatigue analysis, it wouldn't have made us get there earlier.

UNIDENTIFED SPEAKER: Okay. So, this wins out, then?

MR. KEANE: This wins out.

UNIDENTIFED SPEAKER: Regardless of the values, more conservative, less conservative.

MR. KEANE: Yeah. Well, whatever's more conservative wins. So, if we add -- if tool --

UNIDENTIFED SPEAKER: Not now, then. Not now. Without the bias.

MR. KEANE: Right.

UNIDENTIFED SPEAKER: This column AM?

MR. KEANE: Yeah. That's correct.

UNIDENTIFED SPEAKER: So, even the bias in the next one, calculating the fatigue life for the ruptured joint or the defect, not the rupture, but location, we're still getting a seven year charted inspection. So, then we have rupture in five years so is there still something in the process that, you know, we're missing?

I mean, we still have that two-year window that predicted failure over the -- even with the two -- the factor two safety factor, still two years short of the predictability.

MR. KEANE: That's precisely why we've been changing our processes to try and -- until that answer is that, we've put additional conservatisms on several points to make sure that that's been captured in different ways. So, that's --

UNIDENTIFIED SPEAKER: So, there's maybe an indication that the fatigue life calculation may not be the best calculation for that type of feature? Or are there maybe limitations in how the rupture pressure is calculated or the fatigue life is calculated?

MR. KEANE: Yeah. So, let's explore each of those a little bit.

From the way the rupture pressure's calculated we know that -- you can see on the plot in front of you that our critical depth is not nearly as deep as what it truly was. So, CorLAS has been validated through a number of activities. We can pull up some examples of that over time. There's lots of examples there; published information.

And so the way we use CorLAS I think has been shown to be conservative, even just through the simple observations of that graph.

You asked about the way that we're calculating our growth rates, well, clearly it comes down to it's either the tool -- maybe the tool undersized it or maybe the growth rate wasn't there but somehow we didn't get there in time. Which one was it? I don't know, so we're changing both. We're changing the way we deal with both right now and moving forward with that.

What we can say is that our processes wouldn't have got us -- our existing processes were followed. We certainly didn't intend to dig it. Our processes don't suggest that we should have dug it. Even when we look back at things, we're not seeing a, "Oh, geez, we really missed something." And we've looked pretty hard.

So, we've added conservatisms along the way now; additional ones, till we can figure this thing fully out.

I know GE's talked about, well, maybe they would have called it a crack field with a long indication of 3.5 inches. That would have met our excavation criteria right there. So, there's lots of discussions that we had around that.

We've considered it from an SCC growth perspective, too, because at the time we didn't grow it by SCC. Our experience has always been that fatigue won through hands down. And so we wanted to be conservative, we're growing by fatigue and we're going to assume that SCC is growing as fast as fatigue could. And when we look back at the SCC calculations, they're not -- it's not suggestive of that our processes in place were not aggressive enough from a growth modeling perspective.

We talked about trending quite a bit. Well, a little bit. There's lots of trending. Lots of charts. And I'm sure you've seen a million of them, but there's one on -- we can see the -- for the 12 and a half depth bin to just look at the trending for that one specifically looking at all the data that we had.

And the trending almost suggests that as the features get longer, that the trending becomes more precise. That the tools of -- and that would make sense, right? Because the feature's longer, they get more chances to shoot the darn thing -- or hit the thing at the right amplitude so we got that trending. This was a long feature.

UNIDENTIFIED SPEAKER: So, this graph here that you've given us. This has been calculated as SCC? Is that what it is?

MR. KEANE: No, that's fatigue.

UNIDENTIFIED SPEAKER: That's strictly fatigue?

MR. KEANE: That's fatigue. That's trying to -- that's trying to understand our processes in place and just -- that's the double-check of, is there anything that we missed along the way; look at that feature again and just think about that one. It was trying to use the same values that we used.

UNIDENTIFIED SPEAKER: But you also have a CVM of 15-foot count for this count here, right, which deviates from what you've got on this 2005 sheet.

MR. KEANE: Right. The 15-foot pounds would have made it rupture at a lower pressure, right.

UNIDENTIFIED SPEAKER: Take it to another level.

MR. KEANE: Yeah. That's our current process. Our processes currently have us -- with the absence of better information, we use five foot pounds toughness for flash weld or NCRW seams.

And we use 15 foot pounds for DCR base metal pipe. And of course, then, that's in the absence of that information. We have better information for lots of our lines where we've gone through, cut-outs and metallurgical investigations. So, that feeds into the analysis.

And, of course, we want to use a conservative estimate, a lower bound conservative estimate, for predicting critical depths when considering how deep a flaw can grow to. But you want to use the opposite if you're belt calculating from a hydrotest to see how big things could have been, right? So, we've learned not to be non-conservative.

UNIDENTIFIED SPEAKER: So, when, I guess, looking at, you know, potential limitations on the fatigue life calculation, and knowing that our failure at this location was an SCC, or potentially an SCC, I guess, consistent with an SCC, would -- I guess -- and I'm looking at the crack management plan and the reassessment data that we now have a column. There used to be just depth of the unmitigated crack and then you had the fatigue life; I added a fatigue life column. But there's no SCC column?

Is there a reason?

MR. KEANE: There currently is a -- within our processes, we do both now. And we were -- we almost got there for that first process document we're looking at. And so while the Appendix A doesn't describe it, it's both. So, the defect dimensions that you see in that Appendix A, are the same ones we use to grow our flaws via SCC. And that's post 2010. So, post (indiscernible). Yeah.

UNIDENTIFIED SPEAKER: Right. Right. But you don't have a column in Appendix A to say, well, for an SCC crack, you know, here's the expected remaining life of -- with these applied growth rates, or --

MR. KEANE: Yeah. It's -- let me -- that's tracked (indiscernible) a US line.

So, we have a SCC growth thread analysis for each. And so we don't do it -- we don't do this calculation. We bring it to a consultant to have done and we bring it to D&V. And we can walk through that process here. But what we do is -- so, you'll see a (indiscernible) pump station.

UNIDENTIFIED SPEAKER: Could you do it for line 6B?

MR. KEANE: Well, I'm not sure 6B's been done because 6B's almost to the -- at this stage, it's kind of a unique case. We've got a million calculations for 6B from an NSCC perspective but I don't know if it's calculated -- shown in this format, but I can check. All the calculations --

UNIDENTIFIED SPEAKER: Drop down there.

MR. KEANE: Yeah. 6B's almost a bit of a unique -- as you can imagine, it's still being treated with a lot of calculations.

UNIDENTIFIED SPEAKER: Do we want to maybe break at this point? Why don't we go off the record here and stop this interview at this point.

(Off the record.)

(On the record.)

MR. NICHOLSON: Okay. Back on the record, Part 3, Sean Keane interviews, crack management.

BY MR. NICHOLSON:

Q. Okay. I can't remember where we left off. I think we were going to get into another spreadsheet. Can you --

A. Sure.

Q. -- kind of tell us what we're doing and looking at?

A. Absolutely. So, we were talking about our SCC growth calculations and I don't know how we -- we sort of bypassed a few steps along the way. We didn't talk about how we calculate them, but rather just the results of it.

UNIDENTIFIED SPEAKER: Go back in time.

MR. KEANE: So, is it worth going back a little bit? So, this is once again --

BY MR. NICHOLSON:

Q. Yeah, probably -- go from the beginning.

A. These are growth calculations that we're doing post-2010 incident. We weren't doing these same calculations prior to the incident, so --

UNIDENTIFIED SPEAKER: You had not?

MR. KEANE: That's correct. We were not.

BY MR. NICHOLSON:

Q. You weren't doing them at all?

A. We were not doing these same calculations at all prior to the incident. The fatigue -- all the previous calculations we were.

Q. Even if the characterization was a cracked field?

A. If it was a cracked field then we assume that it was growing -- we modeled it using all the Paris law equations and everything.

Q. Oh.

A. Yeah, we grew it as if it was growing by fatigue.

Q. Oh, okay.

A. Which has been --

Q. I didn't realize that.

A. Which has been -- Enbridge's experience has been that SCC has been the dominant mechanism over time. We had never had an SCC failure. They've always been fatigue related. So, based on all of those observations and everything that we've been doing, our, our growth constants that we've used within our Paris law equations were how we were capturing the more aggressive of the two. So -- and so, what we'll see here is that when we've gone back through the system that, that we haven't been missing something along the way when we're looking the SCC growth calculations, so.

So, let's start back at our process document PI-41 for crack ILI interval determination. So, we walk through the first portion of that document about -- describing how we use the, the pressure data from our SCADA systems and how we calculate fatigue growth calculations and how we set or determine our, our fatigue and re-inspection intervals based upon those fatigue growth rates, so including safety factors.

When we look at the, the SCC side of the equation now, it's -- we captured it from the same document and this is the edition now that, that wasn't in the previous sample. And it describes the -- a loading rate approach to determining SCC growth. And this has been developed through -- through a series of research projects and lots of industry learnings and through PRCI and other companies. And it's based upon work that John Beavers has done at DNV out of Columbus, Ohio. And --

Q. What exactly is based on all this? The SCC growth rate?

A. Well, the growth calculations --

Q. The calculations?

A. Yeah. Yeah. So, the growth calculations -- it's -- we can walk through the specifics of the calculations themselves, but it's largely -- it's based at the crack tip strain rate and a growth per cycle, much like a fatigue calculation. So, it's based at the crack tip strain rate though, so it's a little bit different. It follows a slightly different equation for growth and it's a little bit more complicated in some ways. It's not as -- and it's not -- currently there's not a software off the shelf that you can buy that has these equations within it, so we go to DNV to have them perform these calculations for us for all of our pipelines right now.

BY MR. CHHATRE:

Q. This is Ravi. Sean, you said that Enbridge never had a failure in the past involving SCC.

A. Solely SCC failure, that's correct.

Q. And does that mean you like have some kind of combination with SCC or -- who did your failure analysis in the past? Are there reports -- there is no SCC?

A. There's been a number of reports done. NTSB had one back in the Cohasset timeframe and NTSB and --

Q. Oh, I mean I thought you said you never had experience meaning besides what NTSB did in the past.

A. Correct. And so, when Enbridge looks back at all of our failures there hasn't been an SCC failure. There hasn't been one solely attributed to SCC. Now, like I indicated earlier, we've had fatigue failures where there has been an environmental component to them. And that -- the contribution of that environmental component is -- has been accommodated or accounted for through the -- you know, maybe it was corrosion fatigue or maybe it was purely fatigue. I don't know, but they've -- we've used the Paris law equations to account for that synergistic effect between corrosion and fatigue.

So, that -- so if there was a corrosion fatigue that may have existed or a mechanism that existed it was captured through the higher growth -- through the higher constants used for the C&N values.

Q. But are the reports of the investigations there done by your consultants?

A. Correct, yes.

Q. Now, how many we are looking at roughly? I mean are you talking about like 10, 15 ballpark?

A. Yeah, something to that -- in that ballpark. There's not a lot.

Q. Okay.

A. Just thinking through -- yeah, something to that effect.

Q. And these are kind of -- does somebody have the report that we could take a look at real quick?

A. I don't -- I'm not aware of an executive summary that's put together for that.

Q. So, we'd have to look at the entire report?

A. Yeah. Yeah, we'd have to pull it together. We've -- I mean we've done so as part of other line specific activities, so it's -- yeah. But I guess the net conclusion of all of that is that we've just never seen SCC grow to failure in our pipelines, so --

Q. Do you, do you recall what the mechanisms were --

A. Yeah, the mechanisms have largely -- and I say largely because there's a few things -- but been fatigue driven, so it's always been a fatigue propagation mechanism, you know.

MR. CHHATRE: Maybe we should look at those.

MR. NICHOLSON: No, I'm not sure what you two are referring to. We have the Canadian Transportation Safety Board in which a large number of them were Line 3 failures that all seemed to be corrosion fatigue or environmentally assisted. Some actually said that they were SCC --

MR. KEANE: There's that fatigue and a corrosion. Well, I haven't --

MR. NICHOLSON: Well --

MR. KEANE: Yeah.

MR. NICHOLSON: -- the SCC was the initiator and maybe not the final -- but I'm not sure which reports you're referring to Ravi.

MR. CHHATRE: I guess -- I know you're saying the past failure they haven't SCC and their failures are investigated by consultants outside --

MR. NICHOLSON: Okay.

MR. KEANE: You're right. So -- and I think the key point is that within all of those failures that the growth rates

-- that Enbridge has applied growth rates using fatigue or corrosion fatigue, so the C&N values have been bumped up to accommodate those types of things.

MR. CHHATRE: Okay.

MR. KEANE: Okay. So, PI-41 includes the precise strain rate calculations that DNV performed for us. They still use the same pressure spectrum analysis that we do for fatigue, so they still -- it goes through a rain-flow counting and -- mechanism to understand where the peaks and values within the pressure data lie. And then they apply that to starting flow sizes and they grow it over time. So, in a lot of ways it's very much like our fatigue growth calculation.

BY UNIDENTIFIED SPEAKER:

Q. Now is that -- when it, you know, it's calculating a crack tip displacement rate, is that dependent on the rate at which the pressure is applied on these pressure cycles?

A. Yeah, precisely. So, not only do we now capture the peaks and valleys, but we capture the delta T between -- or for that half-cycle to occur.

Q. Okay.

A. Yeah. And Enbridge has -- that's consistent with our understanding also. When we've gone back in time we've played with looking at -- looking at our pressure data and trying to find those observations within it to correlate back with our -- with our failures, with our deeper cracks, with our SCC populations.

And what we were seeing is that we saw some correlations with that pressure data for sure.

And we played with -- instead of using rain-flow counting instead to look at -- find log rhythmic changes and loading rates or -- because if the pipeline kind of slowly increases pressure for a period of time and then pressure's up shortly, well, within rain-flow counting that's all just one portion of a cycle. But we broke that into sub-cycles and then applied growth rates differently and played with all that and there -- we did -- there has been IPC and PRCI research on that, papers. So -- but currently, this is sort of industry's leading method for calculating SCC for -- SCC. So, that's what we're currently applying. And I guess that's the intro into the spreadsheet that's here.

BY MR. CHHATRE:

Q. So, what -- for fatigue or for -- this is Ravi -- for SCC, how do you -- amplitude? I mean, if you back to your graph here --

A. Yeah.

Q. -- what is the amplitude of the cycle? I mean if I look at the traditional way of looking at fatigue and average pressure going up and down that's a cycle.

A. Yeah.

Q. Here it looks like your amplitude -- is going to change, is that right?

A. That's correct.

Q. Is that what you're doing here?

A. That's correct. And for fatigue and SCC, so the amplitude is a function of that cycle itself.

Q. How will that change if I say my pipeline is operating at 600 psi?

A. Yeah.

Q. And I'm getting -- fluctuations from 610 to 520?

A. Yeah.

Q. Now the amplitude is going to be different once I verify 520 as my steady state.

Q. We don't -- we don't call something a steady state. So, unlike a gas pipeline that tends -- does tend to operate fairly steady, within the liquid system in order to -- just for day-to-day operations within the liquid system the pipeline and pressures fluctuate substantially differently than a gas system. So, much like the graph that you drew on the bottom left hand side of the board that's probably more -- pertains more to the way we operate. It's that -- it can be that varied at times, so there's no -- we have an MOP we have stay below. We have a normal that we tend to achieve and then we have a -- everything else. And everything else just -- we just assess it all.

Q. So, you don't try to run the pipeline at a steady state --

A. Oh, absolutely we do. That's not what I was trying to imply, sorry. But rather that when we're assessing the pressure data we assess whatever was operated. So, we don't do deltas from a -- from an anticipated normal pressures. It's just --

Q. I can see that, but if you're running it -- trying to run at a steady state, right. So, how it can be anticipated? I mean if you try to run the pipeline at 500 psi --

A. Yeah.

Q. -- then you still anticipate it at 500. If you move from 500 to 510 or 420, you are fluctuating around 500, which is what your goal is.

A. But none of that -- sorry. That doesn't relate to how we actually work with that pressure data within the calculations. So, within the calculations we just look at what was actually achieved.

Q. What I'm missing here is this kind of logic --

A. Yeah.

Q. -- you're not really giving any thought to a crack closing. Do you see what I'm saying?

A. To crack closure?

Q. Yeah. If you -- in your case the crack is always constantly opening, whereas in real life you are trying to maintain your 500 psi then you go 420 and then go up to 520. At 520 you are closing the crack -- there's a crack closure. And does that factor -- is that factored into your calculation?

A. It's --

Q. See, the way I see your monitoring is your crack is constantly opening, opening and closing, opening and closing, whereas it doesn't remain continuously closed if I was looking at a higher pressure than my -- code. Do you see what I'm trying to --

A. I think I understand your -- so there's -- the last I read there was about seven different mechanisms for crack closure and how they influence fatigue and there's handful of the opening and all the different mechanisms associated with each. And you're asking about the crack closure and how is that accounted for within the Paris law?

Q. In your -- calculation -- growth rates?

A. So, I think maybe the best way to answer that is to say that all of those effects are wrapped up and bundled into the empirical calculation or empirical curve fittings that sit under the Paris law equations, the constants.

Q. I'm not sure I understand the -- I'm thinking -- right? There seems to be -- there's a lot of buzz words, but it doesn't tell me how it is included in the calculations you're talking about, which is empirical to begin with. Right?

A. Yeah.

Q. It's not a mathematical thing that -- the other factors would be included in there. If it's empirical and you're saying all these are bundled up, I don't understand how they are bundled up. It may be, but --

A. Yeah, so when I say bundled up the C&N values for crack growth rate are derived using -- that their curve fits, right? So, they're -- the material -- they're measured parameters that fit back to the Paris law equation, so -- right?

Q. Yeah, but see --

A. So, as such crack closures -- those tests are derived using pressure fluctuations, right, actual delta P over time and you grow a crack to whatever point, you measure it, and you calculate the growth rate. And you --

Q. Your delta P can be in a crack opening more all the time or it can be in a crack closed all the time. In other words, if you happen to maintain a pipeline at 500 psi --

A. Yeah.

Q. -- and if I constantly stayed at 520, 530, 540, 560 --

A. Yeah.

Q. -- in your way of thinking you would -- your average pressure on a neutral line would be like a curve rather than a straight line. So, your cracks are opening, closing, opening, closing. Whereas the way I'm describing it will be constantly opened up, which -- more interaction with the environment. Or I can be below 500 and my cracks really are closing.

A. Right.

Q. So, how does the fluctuations matter?

A. So --

Q. So, that is my -- I have a problem understanding the logic in this model.

A. Okay. So, the --

MR. NICHOLSON: And just -- so your concern is that we're at a constant pressure and the crack is open? External conditions can --

MR. CHHATRE: Well, environmental interaction is significantly higher.

MR. NICHOLSON: As opposed to growing?

BY MR. CHHATRE:

Q. No, it has closing and opening. See, where my crack is closing and opening my environmental interaction is not as severe as when my crack is constantly opening and I'm constantly putting pressure to keep it open. This -- then becomes extremely active corrosion wise. Whereas if I'm closing and opening it is not as active as it will be with the environmental interaction. Plus, I don't have that much environmental interaction when I'm closing the crack as I had opened, so -- and that -- consider then to think how that's incorporated in this model.

A. So --

Q. And maybe -- I don't understand.

A. So, within the fatigue model, not necessarily because the max -- the P max of any given cycle doesn't influence the growth. It's independent of that fact. Within this model you can see that there is -- that is accounted for, so here R is the minimum pressure over the maximum pressure for any given cycle.

And then K max is the maximum of the maximum K for that given cycle, so that's where it's accounted for. And then F is the frequency, the time interval. So, within this model it's accounted for. So, it's not just R like -- right?

Q. Okay.

A. Yeah.

Q. I thought --

A. Yeah.

Q. I'm not sure I understand --

MR. NICHOLSON: Say that one more time. R is the --

MR. KEANE: So, R is the -- yeah, the --

UNIDENTIFIED SPEAKER: Max to min?

MR. KEANE: Yeah, the minimum stress over the maximum stress. Yeah, so an R closer to 1 is obviously closer to steady state.

BY MR. CHHATRE:

Q. And, you know, maybe things have changed since I -- this particular part of corrosion, but I thought for most stressful impacting tests, the V-notch --

A. Yeah.

Q. The stress on the sample is always -- always opening it up. You don't do the stressful impacting test where your crack is closing and opening. And here you are saying you have to go through a cycle, a cyclic stress.

A. Right. Yes, when you -- SCC.

Q. So, that's what I'm --
A. Okay.
Q. -- trying to understand. The studies I have seen in the past, the stressful impacting tests were always typically -- V-notch and the stress is constantly --
A. Yeah, like a --
Q. -- reopening and then --
A. -- a slow strain rate test.
Q. And so, it's not closing.
A. Yes. Yes.
Q. You are telling me so under those conditions I should never get -- then how -- what kind of tests are being done to do this kind of work?
A. So, you're quickly going over my head from a testing mechanism perspective, so --
Q. Okay.
A. So, I don't want to speak beyond my abilities, but --
Q. No, no --
A. But I do know from the -- the results of the research are that you do need that cyclic component, so --
Q. Okay.
A. -- for SCC -- for growth.
Q. As it relates to the --
UNIDENTIFIED SPEAKER: And that's kind of -- that's more predominantly reflected by the R value in that equation?

MR. KEANE: Right. So, the R value is the minimum -- minimum pressure divided by maximum pressure. And then the K max -- K max is the stress intensity associated with the maximum pressure for that given cycle.

UNIDENTIFIED SPEAKER: This -- on this one.

MR. KEANE: Okay.

UNIDENTIFIED SPEAKER: You're saying K is -- under the Paris law is the crack intensity factor?

MR. KEANE: Correct. It's the -- well, it's the stress intensity factor, yeah, K max.

UNIDENTIFIED SPEAKER: Oh, okay. I'm sorry.

MR. KEANE: That's okay.

MR. KEANE: So, the results -- so we've gone through our system and I'll relate this back to a few things here. So, just for ease of walking through -- so, for example, in line 1 there is -- let me get this open. This might not be the right -- these values, these maximum -- crack, we've used the same types of flaws and calculated fatigue -- or pardon me, SCC lives not just for just that one flaw but for a series of them and only right at the pump station.

So, we've looked at our unexcavated ILI features, we've added the tolerances based on tool -- our trending or ILI potential uncertainty and then we've grown flaws. So, in this example you can see that --

UNIDENTIFIED SPEAKER: Is this in your way?

MR. KEANE: Oh, not at all.

UNIDENTIFIED SPEAKER: Oh, okay.

MR. KEANE: So, we've got -- here's the one station that's showing up right here. We've got -- here's our worst cycling quarter that we've used, our OD graded wall thickness, and then this is the deepest unmitigated crack-like or crack field feature. So, we've taken both -- we grow growth datasets, crack-like, crack field or notch-link too -- and we just grow them out. And so there's a series of wall thicknesses and depths or whatever the combinations might be so that we can understand this SCC rate and -- where it's sitting. And then we also look at the longest unmitigated crack-like crack field features because we're -- we're trying to just go through the system real quick for that check to see where we're -- where everything's at, but these aren't specific features themselves.

These are combinations of all the unexcavated features that could exist right at the -- we'll assume it exists right at the com station discharge. And then we'll grow them to see what sort of growth rates we're getting and then compare it with our current planned assessment intervals to make sure that everything's aligning.

BY UNIDENTIFIED SPEAKER:

Q. In that current plan the interval is based on the fatigue analysis?

A. Correct. Yeah.

Q. Has this type of SCC analysis been done on the feature indications on the 2005 at the rupture location?
A. Yeah, there's been quite a bit of analysis related to this and variations thereof, so --
Q. And what were the results of that analysis?
A. Similar to the fatigue side of things, but with slight variations along the way.
MR. KEANE: So, once again that work was completed by DNV for us and -- and so, what we can show you here is --
MR. PIERZINA. Have these been provided, Sean?
MR. KEANE: No, no.
MR. PIERZINA. Okay.
MR. KEANE: Well, I don't know to be quite honest, Brian. So, if they haven't been and you're asking for them then ask for them and we'll provide them. I think Matt might have mentioned that we have completed some additional internal assessments, but we're -- we can share them, but we also don't want to bias the investigation by any means, so --
MR. PIERZINA. You would not.
MR. KEANE: So, from that respect -- yeah, so I guess that -- that's not the intent, so what we have is -- so there's two variations here. There's one working forward and there's one working backwards. And so the -- and you can imagine based on everything that -- back up a step -- so for every month we did a fracture spectrum and took a look at the data and calculated new

growth rates for that failed material. So, starting at -- this one was starting at 25 percent. We're trying to figure out how deep would it grow over -- so using the deepest divider SCC or fatigue is hitting at, you know, less than 30 percent deep.

Now, what we're seeing here is the contribution in red is -- S is fatigue and the blue contribution is SCC. So, as you'd expect for those shallow flaws the SCC does have -- it does dominate. And that only makes sense because if the crack was very, very shallow fatigue would say it's never going to grow, but we know that SCC will grow. And SCC is an -- pardon me, fatigue is an initiation and propagation mechanism. But that initiation and that initial propagation takes a long time, so this shouldn't surprise -- this doesn't surprise me that SCC is dominant at the shallower depths.

MR. CHHATRE: So, you're saying small cracks would not go that deep?

MR. KEANE: Oh, they will, but it'll take time.

MR. CHHATRE: Okay. Okay.

MR. KEANE: Right? So, the curve become kind of flat over there.

MR. CHHATRE: Okay. Yeah.

MR. KEANE: But absolutely, they --

BY UNIDENTIFIED SPEAKER:

Q. This is a 25 percent defect?

A. Right. So, this is starting based on 25 percent.

Q. Okay. And then how long --
A. Around 51.6 inches.
Q. 51.6. Okay.
A. Yeah. So, the calculated depth after five years -- growth is less than 29 --
MR. KEANE: But we also wanted to work backwards because the final depth was closer to 80 percent. So, if you went 80 percent and worked backwards you'd -- you can see now that the fatigue growth is dominating plus it's getting deeper. Very similar along the way, but, you know, at times it's still -- it depends on the pressure cycling. If the cycling is so light like our Line 6B has been then the SCC does dominate, but for lots of it they're very, very close, right? It's a little bit of that, little bit of this, and certainly as it grows deeper then --
MR. CHHATRE: On this --
MR. KEANE: And so -- and I guess this -- sorry, Ravi. I didn't mean to --
MR. CHHATRE: No, no --
MR. KEANE: Just the -- so if you work backwards though you'll end up with a depth of closer to 50 --
UNIDENTIFIED SPEAKER: So, at each one of these points you're taking whatever's the highest contributor?
MR. KEANE: That's correct.
UNIDENTIFIED SPEAKER: And so, it's essentially for -- to get this failure location here with these calculations it's

going to -- if you back calculate it, it would be 60 percent, which would be way outside of the bias.

UNIDENTIFIED SPEAKER: It would be way outside of the bias.

UNIDENTIFIED SPEAKER: Now, what if -- well, I guess, you know, if we do --

UNIDENTIFIED SPEAKER: And that's -- that's assuming -- that's assuming a 51 inch long defect, right, which we know --

MR. KEANE: Well, this one --

UNIDENTIFIED SPEAKER: Well, this one says 54.

UNIDENTIFIED SPEAKER: Oh, 50 -- right.

UNIDENTIFIED SPEAKER: Long, long --

UNIDENTIFIED SPEAKER: Yeah.

UNIDENTIFIED SPEAKER: Well, it was a long defect, right?

UNIDENTIFIED SPEAKER: The 54 is from basically taking the lab work? Or how is that defined?

MR. KEANE: The 54 was -- I want to confirm that dimension.

UNIDENTIFIED SPEAKER: Oh, and the 196 inch wall that reflects the megawatts?

MR. KEANE: Correct. We're trying to stack everything up there. So --

BY UNIDENTIFIED SPEAKER:

Q.   So, what does this -- does this tell you that, gees it's

-- you know, it doesn't match the curves that we're trying to use? Or does it, you know -- you know, there's --

A. My opinion is that what this tells us is that there's probably a component of growth and tool undersizing. And I don't know the weighting of either right now. I know how we've accounted for both right now within our programs and we've looked through the rest of our systems, but we're hoping that the metallurgical analysis can help is with one of those two answers.

Q. Well, what about taking, you know, the work that you're doing and start -- you know, back -- you got -- you know the endpoint.

A. Yeah.

Q. It's about 80 percent. And let's say you know the starting point, the, you know, 19 percent or whatever --

A. Yeah.

Q. -- whatever you think it is, and fit that to the Beavers equation and adjust your --

A. Yeah, we -- certainly we've looked at that too. And what that results in is growth rates that are far beyond what industry and labs suggest should be realistic. So, we know that it's -- that there's something very -- it's probably a combination of the two things going on that the thing's growing really fast, as fast it could possibly could have been, potentially, and the tool had to have had a component in there.

UNIDENTIFIED SPEAKER: And maybe -- but maybe that's --

maybe that's what we're --

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: -- seeing in industry is an accelerated growth -- growth rate given, you know, the environment that's being created under --

MR. KEANE: Yeah. It could be the first one of --

UNIDENTIFIED SPEAKER: Maybe that -- maybe that's the right answer.

MR. KEANE: I can't say it's not, but it would be the first, so -- and there's always a first.

UNIDENTIFIED SPEAKER: Yeah.

BY MR. CHHATRE:

Q. I mean -- was talking -- you're -- your pipeline when you start pumping oil.

A. Yes.

Q. And then having your -- stress -- continuously move doesn't make any sense. I mean one other explanation may be that your -- shouldn't be opening and your environmental action -- a lot more -- than maybe what you are predicting. I mean --

A. Yeah.

Q. The facts cannot be wrong. The theories can be wrong.

A. Oh, I completely agree.

Q. Okay?

A. Yeah.

Q. So, you only have a fact, so we need to revisit and refine the model. And I'm not saying the model is wrong, but maybe it needs refining. But the question I have on this spreadsheet here --

A. Yeah.

Q. -- you only have a critical -- cracking rate -- on that first line fourth column.

A. Yeah.

Q. And then on the very last column if you don't do anything that's your rate, right? And if you don't do anything I don't understand how the rates can be smaller in some cases. So, it looks like you're better off not doing anything, if you --

A. Sorry. Which of the two here? This -- for example, this number and this number?

Q. If I look at this number --

A. Yeah.

Q. -- and this number, right? They're they same. If you don't do anything --

A. Oh, no. These are two different flaws. This series of flaws coming down, these are the deepest unmitigated crack-like crack field features. And then this column these are the longest unmitigated crack-like crack field features.

Q. Okay.

A. So, they're different flaws. So, this one -- this one here is 120 thou [sic] but only 3 inches -- 3.8 inches long.

Q. Okay.

A. And this guy is only 80 thou but it's 6 inches long.
Q. Okay.
A. So, there's --
Q. But they will not be the same -- one time it is not constant.
A. That's right, yeah. These are two different flaws that we're checking at that one location, yeah.
Q. Okay. But that what's makes it difficult to compare and I was --
A. Well, you know, it's not -- the intent wasn't --
Q. -- more than two -- only one equation I guess.
A. Right. Well, the intent here is that we're trying to find the most aggressive that it could be and then apply it elsewhere, right? So, that's -- it's is it this one or is it that one? Which one's the bigger number? So, we can have that quick check throughout everything.
UNIDENTIFIED SPEAKER: And so, what does it tell us --
MR. KEANE: Well, for this particular line, which doesn't cycle a lot -- did we switch lines? Did we switch --
MR. CHHATRE: Because -- is critical or depth is critical.
UNIDENTIFIED SPEAKER: So, the greater of those two is used in O -- to get O. Is that what you're saying?
MR. KEANE: Where --
UNIDENTIFIED SPEAKER: The greater of the two rates?

MR. KEANE: That's correct, Matt. Yeah, the greater of the two is used to calculate this one. And then all we're doing is we're just making sure that these numbers aren't close to these guys here because these were our current intervals. So, we just -- we wanted to go through the system and make sure that we weren't missing something along the way here.

UNIDENTIFIED SPEAKER: All right. Have there been any lines that you've done this analysis on where the SCC has become the dominant criterion?

MR. KEANE: No. No there hasn't been. And -- go ahead.

BY MR. CHHATRE:

Q. Also your graph here can tend to indicate that the more offender really should be fatigue rather then the SCC, does it not? The dominant mechanism is showing as fatigue.

A. Oh, no.

Q. At the tail end.

A. Well, I wouldn't interpret it that way. Oh, at the very tail end?

Q. Yeah. I mean, as you move a little bit that way --

(Overlapping speakers)

UNIDENTIFIED SPEAKER: The last --

MR. CHHATRE: As you move to the right --

UNIDENTIFIED SPEAKER: The last four months?

MR. KEANE: Yeah. There's that -- that last portion --

MR. CHHATRE: Well, actually if I could just compare this for any given -- for most of the incidences --

UNIDENTIFIED SPEAKER: Until about here.

MR. CHHATRE: -- this is bigger -- this is bigger than the total.

UNIDENTIFIED SPEAKER: It's kind of about --

MR. KEANE: It gets complex.

UNIDENTIFIED SPEAKER: -- from the middle of '08 --

UNIDENTIFIED SPEAKER: Oh, okay, --

UNIDENTIFIED SPEAKER: -- it's kind of --

MR. KEANE: Well, I like the concept though that you're describing of --

UNIDENTIFIED SPEAKER: -- than your SCC, so your SCC is --

MR. KEANE: But we -- and we have applied that.

UNIDENTIFIED SPEAKER: It's all about --

MR. KEANE: And when we've looked at it, it's just --

UNIDENTIFIED SPEAKER: And then that's kind of a flashing point --

MR. KEANE: But maybe the other way to look at things is to --

MR. CHHATRE: Right.

MR. KEANE: -- to not add all the tolerances and just --

MR. CHHATRE: Almost --

MR. KEANE: -- take it verbatim, right?

UNIDENTIFIED SPEAKER: No.

MR. KEANE: And then see how that looks.

UNIDENTIFIED SPEAKER: Yep. And, you know, and maybe --

UNIDENTIFIED SPEAKER: But it's not what this --

UNIDENTIFIED SPEAKER: -- maybe the --

UNIDENTIFIED SPEAKER: This is SCC for the whole --

UNIDENTIFIED SPEAKER: That's -- calculation here.

UNIDENTIFIED SPEAKER: You know, whatever --

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: You know, whatever --

UNIDENTIFIED SPEAKER: Correct.

UNIDENTIFIED SPEAKER: -- you know, concoction, you know, it's building up underneath that --

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: -- you know, is that aggressive, you know, over time? So, it's not a -- you know, it's not a linear thing. It's kind of like a fatigue growth or something.

MR. KEANE: Yeah. So, I haven't seen a lot from the metallurgical investigation, but I did see a few of the photos. And those growth rings are -- those are unique I would -- from my experience with SCC, so I don't know. Is there something different there? Can those tell us something about time periods? I know that was something that we're hoping one day we can learn, so --

BY MR. CHHATRE:

Q. And you -- just on the same topic, just what we discussed just before the lunch, on the initiation locations.

A. Um-hum, right.

Q. What can you tell us about that? How many are ID initiated? How many are OD, either fatigue or SCC?

A. Um-hum.

Q. And where do they initiate?

A. So, the cracks initiate at -- well, there's two different mechanisms, right? So, if it's fatigue then what we see is that they can initiate at -- at the ID, at the weld toe, or at some form of a local stress concentrator. And there's lots of different forms of those, but -- but largely they occur at a manufacturing -- otherwise acceptable manufacturing flaw, right? So -- and that can be ID, it can be OD, it can be center line of well, it can be at a local gouge in a trim mark --

Q. In a base metal?

A. Yeah -- all over -- there's a myriad of places for it to initiate from a fatigue perspective. From an SCC perspective it's -- you know, near neutral pH SCC is -- obviously it's -- the environmental components needs to be there so it's external. And we see cracks right at the toe of the weld, of a D cell weld, we see those sitting up there. And that makes sense because that's a local stress concentrator. And then also we see them initiating within the base metal themselves.

Q. So, you see both SCC and fatigue initiate in OD and ID?

A. Well, not SCC on the ID.

Q. Not SCC on ID?
A. Very rare. I have only heard of one instance, so --
Q. So, ID are all fatigue?
A. Pardon me?
Q. ID initiated failures are all fatigue?
A. Yes. Yes. Or in those very rare cases it's a manufacturing flaw that has failed due to a pressure test or something, yeah.
Q. So, the historical data kind of shows that?
A. Industry experience too, right. Yeah.
Q. And those -- initiated fatigue on SCC where does that start typically?
A. Initiated SCC, where?
Q. Yeah. I mean have you seen --
A. So -- yeah, we see -- we see SCC within very, very shallow metal loss. And when I say shallow I mean lots of inspectors would say that there's no metal loss there. There's just a surface roughness to it.
Q. Yes.
A. We've also seen SCC, a little crack at the bottom of a corrosion bit or a corrosion shape, so -- so we'll see it at both locations.
Q. Okay.
A. Yeah.
Q. So, I mean how -- then I guess my question is if you

start at corrosion -- corrosion of some form.
A. Yeah.
Q. Look in shallow bed, big bed or -- if you would.
A. Yeah.
Q. How do you then interact with the corrosion -- I mean they are not -- they are not in one umbrella. They are different entities. You are in charge of --
A. So --
Q. -- cracks and somebody is in charge of corrosion.
A. Right.
Q. And where is the interaction and where is the common --
A. So, we -- while we both have -- under the planning groups, the corrosion and crack and mechanical damage and others, we do definitely have our own areas of science that we apply, but we certainly will work cross-functional within our groups, so -- so there's lots of interaction between the teams. Where the corrosion --
Q. In what way?
A. Sitting down to talk about and discuss their dig programs and what they're seeing on their pipelines, understanding if they've got a corrosion, are they seeing cracking, within their reports. But we look at their reports and we take their trending, like literally, if there's a -- we don't really do corrosion digs. We just do digs now. And so, we'll take that dig report and we'll look for cracks within it, but that's -- we call that

opportunistic excavation. We'll take that opportunity -- those guys did.

Q. Do you guys -- you know, people from your group?

A. Yeah.

Q. Do you able to go to these digs and actually observe the pipe?

A. It's not -- yes, we do, but it's our field ME are our eyes and ears. So, we work very closely and we select our field ME so that they are our first line of sight out in the field. So, they're -- they are the ones communicating back to us what they're seeing and that comes back in through -- to our groups.

Q. So, do they identify the crack as being at the bottom of the (indiscernible) or --

A. Oh, yes. Absolutely, yeah. Within our ME's scope of work, there's a number of exampled drawings that they choose from that -- it looks like this or it looks like that and those are important for us.

Q. How does the -- how do you input in the corrosion mitigation then? Do you give any input per se or that is a completely different compartment, to the corrosion people?

A. Well, within the corrosion mitigation perspective we don't provide input into their mitigation plans. We take the pipe condition based upon the cracked tool information that's presented to us and we run our mitigation programs. And if those programs are concurrent or if they purposely offset each other, then for --

they might purposely offset just from a timing perspective that we want them to be one year this program, one year that program, but they're not -- the corrosion programs don't influence the crack programs necessarily.

Not unless the dig results from the corrosion program find trending or some sort of leading indicator to us, susceptibility has changed. And that would be something that gets tracked in through our condition monitoring, so --

Q. What I have learned so far unless somebody tells me something different, the CP people don't really have much communication from what I've seen so far --

A. Right.

Q. -- with the corrosion people. And corrosion people in different -- are different than crack people, if you would.

A. Yeah.

Q. And to me all three really are needed if you want to get rid of stress corrosion cracking. And if (indiscernible) completely then telling us about cracks starting it appear -- you stop stress corrosion cracking.

A. Yeah.

Q. I mean you had to have three components for stress corrosion cracking. And you can get rid of any one and you will stop SCC.

A. If you could.

Q. Yeah, that's what I'm saying.

A. Yeah, if you could.
Q. Yeah, if you could. Yeah.
A. Yeah, so --
Q. Or you can move them so far apart that you have not really eliminated them, but you have eliminated the (indiscernible) --
A. Right.
Q. And then you have stopped SCC. You don't necessarily have to stop any one of them completely.
A. So -- and --
Q. And so, where do all these people -- the CP people? Maybe they are all protecting the pipe -- the hydrogen on the crack there. Maybe. Maybe not --
A. Yeah.
Q. And who does this coordination?
A. So, the -- well, from the CP side of things the -- I think the corrosion groups can speak to that more precisely, so I'll leave you to discuss that with them.
Q. Right. Well, that's what I'm saying. I mean -- a solution is needed for all three groups working together. You have what looks like pretty decent boundaries.
A. Yeah. The challenge though is that the -- the ability for CP to literally suppress corrosion on a PE tape line is so --
Q. I understand.
A. Right? So, challenged.

Q. I'm not going to give you any argument on that.
A. Yeah.
Q. But where I'm coming from is, if you eliminate your pitting you have stopped SCC, if you can.
A. Yeah, if you -- well -- not just pitting, but all --
Q. Corrosion.
A. Yeah, remove the environment fully.
Q. Corrosion completely.
A. If we had perfect coating.
Q. Yeah.
A. Yeah, we would; but we don't.
Q. Now, on the other hand because of the -- coating, this bonding problem, the corrosion group tells me that they are mitigating and monitoring the corrosion with ILI. And that way sort of your corrosion is never going to get stopped.
A. No.
Q. So, under those circumstances you end up calculating the life, but, I mean, you are working around it. There is no resolution to solve or stop the problem.
A. Yeah.
Q. And that's what I want to understand. Is that an effort or this is considered a more practical approach or -- their reason?
A. I think both of what you -- both your answers that you just suggested are the reality of it, that at times it's -- we

need to do a full recoat section or pipe replacement section. And the -- the drivers for that are -- historically have been economic based because doing this many digs is not -- it's just not economically feasible. So, it's more cost effective to go in there and mitigate the same threat, but mitigate it in this fashion,
so -- yes.

Q. All right.

A. Okay.

Q. Right. I mean -- that's the impression I have so far.

A. Yeah.

Q. Another thing was who dictates the cycling? Who controls the cycling of the pipeline, if it can be controlled? I do not know if it can be controlled.

A. Yeah. So, the pressure cycling on a pipeline is a function of just -- of day-to-day operations. And when that cycling reaches a point of having a nosedive down into the more and more aggressive zone then we -- our group raises alarms and says something's going on. You guys need to mitigate that cycling. And we can -- we start to review and find action items on how to control the cycling and take -- run our line -- do what we need to do to ensure that the pipeline is safe.

We actually published a paper on that a year or two years ago indicating the importance of monitoring the cycling so you can flag off and identify those types of events and changes and then be able to look back and try and find ways to reduce cycling a pipeline. Cycling is very -- it's truly very complex and what causes things.

You can imagine, if you have five pump stations within a trap-to-trap section, if you put a cleaning pig over at the start, by the time that cleaning pig gets to the third station and you want to bypass the station, well everything upstream needs to slow down. So, all these -- these other stations are now being slowed down. This one gets bypassed so it sees a bigger cycle. All these other ones see little cycles and so, therefore -- and then that's one -- one pig bypass has now affected all these other stations for one cleaning tool.

So, if you looked at the -- if you looked at the cycling at station somewhere else and you're trying to figure out well, why is it cycling? It's hard. It's complex. Batch size, breakout tankage, pigs, injections, deliveries -- right? But the first step in finding that is what we call pressure cycle monitoring. And it's a valuable tool for that reason plus ensuring that the pressure spectrum you're using to calculate fatigue and now SCC -- is still valid. So, make sure that you've used the most aggressive of what's still occurring.

Q. And I realize --

A. Yeah.

Q. -- pigging is not an everyday event -- could be, but is it --

A. Yeah.

Q. -- is it too far out or unrealistic to kind of say maybe the operators -- not just Enbridge, but most operators should make an attempt to see what else they could do with the cycle.

A. Well, we --

Q. Or that is really a unrealistic expectation because -- of the pipelines in operation.

A. No. And in fact it's -- it is so important that there's a dedicated team to it. So, under the infrastructure management team, optimization of cycling and operability there's --

Q. So, you do have -- to a certain extent. You can't eliminate it, but it's doable to minimize the cycling.

A. It's doable to try and find those areas where improvements can be made.

Q. Ways to --

A. Yeah. It truly is --

Q. Okay.

A. It is a challenge, yeah, so -- you know, when I started here I was -- I'm thinking in the back of my head, like, but there must be a way to stop cycling the pipelines. This is driving me nuts. But then you start thinking about, well then, okay, so let me envision a thousand mile long train with little elastic bands between all the cars. Okay? And now I want to start that train moving. Hold on here. That's a huge -- you need the pressure line. How am I going to stop that? Wow, right?

Like there's a lot going on, so -- and every injection and delivery and so batch size is important to us, so -- so when we're going designing of new pipelines we don't do fatigue calculation using Paris law equations. We use an SN curve to -- and so, we set things up that way. You can only -- you only know what you know at that point in time, but where those calculations trigger cycling and we're saying well that's -- no that's too much cycling.

Okay. So, do we need tankage? Can we increase the wall thickness? What else can we change in a design change to try and prevent this all? So, we're actively trying to prevent it on all new pipelines too, but it's -- there's a whole area in there. And so, that's --

Q. Do those tanks help minimize cycling or --

A. Break up tankage?

Q. Yeah. Or they don't?

A. They can. They can. And it depends on what's causing the cycling, so if -- if a certain customer needs a batch size of 10,000 cubes and they need to inject that every -- once a day and then -- but it's only a 10,000 cube batch once a day, well, build in tankage and let's do a bigger batch. So, now you've just taken half of that away, so -- but there's a cost to that and so it has to be a cost balance between what's appropriate and what's not.

Q. Okay. By the end the economics comes into the picture? I mean --

A. But it has to, yeah, at some point, right?
Q. I understand.
A. Yeah, but -- so what --
Q. Okay.
A. Yeah, so -- only because I have it up -- so if you're interested this was the paper we did on this pressure cycle monitoring. And it walks through how we calculated it, so it gives some typical pressure data.
Q. Okay -- I like that graph. Look at your thousand psi, okay?
A. Yes. Yes.
Q. Because your presumption is completely thrown off here. I mean if you can say a thousand -- now on operating your cycling if you look at the cycling now, the majority of your cycles at the bottom are compressing, whereas very little --
A. Well, it's only compressive if -- depending where your neutral state is.
Q. That's what I'm saying. But in your case here neutral is constantly variable. For you to -- as you would calculate opening or closing there has to be some kind of a baseline to compare -- this one year will -- and I'm not sure, I'm just going to point it out because this is the real life.
A. Yeah, that's right. I think -- I'm missing something in what you're describing to me. And so, I'm definitely going to take that away and think about it.

Q. Okay.
A. Because I know you've got a point there.
Q. Yeah, please do. I'm not --
A. Right.
Q. I'm not saying --
A. I'm missing the subtlety.
Q. Yeah, because --
A. Okay.
Q. I'm still thinking especially when you say your growth rate -- particularly high when you -- on this graph you said the growth rates were --
A. Oh, as compared to industries.
Q. Right.
A. That's right.
Q. But what I'm thinking is that it may be because if -- the same graph and I do not know -- depending on where you put --
A. Yeah.
Q. -- your axis, the things will change, you know, compared to that axis. If that is your pick, if that is your initial crack, depending upon what you think, your crack will be constantly opening or constantly closing. See, you have a crack that is psi -- if I increase the psi I'm constantly keeping this crack open.
A. Yeah --
Q. And then -- like completely. And I know the -- from the

corrosion viewpoint that --

A. Yeah.

Q. -- it can be completely a different potential than if you are going to be opening and closing. So, that's where I'm coming from --

A. Okay. No, no, that's -- I appreciate it.

MR. KEANE: I'll hit the highlights in this paper. So, what we describe here is how we -- so this is a little bit of how we calculate our pressure cycling. And so, we lined up -- for every quarter of pressure data we -- we used a starting flaw size that's for us. What we use is we use a 20 percent de-flaw and we calculate -- and for a given flaw length. It's not a flaw that exists in the pipeline. It's simply a flaw that we want to grow to figure out the fatigue life pertaining to that pressure data for that time period.

And then when we calculate -- so we figure out how long it takes to go from 20 percent to 95 percent. And then the next period of time comes around, so 2003 quarter two, and we take that pressure data and we grow it from 20 percent up to 95 percent and we figure out how long that takes. So, it's a fatigue cell calculation to just figure out the track. Is the cycling -- are the fatigue lives changing? So, that methodology largely aligns with TT05 and we describe how it aligns with TTO5 in here and how they calculated their low, moderate, aggressive cycles.

And so -- and we've been doing this for a period of time now. And so, pipelines can go from low, moderate, aggressive and when they do our process describe that bells and whistles goes off if it goes over here because we don't want that. And so, if you did it over here how did you get down here? Right? And so looking at things -- and so, there's actually a case study in here -- there's a few of them where we've looked at things. And this is a little bit small, but you can see here is an example of how we're -- this is us looking at the pressure data to try and understand what's driving these cycles.

So, for this one given station you can see that all of this was related to a pig bypass, all of this over here. And then we have an injection at a downstream portion. And then -- so the injection at downstream means that this upstream portion gets shut down and therefore it's a pressure drop over time because of temperature loss, therefore -- right? So, the cycling becomes very complex in its nature and it's -- so over here we have an unscheduled shutdown right there.

So, the intent of the paper though was to describe that this work can be very valuable for the obvious reasons, plus -- I'm just looking for the -- I thought we had a specific case here. Well, for this given pipeline -- sorry, we don't have a -- well, Figure 4 should be here. So, it came down here and we were able to work through different scenarios to try and drive that cycling back up. And for this exact case it was the fact that we were able to do that. We were able to figure out what was driving things and it was a large -- there's a lot of changes and -- but this is -- you know, it can be done, but --

MR. CHHATRE: Well, I'm glad to hear you can do it.

MR. KEANE: Well, there's --

UNIDENTIFIED SPEAKER: That was corrected by having tankage?

MR. KEANE: Pardon me?

UNIDENTIFIED SPEAKER: Didn't you say that was corrected by having tankage or --

MR. KEANE: No, this -- this one was complex. This one was working with the shippers to increase batch sizes and prevent them to have certain things mixed and blended. And it had to do with pig bypasses and the number of pigs that they were using and this particular line was running lots of pigs on a very frequent basis. And auto-pig bypass wasn't installed in all on the stations along the way. But there was a ton of stuff involved and we can't -- we couldn't maintain -- this is a little misleading suggested that we could get it from here to here. We couldn't hold it up here for that long. It was -- we just couldn't do it.

So, the line operates -- it's down through the moderate area. But the fact that -- we're able to influence change and do things. Also the fact that we saw this thing coming down and we were able to get tools in the line, put pressure restrictions on the line to make sure that everything was okay. This happens to be -- it's not an old pipeline, but -- so, anyway --

MR. CHHATRE: Can we look at the conclusions at the very bottom?

MR. KEANE: Yeah.

MR. CHHATRE: Okay.

MR. KEANE: Sure. Is it big enough to read?

MR. CHHATRE: I think so.

MR. KEANE: Okay.

UNIDENTIFIED SPEAKER: PCS was pressure cycling severity?

MR. KEANE: Severity, yeah.

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: So -- and I think the way we linked into this paper was a simple statement saying that we do monitor our pressure cycling and that because of the way we've aligned our data that these fluctuations potentially identify and change the crack threats -- so. And -- yeah, so I'll leave it at that.

Okay. So, we can go through the details of this process doc -- of this particular process document we're still walking through. But largely, we're still talking about all the different properties that we provide to, you know, OED and SMYS and starting flaw sizes.

UNIDENTIFIED SPEAKER: So, you were asking a question, weren't you, Sean?

MR. KEANE: Pardon me?

UNIDENTIFIED SPEAKER: Were you asking a question?

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: How much do we want to go through the details of that document versus --

UNIDENTIFIED SPEAKER: Do we want to take a break since --

MR. NICHOLSON: Well, let's go off record.

UNIDENTIFIED SPEAKER: Because --

MR. NICHOLSON: Or what's the decision here?

UNIDENTIFIED SPEAKER: Well, I think it was more, you know, how much time do we want to spend getting into the details of this versus --

UNIDENTIFIED SPEAKER: Well, what is that? I'm sorry --

UNIDENTIFIED SPEAKER: It's still the interval determination, right?

MR. KEANE: Yeah, to be fair we've -- we've talked about a lot of subjects here and we've only flipped through about half of one of our process documents, so -- but we've talked about -- we've talked largely to all of them.

UNIDENTIFIED SPEAKER: Right.

MR. KEANE: So, we can continue to flip through the process documents and talk about them, or --

UNIDENTIFIED SPEAKER: All right. Well, let's go ahead and --

UNIDENTIFIED SPEAKER: Turn off the recorders and --

UNIDENTIFIED SPEAKER: I guess what I was going to say is that I know that the trending work that's done is pretty important and I --

MR. KEANE: Yeah, maybe to there?

UNIDENTIFIED SPEAKER: I wouldn't want to --

(Off the record.)

(On the record.)

MR. NICHOLSON: Okay. Back on the record, Part 4.

MR. KEANE: Okay. So, we're going back through the crack management program components and into the comprehensive threat assessment. We're going to start with the fitness for purpose calculations, which is PI-37, and we'll walk through that and field questions as they arise.

So, as you know we use CorLAS software for calculating fitness for purpose. This document describes the fitness for purpose calculations for feature selection freeze with the crack ILI tools. So, the document describes responsibilities of the materials technology -- the line subject matter expert, as well as the -- program analyst. So, in this case somebody else completes the PI listing. A PI listing is -- it's an integration of the feature listing from the ILI tool along with the other key components such as MOP and milepost and -- amongst other criteria that we track, so they just put that into that standardized template for us.

And the materials technology engineer they're also -- they're responsible for, you know, preparing the reports and everything to that effect, so --

BY MR. CHHATRE:

Q. Well, what do you mean by standard practices as document -- what's the --

A. That deviate from this procedure itself.

Q. Okay.

A. Yeah. So, within this procedure we indicate to you is -- for flash weld in low frequency -- pipe. So, if somebody wants to try and deviate because they've got a body of knowledge of CVN testing on this particular -- on that particular pipe material, then that might be possible, but let's take a look at that in detail.

Q. But it requires senior --

A. That's right. Yeah, we want somebody senior to be looking at that.

Q. Are there any qualification definitions to be come a senior -- I guess for lack of a better word regular --

A. Yeah, the -- well, a senior engineer within Enbridge has to have a certain skill set and demonstrate a series of experience behind them. We could go into those job description kind of qualifications required, but within my team right now I have one senior engineer -- pardon me, two senior engineers, both newer to the company, but come in -- one was a quality manager at a pipe mill for a number of years prior to and the other one was a research engineer at Seifert. And that -- so they've joined the group as senior engineers. And everybody else is largely at the engineering level. I have a few EITs, as well.

So, the procedure itself is -- we've already spoken about how we calculate -- or how we use CorLAS, so -- but the first part I guess in calculating with an ILI feature set is to look for the quality issues that affect the results of the crack ILI, so that's the very step one in our procedure. So, we've got a process document PI-36 that describes that performance.

So, in that document what we're looking for is the items such as sensor failure or just little bits and pieces, tool over speeds and over rotations, and let's make sure that we fully understand the report quality because we just don't go run off and calculate the ILI pressures. We want to understand the quality of that report to make sure that there's nothing in there that we need to be cognizant of. And if there is something in there then let's think about ways to incorporate uncertainties and risks associated with it, so.

Q. So, do you guys select the ILI tools or ILI input in the selection?

A. Yeah, we do select the ILI tools for -- now, for crack tools there's not a large suite of tools that we can use. We don't use transverse or -- we don't use MFL tools for crack detection. They have a place, but that's not one our go-to tools for crack ILI.

Q. Okay.

A. We're looking for something that's more specific to tight narrow cracking, so -- and right now within industry there's EMAT technology, which we're currently doing research with, and there's ultrasonic technology. So, within the UT tools there's GE and there's NDT. Those are the two main vendors that we've used.
Q. Which ones are for ultrasonic tools?
A. Yeah.
Q. GE and which one?
A. NDT.
Q. Okay. But they use both the same technology?
A. Largely. Both tools were developed from the same I'll call it body of knowledge in Germany, so the -- some of the original designers that worked on the GE tools then went and built the NDT tools.
Q. They used the same principle of --
A. Yeah.
Q. -- multi-axial crack?
A. That's right, yeah. Yeah, so they both use similar electronics and algorithms for onboard data processing and management of data.
Q. Okay.
A. There are some differences within the tools' functionalities themselves with some of the ways they process the ILI data and some of their algorithms. I mean each vendor has their own areas that they try and --

Q. Right. But the technology is still the same?
A. The technology is still the same.
Q. There's not a different technology --
A. There's a 45-degree immersion probe running through the pipeline sampling as fast as it possibly can and recording terabytes of data at times.
Q. Yeah, okay.
A. Yeah.
BY UNIDENTIFIED SPEAKER:
Q. So, the GE USCD tool -- well, that crashed in 2009.
A. Yes.
Q. Is that -- so that's good for a 30-inch diameter up to what?
A. The range on that tool, I would like to confirm, but I believe it's 34 inch down to 26 inch.
Q. Okay.
A. Yeah, on that body. Yeah, and then the -- it might go -- yeah. It might go up to 36, but I don't think so. I think it's just 34. The dual tool is one of GE's other tools. It can go up to 36 inch for sure and all the way down to 24 inch. And then they have their CD+ tool, which is largely the same as the CD, so the same range. And then they've got a smaller suite of tools that can go down to -- they might go down to -- from 10 inch and then up to sort of about 10 to 22 range. That might be two suites of tools in there, but --

BY MR. CHHATRE:

Q. I think somebody told us, but what is the dual tool? What does the dual tool do?

A. What is the dual tool? So, a dual tool is a more advanced version of the CD tool and it's advanced from the sensor technology. Instead of using -- and actually, can I just back up a second?

Q. Yeah.

A. What's your -- what's everybody's background in ultrasonics? I don't want to overstep -- does everybody have a base level or --

Q. I have a little, but you will not overstep my background.

A. You have -- you've got a little bit?

Q. I have a little bit, but not a whole lot.

A. Okay. That's fine. So, if I say transducer you know what I'm talking about?

Q. Yeah.

A. Okay. So, the CD tools work with just a single element or dual element -- single element actually, single element transducers and the transducers themselves are angled such that they induce the sound wave in the steel of the pipe at 45 degrees. So, they're -- so those transducers are fixed on sensor rings at certain angles.

The dual tool is a phased array transducer and it's --

so it's a phased -- it's a phased element and then it's run so that to replicate a CD tool. So, they have virtual sensors that are within certain element groupings that will then pulse and steer those -- the sound waves to replicate a 45-degree sound wave through the steel. So, it's -- so they're using the dual technology to replicate the CD technology largely, if that makes any sense.

Q. No, I'm still --

A. Okay.

Q. I mean I think I understand when you say crack detection technology -- CD technology is --

A. Yeah. Yeah --

Q. You're seeing the transducers; they're oriented at 45 degrees.

A. Pardon me? Yeah, that's right. They're oriented --

Q. 45 degrees.

A. -- such that they induce a sound wave into the steel at 45.

Q. At 45.

A. So, they've got to shoot at a different angle because -- yeah.

Q. Right. Right. And then --

A. And --

Q. -- look at the signal that comes back and depending on the break in the signal they decide -- crack or the dimensions and that kind of stuff?

A. Not a break in the signal, but just the signal characteristics, right, so --

Q. Yeah, but then disturbance -- scattered --

A. Correct. Yeah, yeah. The sound's bouncing back --

Q. Yeah.

A. -- off the corner trap of a crack, yeah.

Q. Okay. And that's your CD tool?

A. Yeah.

Q. And I'm still at loss. What does dual tool in addition to what CD does?

A. The dual tool, the way it generates the sound is different.

Q. Okay.

A. So, it uses a phased array technology.

Q. Okay.

A. So, it's -- instead of being a single half inch or -- well, it's -- just sub that, three -- but approximately a half inch diameter probe. It looks more like a -- like a cell phone kind of -- it's a rectangular shape about this dimension a little bit smaller. And then what it can do is it'll just -- it'll group these sensors or this portion of it together. It'll fire off in a series so that it'll induce that -- it'll steer that sound wave to go off at the angle that's desired. So, it's fully programmable and to do what you want it to do. So, it can shoot sound waves straight back and forth like a WM tool works. It could off at 60 degrees or 45 degrees.

Q. So, it's not just fixed at 45 degrees? That's the difference?

A. We -- GE operates at -- fixed at 45 degrees.

Q. Okay.

A. That's the standard way for running of the tool.

Q. Okay.

A. Yeah. Yeah. So, largely the difference between the two tools is that -- just in the abilities for the dual tool that GE is able to play with and do more research with the dual tool because they can vary a lot of different stuff on it through programming the electronics.

Q. Okay.

A. But they operate it within the pipelines to be very similar to the CD technology.

Q. All right.

A. Okay.

BY UNIDENTIFIED SPEAKER:

Q. Well, while we're on the theme though, right, I heard from the corrosion group that they use -- they're using two types of technology or at least two MFL tools to help generate overlaps.

A. Yeah.

Q. Right? Where one tool can't detect something that other tool is most likely capable of --

A. That's right, yeah. They're --

Q. But I didn't hear you say anything about using the similar --

A. Because there isn't any --

Q. -- approach.

A. There's not one that exists.

Q. So, CMFL isn't going to complement the oversize?

A. No. Well, now the CMFL is -- provides a different assessment and it does have an ability, but the technology is limited for tight longitudinal cracks. It's just a limitation of that tool itself, so I'm not suggesting that there's no value to run that technology. We absolutely -- we're doing lots of work with it, but largely it's run under the corrosion teams and then that's where my team and Ryan's team work together to build the trends and to understand what can it do, how can it help us from a crack perspective.

When we look at the -- we've run CMFL down Line 6B. And when we look at the crack features that it would have culled we're not seeing a wow, thank goodness we ran that.

Q. But you don't think it would have identified that long crack at the rupture site as a colony versus a single axial --

A. I don't think it would have identified it as a --

Q. Just changed the characterization?

A. I don't think -- yeah, I don't think it would have identified it as a SCC or a colony, but I don't know that it wouldn't have found it or identified it as a narrow axial type feature because -- I'm looking at Matt Fox, but I don't know. Was -- if that feature was open and had a bit of a width to it then it's possible that it would have. So, because of that potential we've been running CMFL tools down all our tape coded lines and Ryan probably told you.

So, we're looking at that and I don't know -- I don't think we found anything to date saying thank goodness we're running this tool everywhere, but we're certainly -- anything else we can throw at it we're throwing it, so --

Q. Okay.

A. Yeah. It's a good technology. It just has limitations.

BY UNIDENTIFIED SPEAKER:

Q. Now the dual tool could essentially work similar to a USWM tool?

A. That's correct. And we've run it like that before also.

Q. And could you do that concurrent with the -- or can it do both at the same time in a single run?

A. That's the Holy Grail of where we're trying to get to. I guess the next step would be to be able to run it not just at 45 degrees and zero degrees, but give me a whole sweep of angles --

Q. Right.

A. -- like the tool's able to, but you just can't do that. The tool is unable to gather that much data while it's moving down the pipeline. It takes time for the sound to dissipate through the steel and that much time it takes for the sound to dissipate is such that the tool has already gone past it before it can even do its second scan at a different angle.

Q. Um-hum.

A. So, while the tool has all this great ability it's not useable ability because the tool needs to be slowed down. We can't slow the pipeline down to a point where the tool will be moving slow enough, so it would have to be literally crawling down the line. So, we are exploring ways to do that -- yeah.

MR. KEANE: So, within our -- this procedure we've got -- we identify timelines for completing some initial -- for completing the fitness for purpose assessments and, you know, initial QA type assessments, et cetera, et cetera, along the way. I'm going to keep it fairly high level and let you guys dig in where you see fit, so.

We have template files for doing our assessments and how to calculate everything and where to store everything. So, this document describes where those files are located and what they're named. As I indicated, we've worked with DNV to advance beyond a DOS version. Well, I guess it's a DOS front end to CorLAS, so we now have it within a nice little Excel sheet and we have full control over that Excel file. So, now we can control -- we can literally just use like a database structure, an Excel sheet structure, so it's a lot nicer.

BY MR. CHHATRE:

Q. Have you seen a circumferential factor in any of your pipelines?

A. I'm sorry?

Q. Have you seen circumferential factor SCC or -- in any of your pipelines?

A. Circumferential factor?

Q. Going -- like if you look at the -- for example --

A. Oh, a circumferentially lined SCC?

Q. Yeah. Have you seen them now or?

A. Yeah, we have. We found some very shallow indications at odd locations and want to refine those. We're trying to figure out well, why do you have axial stress acting on location -- on this pipeline at this location? And the depth of what we found has been very shallow, but it's very seldom that we found anything.

Q. Well, which tool will detect that? That isn't ultrasonic. The GE tool will only look at the axial.

A. Yeah, no --

Q. It is not really good circumferential defects.

UNIDENTIFIED SPEAKER: Oh -- vertical.

BY MR. CHHATRE:

Q. But that's not --

A. We don't dig --

Q. But the --

A. We don't do the dig to find that feature.

Q. -- you got to open the pipe.

A. Yeah, we don't do the dig to find the feature. We do the dig for another reason and we found that feature.

Q. Okay.

A. Yeah, so there is -- yeah. It -- we do run -- we are running MFL tools looking at -- looking for larger --

Q. Circumferential --

A. -- circumferential defects. But I am not aware of anybody flipping the transducers and ultrasonic tools to try and find smaller ones. We've tried it, but we haven't been successful with that, so.

Q. Yeah.

A. We've tried it in a lab setting, not on a pipeline.

MR. KEANE: So, the -- so we use the CorLAS model for fitness for purpose calculations for all the ILI features and we use the maximum depth of the depth bins, so that's one difference that's occurred since 2008 in our pipelines.

Between 2005 and 7, 6, 7, in that timeframe, we completed quite a few digs and validated for ourselves the use of getting the maximum profile from the crack tool. And so, that work -- we've got lots of digs on SCC that -- where the ground profiles really lined up with the -- with what the analysts had called for the profile. In approximately 2008 GE changed and said that takes our analysts too much time so we're going to automate that whole system for you, and so they automated it and so we backed away from it.

So, we still get those profile depths, but we stopped using them at that point because we wanted to gain enough confidence in their use over time. So, at that point we just stopped using it. We had a lot of body of knowledge prior to it, but from that point forward we stopped and we still haven't gone back to using profile depths for the newer tool data.

UNIDENTIFIED SPEAKER: Oh, so you just use that maximum of the range, is that what you're -- okay.

MR. KEANE: Right. Yeah, so we're just using maximum of the range. Yeah.

UNIDENTIFIED SPEAKER: As of 2008?

MR. KEANE: Yeah, approximately 2008, yeah.

UNIDENTIFIED SPEAKER: 2008?

MR. KEANE: Yeah. So, there's features -- we don't want to lose sight of where -- if we step forward in our processes a little bit at some point we'll end up visualizing all of our ILI features along the length of the pipeline and overlaying different datasets. And when we do that visualization process we don't want to lose features that are either very deep or they don't provide us a depth bin, such as these greater than -- like saturated type signals, greater than 4 or greater than 3.

So, we just assign these types of features a depth and we just -- you know, 60 percent are greater that 160. It's not that the fitness for purpose calculation is -- it's not that

that's what we think the -- that pressure would be or that's not the depth we would use in calculating fitness for purpose for the feature. It's simply a method for us to put a spot on the map so we don't lose it. And we've put it at the deeper depth so it stands out. It's going to give you a low value, so we'll see that in the trending.

Because at times we have run our initial crack took runs and we have found features like that and we want to understand where those are occurring and are they close to a pump station or are they -- where are they at? So, that's what this whole section -- this paragraph 5.6 is on. It's just describing why we do that. And --

UNIDENTIFIED SPEAKER: I'm not sure I understand what a saturated depth is.

MR. KEANE: So, for the ILI tool, the crack ILI tool, the way it works is there's a -- on the X -- if you visualize that on the X axis a amplitude -- so that's like the sound coming back and then vertical axis is crack depth. And so there's a bit of -- there's a curve that correlates amplitude to crack depth. And the top of the curve becomes basically flat. So, at some point you're not getting more sound back from the crack tool, and therefore, they can't see if it's greater than -- depending on the ILI boundary here.

UNIDENTIFIED SPEAKER: There's an upper boundary.

MR. KEANE: Yeah, there's an upper bound for what they can see.

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: So, is it greater than 3 or is it greater than 4? Well, they might be able to see that it's 3.5, but it goes into that greater than 3 bin, so. Yeah, and it says right here that fitness for purpose must be determined based on known operating pressures, so -- but once again, that's just as a placeholder so we don't use it.

So, there's -- we'll skip down a little bit to some of the relevant or key inputs to the model.

MR. CHHATRE: Now, if you look at this up here for example --

MR. KEANE: Okay. I'm just going to look for the -- all the -- so -- here we go. So, within our model -- so this is where we describe our material properties and our various other constants that we're going to use so, yield strength and ultimate strength should be set as required, which means nominals for us, so we just use nominals. Flow stress, we -- it says in here -- it describes how we use them. You'll see that back in 2005 we were a little more conservative with our calculation of flow stress and we actually -- we used the average between UTS and SMYS. So, DNV would say that that's pretty conservative and they actually recommend that we do this, so we've changed and we just follow this down.

MR. CHHATRE: With -- is axial defect is --

MR. KEANE: Yes.

UNIDENTIFIED SPEAKER: Going back up the saturated signal?

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: That's -- so depths greater than 4 millimeters would be represented as a depth of 60 percent?

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: But is that -- but in a quarter inch wall that's going to be more than 60 percent.

MR. CHHATRE: 66 probably --

UNIDENTIFIED SPEAKER: No, the 4 millimeters would be --

MR. KEANE: Yeah, so --

MR. CHHATRE: Yeah.

UNIDENTIFIED SPEAKER: -- like .15?

MR. KEANE: Yeah. The intent is, is that it's -- once again this is just a placeholder so we can see it on the graph. So, whether it be 60 percent or 66 percent or 56 percent or -- it's going to stand out.

UNIDENTIFIED SPEAKER: On the out --

MR. KEANE: No. On a --

MR. CHHATRE: Didn't -- flags on them?

MR. KEANE: Hold on.

UNIDENTIFIED SPEAKER: A dig flag?

MR. KEANE: Yeah, they do. They flag those out.

MR. CHHATRE: They flag those.

MR. KEANE: So, we plot -- absolutely they flag all that to us. So, what --

UNIDENTIFIED SPEAKER: It's right here.

MR. KEANE: So, what we do is we're going to calculate fitness for purpose for every feature and we're -- so when we've got that process document the next thing the guys do is -- guys, get those onto a graph so we can figure where they are in the pipeline, right? So, pressure and the vertical axis, milepost or kilometer post on the horizontal access, plot out our MOP or hydro-test pressure for the various segments and start overlaying our datasets to get those features on here and plot them out.

So, the blue ones are base metal features, the red ones are well features, circles -- I think circles were -- circles are internal and squares are external. So, when we plot them out I want to them to stand out on the graph, right? So, I want them to be down low and that's the only reason why we even put that placeholder in there. If we go back to actual operating pressures or try and calculate something for fitness for purpose, what we truly believe, it's going to blend in again and that's not the intention. We want it to stand out so we can say why do I have a deep feature which is downstream from that pump station right here? Why do I have this big cluster of base metal features right here? Right? That's why, so we can start asking those kind of questions.

Within our selection criteria -- and we'll get to that

-- we got those easy to find ones. Well, anything that impedes upon our safety factors, anything that -- we can go through the list -- a crack field that shows signs of growth, so it belongs in the -- grid in the 3 inches. Yeah, it must be coalescing. There must be -- something's going on there. It's active. Let's select it.

BY MR. CHHATRE:

Q. Now, based on your ILI inspection and your analysis, who recommends what the repair procedure should be? I mean the repair or replacement for that particular indication if you would, or a series of indications. Who decides that these indications should be --

A. Yeah, so the --

Q. -- repair or replace the joint or --

A. Yeah. So, there's a series of people that you described and I'll come back up to the process -- or to our -- sorry, to our department structure again. And in -- there's a group right in here -- once again, under this -- this pipeline section in there --

Q. Okay.

A. -- within the infrastructure team. And they have replace rehabilitation projects.

Q. Okay.

A. And so, the first thing that happens --

Q. But they are not under your --

A. No, no. I'm over here in this wing.

Q. Right.

A. But when I issue my dig programs -- I'll just go back to the same chart here -- so when we issue a dig program if we selected 30 features in here to go dig because, hey, there's something going on there and I'm not -- we're taking those out, all of those things are coming out. Thirty digs in one mile. That's going to immediately go over to the infrastructure team as well as to the guys building dig packages. So, they're going to start actively getting ready to do all the digs.

At the same time these guys over here are going to say, whoa, that's -- we can -- no, let's just take all that out. So, that's what that team does, is we'll identify it as the density of features over here, there's something going on, we've got to be doing something. So -- and we can look at -- we've got a few examples of even though this org structure is new -- we've executed through those types of decision making already through a few examples.

Q. But it's still not your decision. It's somebody else's decision to repair or replace?

A. It is -- there's a lot of stakeholders within that decision, so we'll formulate a decision record that considers the economic decision, the threat decision, like everybody's own portions of it. It's not just one group that says we have to do it, so -- because it might be that a re-coat project is more cost effective than a pipe replacement project, or a reroute's required, or no we can actually just dig all of this and we're better off to just come in and repair them.

Q. I mean all of these -- somebody or some group has to make the final decision, right? I mean you may have input into that, but who --

A. So, as it works its way up the ladder through our organization structure then ultimately -- so it's going to up through Scott and up to Walter and Walter's going to make that final I agree with this recommendation that this needs --

Q. Right. But who made that recommendation? Your group does or the other group does?

A. The other group does.

Q. The other group does.

A. The infrastructure --

Q. So, that's what -- I didn't know that.

A. Okay. The other group makes the recommendation, but they take the input from the other groups, right. They take the input from the other groups.

Q. Okay. So, anytime your group or corrosion group recommends a dig?

A. Yeah.

Q. And if they decide to repair, replace or do nothing approach?

A. Yeah.

Q. They do seek input from you guys?
A. Yes.
Q. As to what the decision should be?
A. Correct, yes.
Q. And if the decision is to do nothing or repair do they seek your input as to would that in fact --
A. Well, if I -- so the decision can't be do nothing. The decision has to be that you can mitigate these features -- once we make a decision to -- if our groups recommend -- we don't recommend I guess -- the planning groups require that action be taken. And once that action's taken it can take different forms. It can be they can replace the pipe, we can do the re-coats, we can do the digs, but that's the decision there.
Q. It's the planning group's decision to take some kind of an action?
A. Yeah, we make that required -- we need to do this.
Q. And that comes from your group?
A. Yes.
Q. So, planning and your group makes the decision as to --
A. That's correct.
Q. -- you have to take some action?
A. Yeah.
Q. And what that action is, is decided by the other group with input from you guys?
A. That's correct. Which of the various mitigative actions

can occur, yeah.

Q. And does it ever happen that you guys disagree on the mitigative action?

A. I'm now aware of any.

Q. Okay.

A. I'm trying to think -- there's not a --

Q. Well, is it that you guys fear that, gee, you know, the damage is so bad you should replace it and the --

A. If we made that as an absolute recommendation then, yeah.

Q. No. I mean you made a recommendation to say do something.

A. If we said we have to go in there and you're going to have re-coat or mitigate the cracks on every single joint of pipe or whatever, then how they're going to achieve that, there's different ways.

Q. Right.

A. And I would say that they're both equally acceptable.

Q. Okay.

A. Because they both line up three-quarter pipe.

Q. Now, do you guys have input as to what kind of repair they do? Or let me just say --

A. Absolutely. We will say what kind of repair -- now, ware you talking in the ditch?

Q. Okay. You identified this -- let us say in these two

areas to take some kind of an action and you make a recommendation to at a minimum you should repair it.
A. Right.
Q. That's a recommendation coming from your group to other group, planning group who is actually going to execute?
A. Right. Yeah, the infrastructure -- oh, okay.
Q. And then what happens is they say, okay you want us to repair it so we'll go ahead and repair it. Now, do they seek your group or corrosion group's, depending upon whose recommendation it is, input as to what repair actions are acceptable or they make that decision on their own?
A. No. We're part of that. We are a stakeholder within that process. So, our recommendation is to -- our recommendation is very clear that we need to mitigate that feature.
Q. Right.
A. And that our normal mitigation process is simply to go do the dig.
Q. Okay. Okay.
A. And so, it's only in those circumstances like if in here -- yeah, you have to do a whole bunch of digs in there. Hey, let's get in there and let's replace, let's get in there and let's re-coat, let's get in there and let's --
Q. Okay. Now, the repair here is -- the repair decision made is to sleeve it, does that come through -- is that vetted through your group?

A. No. No. And the reason being is that that's -- we have ONMP that describes acceptable repair methods in the field.

Q. But I thought you made the input as to what repair technique measure should be used?

A. But now, once you're in the field if they grind remove that -- let's say that this is shallow cracking. If they grind remove all that shallow cracking and they only take off 10 thou off the pipe and all that's -- all that remaining removed metal, the metal loss now, is completely acceptable and we re-coat the pipeline --

Q. And who made that decision that it's acceptable? Corrosion group does or who does that calculation?

A. That calculation is contained within our ONMP procedures.

Q. Okay.

A. So, the field has the ability to -- the field, I guess supervisors, the -- yeah, the --

Q. And the field group falls under which umbrella?

UNIDENTIFIED SPEAKER: Operations.

MR. KEANE: Yeah, the -- sorry.

MR. CHHATRE: I'm confused.

MR. KEANE: All right.

MR. CHHATRE: Okay. Go back to your chart. Go back to your chart.

UNIDENTIFIED SPEAKER: Not anymore, huh?

MR. KEANE: So, main --
MR. CHHATRE: Go back to your chart.
MR. KEANE: Yeah.
UNIDENTIFIED SPEAKER: Or to micro --
BY MR. CHHATRE:
Q. Okay. So, you are the manager of integrity --
A. I'm supervisor over here.
Q. Yeah, yeah.
A. Yeah.
Q. So, you made a recommendation that those areas in the previous slide should be mitigated somehow?
A. That's right.
Q. Okay. Now you may even go one step further and say in your opinion it should be replaced or in your opinion it should be sleeved --
A. Yeah.
Q. -- or ground or whatever your recommendation might be?
A. Yeah.
Q. Then it goes to the manager of pipeline and they're the ones who make the recommendation to somebody about your guys' recommendation for that particular location.
A. So --
Q. Did I understand it correctly?
A. No not quite. Because there's a difference between the planned reconditioning of the pipeline for a vast section versus

the in-the-field assessment for a joint of pipe. So, if you're in the field and they've only -- they've already opened up the excavation and they're going through the normal NDE and evaluation processes they know that they have to -- the corrosion is held to a certain standard and they have all that standard. They've got the ability to do those calculations.

Q. And they meaning who?

A. The -- yeah, so that's on this chart here.

Q. Okay. So -- under the vice president?

A. That's correct. It's --

Q. So, it's under a completely different -- right?

MR. JOHNSON: Walter goes up to a senior VP, Art, which isn't shown here. And then under Art's group is mainline digs.

MR. CHHATRE: True. But at the vice president's level there's a different vice president, a different group?

MR. JOHNSON: Yes.

MR. CHHATRE: Okay. I mean I didn't believe it was the CEO.

MR. KEANE: Yeah.

MR. JOHNSON: No, no. It's the same senior vice president, though. So, there's various senior vice presidents.

MR. CHHATRE: Right.

MR. JOHNSON: And the dig group is under the same senior vice president as the integrity group.

MR. KEANE: Right.

MR. JOHNSON: There's one more above Walter here.

MR. CHHATRE: Okay. But I --

MR. JOHNSON: That's Art Meyer.

MR. CHHATRE: But then that senior vice president, the other vice president who handles the -- but I don't think that's complicated. You have one vice president here who doesn't have the authority or the responsibility. So, some other vice president has the responsibility, right? It doesn't matter who do those -- report to?

MR. JOHNSON: To repair to integrity's standards.

MR. KEANE: Yeah, I think that's -- I was just going to say the same point. So, the ONMP, the guidance that gets provided to the field through our Operations and Maintenance Procedures comes out of the planning groups.

MR. CHHATRE: Okay.

MR. KEANE: So, the planning groups are the -- the stakeholders are the -- not the stakeholders -- are the owners of those ONMP documents, I suppose. I think -- is that the right term? The owners?

MR. JOHNSON: Yes, you're the --

MR. KEANE: We're not the stakeholder. We're the --

MR. JOHNSON: No, you're the -- you're subject matter experts.

MR. KEANE: Here we go.

BY MR. CHHATRE:

Q. Now, I'm confused. I thought it was a very simple example that you had those two areas that you've identified --
A. Yeah.
Q. -- that some action needs to be taken.
A. Um-hum.
Q. I'm just going through the logical step so I understand the process here.
A. Yeah.
Q. So, you guys made a recommendation and you made a recommendation to the manger of pipelines, right? Because they are the ones who are going to push it upwards.
A. So, we make the recommendation to do a dig and maybe we make -- right? So, maybe -- and maybe there's a bunch of digs close together. So, that requirement to go and dig go ups through this food chain and then the execution teams that are actually out doing the digs and everything are -- sit under the senior VP under here.
Q. Okay. But -- so where does this manager of pipeline comes in the picture? I thought earlier you said manager of pipelines passes it upwards to do some type of an action.
A. So, that's where these larger scale projects -- so to replace the rehabilitation projects, this little arrow here.
Q. So, where do -- okay.
A. So, not for a single location. The decisions in the ditch to grind remove a short SCC colony --

Q. Let's look only at the short -- like those two joints at those two locations you have, right?
A. Yeah.
Q. So, when you make the recommendation it goes to the manager of pipelines?
A. Yeah.
Q. To push it up to get approval to do the digs or --
A. Well -- so we approve the digs and the -- the approval levels don't go all up to the VP for every single excavation.
Q. Okay. So, where does it go? What do you do after that? You made the recommendation. Who actually runs with the recommendation and makes sure it happens?
A. The main -- we have a mainline projects group --
Q. Okay.
A. -- which is not on this org chart unfortunately.
Q. Okay.
A. But rather sits under --
Q. -- and you'll get --
A. Pardon me? Yeah, so it's somewhere else. That's right. And so, that --
Q. And so they make sure it happens?
A. That's correct.
Q. And so the repair method, what to use, is decided by whom? The other VP --
A. No. It's decided -- it's laid out and defined within

the operation and maintenance procedures in our ONMP.

Q. Okay.

UNIDENTIFIED SPEAKER: -- correct? They're the SMEs?

MR. KEANE: Well, yeah, we are the SMEs for that, right? It's -- it depends what it is. So, if they're talking about corrosion repair --

BY MR. CHHATRE:

Q. No, that's the crack. I mean that's what we're talking about, right?

A. Sure. If it's crack --

Q. It's -- communication --

A. If it's a crack repair then this team in here looks at the ONMP to make sure -- we own that procedure that says how can you repair a crack in the field?

Q. Okay.

A. Yeah. And so, in there it says that you can grind remove a crack --

Q. Okay.

A. -- provided that it's safe to do so and provided you've done all your checks with ultrasonics, et cetera, et cetera.

Q. So, who makes the decision as to which one to use? Or they always grind because --

A. That's a field decision. That's determined in the field.

Q. In the field?

A. Yes. Now, we -- go ahead.

Q. So, the field is really under a different vice president? Like the field people when they take your I guess order or your recommendation --

A. Yeah.

Q. -- and go to that location, dig it up --

A. Yeah.

Q. -- and decide we can grind it or we can sleeve it?

A. That's right. They have both --

Q. Do they come back to you and say, okay, this is our decision what do you think?

A. Yeah. Yeah, at times, but not necessarily.

Q. So, I guess my question really is -- okay, so you guys have input. Now, my question is do you consider crack repair, sleeving a good crack repair procedure especially if the crack is inside? From what I've heard so far in the last two or three days is that sleeving is done to take care of crack -- damage.

A. Yeah.

Q. And how the sleeve is going to repair the crack from propagating longitudinally for -- that's the -- I was coming I thought from initial discussion that you had had no input, but now I know you have an input --

A. So --

Q. -- as to repair. And so, I'm trying to find out why sleeving is an acceptable repair for a crack. I mean --

A. And you ask specifically for an internal crack?

Q. I mean external may be stopped at the -- if you are welding the sleeve circumferentially --

A. Yeah. Yeah.

Q. -- you're offering some -- for the crack. I do not know how much because if the crack is on the longitudinal seam it doesn't basically have to propagate always on the surface.

A. Right.

Q. It can go underneath and run beyond the sleeve?

A. I don't even know if that's theoretically possible, but I know from -- if we look at -- I think an internal flaw would be the most interesting --

Q. The more -- yeah, and that's where I'm coming from.

A. -- to discuss.

Q. Correct.

A. So, our processes start with field ND to identify where that crack is. We're using ultrasonics in this case because it's an internal flaw. So, they'll go through and they'll mark that off on the pipe and then they need a 6-inch band -- the field ND needs to assess the 6-inch band around the circumference of pipe that has nothing on it. It's got to be clean. And they can line the sleeve over there, so -- PRCI repair manual describes that as long as it's -- as long as you've got that 2-inch buffer you're good. So -- we have that 6-inch band that we look for.

Now -- and that make sense technically that that's

sufficient buffer because cracks don't grow longitudinally in length by fatigue. They do, but in comparison to the depth portion that they grow through it's minimal. They have a semi-elliptical shape to them, right? So -- and if you're talking even on a half-inch wall thickness, well, if it's semi-elliptical and it's only a half inch deep it's not going to be really, really long.
Q. So, your guys are okay with that --
A. That's right.
Q. That's all that I'm really trying to find out.
A. Oh, okay. Yeah. And then once it does go through all -- because it's still subjected to pressure cycling, albeit minimal, but once it does go through all, if it does -- the pressure difference between the annulus of the sleeve and the internal is now equalized so that crack is now -- it's not moving. The driving force is substantially reduced.
Q. Okay.
A. Yeah, okay. Good.
Q. If that's what you guys do, I just want to make sure.
A. Yeah. Absolutely, yeah.
Q. Yeah. It wasn't clear to me yesterday who was blessing it.
A. Oh, okay.
Q. And now I know who is blessing it, so.
A. Okay. Good. Thank you.

MR. KEANE: I think we were -- actually, we were talking about this. So, we graph out our features for the purposes of visualizing so we can identify observations within the datasets. You can't get them just through a spreadsheet. You can't see -- you can calculate the densities. You can look for a lot of different things, but once you see it and plot it out that's where things start popping up going, wow, what's going on? So, you can see that stuff starts to line up and -- so that's one of our tools along the way.

And we have room within our selection criteria for just saying that there's something unique going on here and we want to do a few digs. Even though nothing meets our criteria there's something going on and we want to do some digs to figure that out because this is all the same pipe type. There shouldn't be a distribution of flaws. And there's something clearly going on here because this is right at the pump station and suddenly you have this huge density of features, so what's going on? So, graphing it out is really important to us and we've been doing this for a number of years and we find it greatly beneficial. So, this is --

MR. CHHATRE: Does your vendor identify some of the areas or this all done internally by you guys?

MR. KEANE: No, this is by internally.

MR. CHHATRE: Okay.

MR. KEANE: Yes. Yeah, yeah.

UNIDENTIFIED SPEAKER: What's the jump in pressure around milepost 1009?

MR. KEANE: I'd have to confirm, but I'm going to speculate a replacement section. And the reason I'm saying replacement section and not wall thickness change is so -- because wall thickness could do the same, but a wall thickness change wouldn't correlate to a hydrotest pressure that is jumped up also. Because the likelihood of hydrotesting this separately from this, I can't see why we would have done that. So, if this was a replacement section then we would have tested it high and so -- then that makes more sense.

UNIDENTIFIED SPEAKER: It kind of looks like the seven mile diversion around Grand Rapids, but --

MR. KEANE: There you go.

UNIDENTIFIED SPEAKER: It actually does.

MR. KEANE: There's somebody that knows the system very well, so.

UNIDENTIFIED SPEAKER: Well, it happens to be Clearbrook at 909, so.

UNIDENTIFIED SPEAKER: I was wondering the same thing because that's a line one chart.

UNIDENTIFIED SPEAKER: So, that might be -- that might be a diversion that was laid --

MR. KEANE: You're right. It is.

UNIDENTIFIED SPEAKER: -- and then hydrotested separately when it was put in and then --

MR. KEANE: Brian knew exactly what it was.

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: Yeah. Yeah.

UNIDENTIFIED SPEAKER: But it's already got a number of indications then?

MR. KEANE: Well -- and so, that's a really interesting observation. That's something that we have to manage within -- in Enbridge, within the industry actually. So, when we do our calculations in CorLAS -- and we're conservative -- you know, that's our target, 5-foot pounds for -- and for tightness.

The pipe comes out of the mill with flaws and reflectors and -- it just does. That's just part of the reality of manufacturing. And so when we run our crack tool we find stuff. We find acceptable manufacturing flaws. If you look at the -- you know, this is probably close to 100 percent SMYS for both sections. So, this stuff up here, it's high up, right? This is way above your -- the flow stress levels for the pipe. Does it have to be excavated? Well, we're curious what it is, so we want to find out, so we'll probably do some digs. I don't know exactly what we did for the specific case but, you know, there's a learning here. We've got to understand it. But do you want to dig all of these completely normal manufacturing flaws or do you want to monitor them? So, those are the decisions that we have to wrestle with is how many do we monitor, how many do we dig?

The ideal situation is when things drop out from the crowd. Well, clearly this one shouldn't be there. That's one low, right? So, there's a bit of a line here of flaws. Well, why is there a line? So, that's nice when we see those observations, but it's useful for so many different ways. So, that's why -- you got to keep in mind we're at 100 percent SMYS --

MR. CHHATRE: What does AW mean? AW ID --

UNIDENTIFIED SPEAKER: Adjacent to the weld?

MR. KEANE: Yeah, adjacent to the weld or in the weld or not determinable. And then radial position here is external. So, you know, historically every now and then the analyst would say, yeah, I got this feature and it's not really external breaking and it's not really internal breaking so they call it MD. Well, so do you mean mid-wall?

BY MR. CHHATRE:

Q. You can't tell?

A. Well, they can tell, but what they mean is mid-wall, so we just group -- we put it here and we track that and we look for those features. You'll actually see a selection criteria related specifically to those MD features.

Q. And what is --

A. Which ones?

Q. RAD --

A. Radial position.

Q. Okay. External.

A. So --

Q. So, anytime you don't see external that means everything is internal? I don't see anything internal in that one.

A. So, the internal ones here are showing as the round circles, so that's an internal flaw right here.

Q. Okay. Okay.

A. Yeah, so external -- so, you've got a lot of external stuff on this line.

UNIDENTIFIED SPEAKER: Yeah, every circle --

MR. KEANE: Yeah, yeah. There's some internal. Some of the lines have about a 50/50 split. Some of them like 6B have a lot of external stuff.

MR. CHHATRE: Right.

MR. KEANE: So, each one --

MR. CHHATRE: Have you guys figured out what's causing the internal besides manufacturing defects or --

MR. KEANE: I haven't seen anything except for manufacturing defects for internal.

MR. CHHATRE: Okay. So, all internal are really manufacturing defects?

MR. KEANE: Yeah.

MR. CHHATRE: All internal --

UNIDENTIFIED SPEAKER: -- line 3.

MR. CHHATRE: All internal corrosion?

MR. KEANE: Oh.

UNIDENTIFIED SPEAKER: You know, railroad --

MR. KEANE: Well, yeah, do you call railroad fatigue manufacturing though, you know.

UNIDENTIFIED SPEAKER: I don't.

MR. KEANE: Yeah. It's transportation --

MR. CHHATRE: It's transportation.

MR. KEANE: -- at some point between -- it's before construction still, so -- but certainly everything internal is a fatigue governed threat.

UNIDENTIFIED SPEAKER: Right.

MR. KEANE: So, are potentially subjected to the fatigue propagation mechanism I guess is the proper way to say that.

MR. CHHATRE: Okay.

MR. KEANE: Okay.

MR. CHHATRE: All right.

MR. KEANE: So -- yeah, so we calculate fitness for purpose. We use flow stress following that definition. We talked about that. Factor toughness -- this is -- we've stated this, but at weld we currently just base a CVN of 5-foot pounds for -- and basement all is 15-foot pounds. This value here is -- this 1452 or 500, that is a value that CorLAS uses, so CorLAS converts a CVN value into a J value and it's 12 times the area of the sharp -- no, it's the area of the sharp E times CVN value divided by 12. I said that wrong, but -- but anyway, they've got a conversion factor there.

So, this is the new portion here, so the wall thickness, and it -- maybe I'll just read it, but it says wall thickness used for the fitness for purpose calculations is lower of the reported wall thickness from the ultrasonic WM tool or nominal wall thickness. So, if an ultrasonic wall measure inspection is not available or if the quality of inspection is in question the lower of the reported wall thickness from the crack inspection tool or nominal wall thickness shall be used.

And then we also -- if -- like indicated, if there's variance of more than 12 percent then an additional review should be undertaken to determine the appropriate wall thickness used for the assessment. And obviously that would lead to additional questioning of one -- when something is wrong in one of these datasets we need to correct it, so.

BY UNIDENTIFIED SPEAKER:

Q. You said 6.4 what you just read is new, but actually isn't the part above it also new? Because it's -- there's that 15-foot pounds CVN value. Your spreadsheet said 20 pounds.

A. Yeah, so that -- that's correct. You know what? The reality is that the difference between 15 and 20 foot pound is very negligible, so when --

Q. But is this a new section or not?

A. Well there --

Q. Or was there a definition before?

A. I have the documents. Let me just do a quick comparison of the two versions because we submitted these documents to you -- oh, do you have up already?

UNIDENTIFIED SPEAKER: It was 5 and 15 before.

MR. KEANE: It was 5 and 15 before?

UNIDENTIFIED SPEAKER: Um-hum.

MR. KEANE: Okay.

UNIDENTIFIED SPEAKER: I think it's in the document that we got --

MR. KEANE: Yeah, so --

UNIDENTIFIED SPEAKER: Yeah, you're right.

MR. KEANE: Yeah, and --

UNIDENTIFIED SPEAKER: Yeah, it's the same. Okay.

MR. KEANE: And actually, in the previous version you can see that we still had the DOS version going on.

UNIDENTIFIED SPEAKER: Yeah, I was looking at that file.

MR. KEANE: Yeah, so --

UNIDENTIFIED SPEAKER: I think it's --

MR. CHHATRE: You can tell -- by looking at the text?

MR. KEANE: You can because we got a screenshot.

UNIDENTIFIED SPEAKER: He's got a screenshot of --

MR. CHHATRE: Oh, okay.

MR. KEANE: Yeah, and our previous process document had the screenshots of how to do things. It was a challenge. Not a challenge, but it was time consuming --

UNIDENTIFIED SPEAKER: Well, it's the same program though. It's just -- you got an Excel front end.

MR. KEANE: Yeah. But it used to take computer processing time because -- to churn through this at the right speed you can't push that -- it was actually a Fortran program. You couldn't push it fast --

MR. CHHATRE: Fortran. That's old.

MR. KEANE: Yeah, yeah. Yeah. Fortran '78, right?

MR. CHHATRE: That's my generation program.

MR. KEANE: Yeah. Well, that's what I learned to program in school, but -- so it would literally take days for our -- for the computer to just churn through. That's why when you walk through the floor most of my team still has two computers. And it's because one's for processing and one's for doing your day-to-day work. So, one -- yeah -- so, anyway.

UNIDENTIFIED SPEAKER: All right. That's --

MR. KEANE: Yeah, so it was -- and you can see that there's not a lot of -- there's changes to the documents, but once again a lot of this is just the wording and we've tried to make clarifications. We're currently going through another revision of our documents right now, so they're continuously being enhanced.

MR. CHHATRE: Now, are these documents by mandate required to be either reviewed and/or revised periodically?

MR. KEANE: They are, yeah. It's -- and I might just ask Brian -- he might know -- but Brian, the INS documents have an annual review requirement through HCA?

MR. PIERZINA. You received that document yesterday, a hardcopy that talks about that.

MR. CHHATRE: Okay. Okay.

MR. KEANE: Okay.

MR. CHHATRE: I just want to make sure.

UNIDENTIFIED SPEAKER: There's a procedure for that.

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: There's a procedure, but I changed procedures.

MR. CHHATRE: Yeah, I got that.

MR. KEANE: Yeah, yeah. And we have a nice MOC procedure around all of this, so. And just records of everything that we complete, so it gets stored and documented so that if we want to go back up we can --

UNIDENTIFIED SPEAKER: Yeah, I did have a question about CorLAS and, you know, what the potential limitations are for that, you know, as far as aspect ratio, crack aspect ratio and, you know, what are the limitations that you have as far as use for longer crack -- or, you know, where the length is long relative to the depth?

MR. KEANE: So, CorLAS does have limitations related to length and depth also, so -- but generally those are outside of our day-to-day operations for what we work with. So, from a depth perspective we always truncate our plots up at 80 percent deep when we're looking for critical flaw depths curves, but, you know, in discussions with Carl Jaske and others he would argue maybe you should go a little bit higher. I'm like, well -- but we don't need to go higher than 80 percent.

Now, from a length perspective there's also limitations in CorLAS and off the top of my head I forget precisely what they are, but we've had lots of discussions with individuals to confirm that our use of it is -- is appropriate. So, is it appropriate for a 51-inch long flaw? Well, I think the failure of pressure and the -- and the alignment with the CorLAS calculation probably suggests whether it is or isn't, so -- I mean it's --

UNIDENTIFIED SPEAKER: Is there a user manual for CorLAS?

MR. KEANE: There are.

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: Are you looking for one?

UNIDENTIFIED SPEAKER: Not at all.

MR. KEANE: Oh, okay.

UNIDENTIFIED SPEAKER: I'm checking battery life --

MR. KEANE: Oh, yeah. There is -- there's several of the user manuals. The CorLAS 2.2 is the current -- well, was the current version until we moved into the 6L version. And so, we have -- it really was a small update between the manuals. It's just a few pages. And then, in addition we have Carl Jaske come down and he's been providing my team training on how to use CorLAS, so we have that every year.

BY UNIDENTIFIED SPEAKER:

Q. Now, I believe -- like in the SEPA report they indicate a limit of about 400 millimeters in length?

A. Yeah.

Q. Is that -- you know, so once we get up to 51 inches -- pretty far outside that?

A. Yeah. Yeah, no we're aware of that report and -- but like I indicated we've discussed it with individuals. But I truly believe that the best understanding of the limitation is evidenced of things such as the burst testing that has been done over the years and unfortunately we could even look at Marshall for an example, so.

Q. Are there -- in generating the values in Marshall were you using the same parameters that you use, you know, for all the analyses or, you know, were there any adjustments that had to be made or --

A. No. No, the only difference to what we've talked about in this -- in this current 2011 process document is the CVN value, which was 20 foot pounds.

Q. Okay. And that was based on the subsequent testing or --

A. No, that was the value used in 2005.

Q. Oh --

A. Yeah, which was based on the -- our understanding of a de-saw pipe and the base metal parameters that we've seen typical of other pipelines, so.

So, we were moving then -- the next process document done for us is the crack excavation selection criteria.

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: We had talked about the next -- about getting into the field NE trending. Which one of the two would you prefer to see first? Do you want to go to the field NE and outlier analysis?

UNIDENTIFIED SPEAKER: Ravi, do you have an interest in excavation and selection criteria?

MR. CHHATRE: Well, I -- just briefly we can go through it -- I don't have questions, but I just want to find out what's involved.

MR. KEANE: Absolutely. Okay. Now, this is different from the time of Marshall, this document here, so it might be more -- it might be relevant to see both sets. I'll leave that to you to decide.

UNIDENTIFIED SPEAKER: Yeah. It might be more important to look at what was in place at the time of Marshall.

MR. CHHATRE: Correct. And that's --

UNIDENTIFIED SPEAKER: Because of the fact that if it weren't selected --

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: -- then it's important to understand why.

MR. KEANE: That's right.

MR. CHHATRE: Anything you guys have done since the accident until -- you got to keep Matt informed not just for the last -- but periodically, so that way if there's any credit then we want to give it to you guys for making some change or -- avoid giving any recommendations. Because if we were to recommend something you already did there's no reason to make a recommendation.

MR. NICHOLSON: Do you want to take a break here?

UNIDENTIFIED SPEAKER: It's not a bad idea.

MR. KEANE: All right.

MR. NICHOLSON: Let's go off record.

(Off the record.)

(On the record.)

UNIDENTIFIED SPEAKER: Okay. Sean Keane interview Part 5. We were reviewing PI-39 at one point? Okay.

MR. KEANE: That's correct. So, we were reviewing the -- up to the stage of going into talk about the PI-38, the crack excavation selection criteria. And the -- I indicated that the criteria has evolved over a period of time, so it would be probably most relevant to start back with the 2005 and then work our way forward.

So, what I've opened up here is in 2005 what we did in that day is we created what we called crack and line inspection program summary document. And so, I've opened that document up.

It's been updated to be -- with some of the more current dig results, but you'll see that the document itself is -- it's the same as the way it started off in 2005 and it's only been built up on, so --

This document itself is -- as it indicates it's a working file that tracks learnings and status and as such it's truly just a working file that documents everything that we're doing with this pipeline in response to the crack ILI program.

MR. CHHATRE: Can you go back -- on the top where it says date --

MR. KEANE: That's correct. Yeah, so that's what it indicated is that we've updated this document with all of our previous digs, post-Marshall also, and -- because this document has trending within it. So, we've -- we have updated it to add more information into. So, we haven't removed anything. We've only added more.

MR. CHHATRE: Okay.

MR. KEANE: And you'll -- that'll be very obvious when you hit that portion. So, the first portion is the USCD data quality and walking through was there any concerns with the data quality. And so, the report indicates that there was two tool runs required to capture all the data. And we looked at that -- we saw that earlier this morning also when we looked at the EGS 305 and the EGS 205. So, those were the values that were indicated within our overall feature listing that we provided.

Depths profiles were requested for 142 features. In 2005 vintage our tracking system for e-mails is a little bit different than current, and so what we used to -- what I used to do was I would indicate where my e-mails were, what they were titled and where they were sent. That made it easy for people to find within our tracking systems. So, you'll see that I always reference those e-mails.

So, in -- yeah, so we found 142 feature profiles and they were selected based on -- so everything that was deep and anything that had predicted failure pressures less than the hydrotest pressure, except for the ones that were called surface breaking laminations.

BY MR. CHHATRE:

Q. This is Ravi. CL -- it means crack length and -- what is --

A. CL is crack-like and NL is notch-like.

Q. Notch-like. Okay.

A. Yeah. And Enbridge -- you can see obviously even back in 2005, Enbridge has treated notch-like as if it could be a crack feature that might be growing by -- might be growing due to in surface growth. So, we've always just grouped these things in together and we treat them together. Yeah, crack-like and notch-like. And also, notch-like features with fitness for purpose predicted failure pressures less than 95 percent of hydrotest pressures. So, basically, we requested 142 further reviews of features based on their depth/length combinations is what this says.

When we received those depth profiles back we noticed that GE indicated that the notch-like depths for lots of the profiles had depths that exceeded their original depth range.

Q. Can I ask a question? I'm sorry.

A. Of course.

Q. Why your notch-like features required 95 percent of hydrotest, but you go to the -- where you say crack-like features were only less than hydro -- pressure. It doesn't say --

A. Yeah. Yeah, and so --

Q. What's the difference? Why --

A. Yeah. So, the logic here is that there was a substantial population of these notch-like flaws were just right within that 5 percent band and at this stage we were just trying to understand what are we looking at? Tell us more about this dataset. So, we were just trying to capture what the analysts were seeing, so this is a look for -- an opportunity for us to look deeper into their processes. So, it's sort of at -- yeah, it's an area for us to gain more insight.

BY UNIDENTIFIED SPEAKER:

Q. Sean, have you done a similar analysis for the Stockbridge to -- yet? Or this is just Griffith to Stockbridge, correct?

A. No this is the entire system. Yeah, this is Griffith to

Sarnia.

Q. Ah, okay.

A. Yeah, and we --

Q. All right.

A. -- had three different call signs for Sarnia.

Q. All right. All right. That's --

A. We had RW, RE and SR.

Q. All right.

A. Yeah. And that determines if you're -- if it's coming into the west side of the station, if it's exiting on the east side of the station, or if it's central to the station, so that's -- but anyway, that's Sarnia.

Q. Okay.

MR. KEANE: So, we noticed that some of the notch-like profiles came back with deeper depths and we talked to GE about that. So, we put -- we understood what the cause was. It's that the -- mistakenly prophesied on using crack-like features, which provided less amplitude return than notch-like. And so, we just understood all of those different components of why GE was being a little inconsistent on the notch-like features, so.

I'm just going to make this a little bit bigger so you can read it, Ravi.

MR. CHHATRE: Yeah, please. Thank you.

BY UNIDENTIFIED SPEAKER:

Q. Then the original depth range? I thought this was the first crack run.

A. It is, but -- so GE reports their features within a depth bin, so 12.5 to 25 percent for example. And then when we asked for a profile depth and they gave us a profile and it had some of these notch-like features and depth profiles --

Q. Oh, the profile depths, okay.

A. -- that exceeded 25 percent.

Q. Okay.

A. And we said, well that doesn't make any sense. What's going on guys?

Q. Right. Yeah.

A. Yeah.

Q. Okay.

A. So, it was a -- the analysts had used the wrong sizing profile or algorithms for themselves.

Q. Okay.

MR. KEANE: So, they were more conservative than what they told us, but that's okay. They also reported -- this report contains ND features as a feature type. And we said, well, we can't just have things that you're not sure of. Just assume that they're all cracks and tell us how deep they are. So, that's what this e-mail is.

There was one other feature. It was called an inclusion like base metal ND feature. It had a descriptor called lamination possibly with contact to surface, external and internal. We said that's unusual. What's the analyst trying to tell us about that feature because it sounds like it's through wall if it's contacting the external and internal surfaces. And that comment was an error, so --

UNIDENTIFIED SPEAKER: So, Sean, when it says "see e-mail…" are those appendices to this document?

MR. KEANE: No.

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: Those are -- if we -- if you or if we wanted to go back and find those e-mails it's just a matter of just digging that up because it's --

BY MR. CHHATRE:

Q. It's traceable e-mails?

A. Yeah. Oh, absolutely, yes.

Q. That's all you're saying then?

A. Yeah. So, this -- when you look at this, this is a filing structure for e-mails right there, this bracketed system, so it's the program Line 6B 30-inch Gretna to Sarnia CD 2005.

Q. Now this --

A. So, it all gets filed into there, but I didn't want them to get lost, right? I wanted the important e-mails to boil out and so I've tracked them through the documents.

Q. This is Ravi. What kind of -- when you contract to GE what kind of quality control -- did you have? It looks like they are not -- the internal quality control on the document when they send it to you.

A. So --

Q. Is that a correct statement of the --

A. Well, I -- on the examples on the screen I agree with your comment except that I can't speak to all the quality controls in place in the day, so I'm just not familiar with GE's systems back in 2005.

Q. Okay. Is this -- would you consider the -- or a final report? Because a final report would have quality control features in it. The final draft would not.

A. The -- no, this would -- no, these were from the final report.

Q. Okay. Fine.

A. Yeah, so -- yeah.

MR. KEANE: So, we also asked them to define all the descriptors that they were using. By descriptors we mean anything within the comments. So, they were using things like striking and strong and we -- well, what do you mean by striking? What do you mean by strong? So, we asked for that definition. Once again, so that's just the analyst trying to convey something else and we're trying to understand well, what are they trying to convey?

So -- and you notice that -- you know, I don't know if you recall, but there is no features on this particular joint that failed that had any commenting behind it, so there was -- the analyst hadn't reported anything there on these features.

So, this is in table format. It doesn’t show up too clearly on the screen, but the excavation criterias in place that were used for feature selection and -- just bear with me a moment here. There's a US -- I'll just describe the various categories and then we'll get into the details. So, there's a USCD feature and so you can see that there's crack-like, notch-like, crack fields, et cetera. And there's some of the descriptors of interests, so those are a separate colony -- column and we'll talk about those further down -- you can see here.

And then we'll talk about the previous field validation and that was the nature of the feature and our ILI detection sizing abilities. This was our experience going into the 2000 -- into the selection criteria. So, these are the feature calls and these are our previous field validation and experience with these feature types or these descriptors. And then here was our Phase 1 digs and so we have our, you know, dimensions for fitness for purpose and our -- what's our investigation criteria trigger and additional notes and also some training results.

And then we'll walk back all the way across the time because we did more digs in 2008 and then 2009, 10 -- and some 2010 stuff. So -- because there was quite a few digs done here, lots of programs.

So, for crack-like features -- and I don't know if you want to walk through all the different feature types and categories and stuff because it's -- there's lots in this -- I mean it's a fairly big document here, so -- but I think it's worth walking through the relevant ones, those being crack-likes and crack fields.

So, crack-like, the nature of the feature is -- well, high expectation of crack with variable depth along the length, so a typical crack feature, single axial crack. And previous experience showed good ability to define depth and length. And within our excavation criteria, our dimensions for fitness for purpose. How did we calculate fitness for purpose? We used the best available ILI data. So, that means we'd use a feature profile if we had a feature profile. And if we didn't, then we'd use the maximum depth and total length of the feature.

And we'd investigate according to fitness for purpose. And there's a little sub-star on here and that's -- let's just go find it. I'm going to have to zoom in so I can read this text, but I'm just going to try and make it bigger just for a second here. I think that's a star. Yeah. And the star means, investigate according to fitness for purpose unless a descriptor indicates otherwise, so -- because there's some descriptors such as -- here's one called sliver -- we had done a lot of digs on slivers and we were finding nothing. There was nothing there. They were just little internal laminations, so -- so anyway. There wasn't --

BY MR. CHHATRE:

Q. -- a very narrow (indiscernible)? Is that how you would describe a sliver?
A. No. No. A stringer within the steel itself. An embedded stringer --
Q. An inclusion --
A. An inclusion.
Q. Manganese sulfide inclusion?
A. That's correct.
Q. Okay.
A. Yeah. Like a -- manganese sulfide inclusion.
Q. Okay.
A. Something like that. Very, very small, little --
Q. So, that's why they call -- they're calling it a sliver?
A. Right. So -- but they would call it a crack-like with a descriptor called sliver, so -- yeah, so not all crack-likes were the same back then. That's changed but --
Q. Okay.
A. -- in 2005 that's -- this is how it worked.
MR. KEANE: So note, so profiles for all 25 to 40s were obtained and we dug all of them -- or selected all of the 25 to 40s that had predicted failure pressures less than our previous hydrotest. So, the intent there was that with the best data coming out of the ILI tool, that with our conservative calculations for fitness for purpose, it was showing that it would have a predicted failure pressure that would have been below the

hydrotest pressure; therefore, it's showing a sign of growth. And therefore, it's coming out of the pipeline.

So, the programs back in the day were truly geared towards looking for signs of growth. So, any crack that looks like it could be growing should be coming out, so -- and that's exactly what this criteria describes. You can see it right there.

We're going to see the same thing on crack fields where we'll use the total length for the feature, but even aside from that if it looks like it's coalescing, well, the feature -- the cracks can only be coalescing if it's growing. And if it's growing it's got to -- we don't want that. So, that's why we had this longest indication greater than -- normally what we do is 3 inches, but for this program we dropped it down to 2.5 inches. There was a lot of SCC on this program, so --

BY MR. CHHATRE:

Q. Was this the first inspection?

A. This is the first crack inspection.

Q. So, how would you get the growth rate that the crack is growing that you want to know? How would they know the -- rate?

A. We don't know. But what we do know is, we have those leading indicators if the growth is present. So, that leading indicator --

Q. Like --

A. -- for us is --

Q. I'm sorry.

A. Oh, that's okay.

Q. What is the leading indicator?

A. Oh, something suggestive that growth could be present. So, do we have an indicator that maybe we're seeing a sign of growth there? That's all I mean.

Q. How would GE -- I mean I'm assuming that it takes -- how would GE know from these signals there's an indication that a crack is growing?

UNIDENTIFIED SPEAKER: Oh, go ahead. You can erase that if you want.

MR. KEANE: Oh, I -- it's just a single -- so within their C-scan -- so let's do -- just do top of pipe, bottom of pipe, and length. So, they'll end up with seeing -- they'll see stuff all along the long seam and then they'll see an SCC colony. So, wherever that SCC colony lies it'll kind of look like that. So, if that's their SCC colony that they see on their C-scan, they look for this. What's the biggest discrete connected reflector that they can find? And when they find that to us, if they're all small then, well, that's fine. It's typical of a shallow colony where there's lots of little chicken scratch, right? Lots of little stuff. But if the cracks are growing then they have to interlink together. And if they start interlinking together, right?

If that happens within a colony, then that's a sign of growth. So, therefore, if this exists then we want to go dig those. So, not only do we take -- this is a good example -- so we take the full colony length, this entire length, and the maximum depth of that colony and we do a -- calculation. Not a -- calculation, sorry, a fitness for purpose calculation. And if that's less than hydrotest, fine, we'll go dig it. But if this is long, longer than 3 inches is what we used to do, then that's -- it shouldn't be longer than 3 inches. Go and dig that because that could be growing. So, that's what it is.

MR. CHHATRE: -- not really a number to be --

MR. KEANE: There's nothing magic.

MR. CHHATRE: Okay.

MR. KEANE: Nothing magic. No. It's arbitrary selected from looking through other datasets, looking through -- well, let's -- right. If we take the longest of -- if you want to try and find the worst crack field feature, well, it's going to be the deepest one. Okay. What else? Well, it's going to be the one with the longest interacting interlinking cracks. Okay. Well, how many of those -- what's too long? Well, I don't know what's too long, but I can tell you that we don't have lots longer than 3 inches. Okay. Well, take all the 3-inch and longer. Okay. Well, what about 6 feet? Well, there's lots of crack fields reported. Let's go down to 2.5 inches. Let's get all that stuff. Let's make sure we understand it, so.

UNIDENTIFIED SPEAKER: So, the notes are really like instructions that you were going to put out on your D report?

MR. KEANE: No.

UNIDENTIFIED SPEAKER: How you're going to select the dig?

MR. KEANE: The notes are the criterias used to make the selections.

UNIDENTIFIED SPEAKER: Oh, okay.

MR. KEANE: Yeah. So, as --

BY MR. CHHATRE:

Q. Now, 25 to 40 percent that's your criterion -- or the GE's criterion?

A. No. No. GE has no criterion for our selection criteria for what we dig.

Q. Unless you have 25 to 40 percent?

A. What we do here is we obtain profiles for everything that's deep.

Q. Right.

A. So, 25 to 40s, that was the deepest stuff reported. Because we wanted to look at those -- the profile shapes. We wanted to understand those features, so we asked for those.

Q. And the 25 to 40, why 25 to 40?

A. They're the deepest things reported to us.

UNIDENTIFIED SPEAKER: That's the bin size.

MR. KEANE: Yeah. Oh, yeah, sorry.

UNIDENTIFIED SPEAKER: He's asking who sets the bin size?

MR. KEANE: Oh, GE -- GE does set the bin sizes. So, in 2005 they had less than 12½ percent, 12½ to 25 percent, 25 to 40 percent --

MR. CHHATRE: 25 to 40 percent --

MR. KEANE: -- greater than 40. Yeah.

MR. CHHATRE: Yeah. I knew about that.

MR. KEANE: Yeah. Okay.

MR. CHHATRE: I -- you know, I had a question at that time, but -- because the detection limit was considered lower than the things they were -- wasn't even reporting that, so I asked them and GE's answer was they can detect much smaller, but they were doing chemical sets.

MR. KEANE: Oh, yes. Yeah, we would probably agree with that too.

UNIDENTIFIED SPEAKER: We haven't gotten this document that Sean's reviewing.

UNIDENTIFIED SPEAKER: It's on my list.

MR. KEANE: Good.

UNIDENTIFIED SPEAKER: Okay. Oh, and you've got it, Jay?

MR. JOHNSON: No, but Matt does. I'm kind of --

UNIDENTIFIED SPEAKER: We're up to 50 --

MR. JOHNSON: -- handcuffed here with all my computer -- so, Matt's list was more thorough than mine.

MR. KEANE: It's -- obviously I think it's an important document.

UNIDENTIFIED SPEAKER: What's that?

MR. KEANE: It's a good -- it's an important document.

UNIDENTIFIED SPEAKER: Oh, it's --

MR. KEANE: It's a summary.

UNIDENTIFIED SPEAKER: Yeah, I can't believe this wasn't supplied to us with the 2005 spreadsheet we're looking at actually.

MR. KEANE: Okay. So, then --

BY MR. CHHATRE:

Q.   Do you have a length for that also that anything less than 1 inch --

A.   So, are you talking the crack lengths?

Q.   Right.

A.   So, the length is -- so investigate according to fitness for purpose, so figure out the critical length for a given depth.

Q.   Okay.

A.   So, everything was calculated to fitness for purpose --

Q.   So, 25 to 40 will dictate what the length will be?

A.   Precisely. So, you look at -- you'll end up with a profile and -- like a depth profile. We throw that into CorLAS, we determine a --

Q.   Length?

A.   Well, no. We determine a fitness for purpose calculation, so predicted failure pressure for that length depth profile and we investigate according to the results from that assessment.

Q. Okay. All right.

A. Okay. And so, if it falls below hydrotest pressure than that would have been -- that's our criteria.

Q. With -- criteria for immediate dig. It's the criteria to look at it, but for immediate dig.

A. So, the -- that's correct. It's a criteria for assessment. The criteria for immediate digs would have been if it was saturated, so anything greater than 20 -- anything greater than 40 percent would have been immediate.

MR. KEANE: Now, any of these -- we'll work our way down here, but anything with predicted failure pressures that need to -- that are low and potentially impacting integrity we would want to restore that safety factor of 1.25. So, we would have taken pressure restrictions as appropriate based on the fitness for purpose calculations.

So, then we just have our trending results, so depth trending meets tool tolerance or as conservative for all but one feature, profile depth aligns well with field max depth. So, we can probably skip getting into the details of this. Further down in the document where we just -- we show our trending so we can talk about it there.

UNIDENTIFIED SPEAKER: Does this table show how many of the crack-like features were --

MR. KEANE: That's further down also.

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: Yeah. So, from a crack field perspective we had a high -- of find SCC and good ability to define maximum depth and attracting length. Conservatively used max depth and total length. Investigated according to fitness for purpose and select all -- and select all the 25 to 40s -- so once again, everything that's looking deep and everything with long indications greater that 2.5 inches. So, anything that's looking like it could be growing, once again.

These trendings confirm -- and attracting lengths. Majority of SCC, some features with metal loss features -- 25 to 40 trend well. Several features less than 12½ reported below 12½ and 25 percent deep, so there's not a lot to this -- we'll talk in more details in the trending. So, crack-like --

BY UNIDENTIFIED SPEAKER:

Q. Wasn't there a feature on the -- oh, it was -- okay. Sorry. I was just thinking we had a crack-like feature that was in the 25 to 40, but --

A. Investigate according --

Q. Right.

A. -- to the profile.

Q. But it would have been an SE -- it wasn't identified as an SCC feature.

A. That's right. Yeah. So, and that's one of the ways that we could have selected this joint for digging is if we -- if we would have got profiles -- well, if we didn't use profiles then we probably -- then this join would have been selected for digging because it's 25 to 40. Not for the right feature, but we still would have got there.

Q. Right.

A. And -- yeah.

BY MR. CHHATRE:

Q. This is Ravi. So, it looks like the crack field you have a length even though it's 2.5 inches or more. Even if you had --

A. Yeah.

Q. -- in there. I don't see any length on the crack field under the first row. That's why I keep on asking you why there's no length.

A. I'm sorry?

Q. If you look at the crack field --

A. Yeah.

Q. That's 2½ -- you are giving the length of the feature more than 2.5 inches that requires --

A. That's right.

Q. But then if you go up on the top -- you're not seeing that.

A. Sure. And that's -- they're very different criterias. So, there's not -- these are -- we expect -- we don't expect that these are SCC. These -- sorry, this row is crack-like features. They should be -- our experience has been that they are single cracks.

Q. Right.

A. And a single crack is best assessed with a length, depth, how does it look, plot it out, determine fitness for purpose. So, there's not a need -- we're not looking for growth. We're assessing growth potential from comparison to hydrotest back in the day. That was the philosophy. So, there's not a select everything with the length greater than 2.5 inches. It does not apply.

Q. But is that philosophy still valid?

A. Pardon me?

Q. Is that philosophy still valid or you're putting in length in there?

A. So, yes, we still use this for our SCC --

Q. No. I mean the first row. There was a -- there's a single crack and --

A. We still use fitness for purpose as a criteria.

Q. So, there's no -- no length requirement.

A. There's a -- that's right. There's no --

Q. Okay.

A. There's no length maximum, yeah.

MR. KEANE: Okay. So, in 2008 we did some more digs and we got a better description of it down lower, but basically increase the selection of crack fields from a high density location. So, we had one area that had more crack fields on it, so higher density location. We wanted to understand, well, is there something in this dataset in here that's indicative of growth or what's going on, so let's take a look harder, so we did.

We extended out and did more digs in this location, so -- a very hard to get at location.

UNIDENTIFIED SPEAKER: But why in 2008?

MR. KEANE: Condition monitoring. Continuously expanding and understanding more information along the way. We're doing more in 2009 still, right, and 2010. Constantly understanding our pipeline, yeah. And it's not a ton of dates back -- you know, we did digs here and then we did corrosion digs and then we did some more digs here, but it's -- well, this -- here was one high density location of SCC rate at a wet/dry cycle. What's going on, right? So, it's an opportunity to dig and learn, so we're taking those.

So, I guess we can walk down and we'll see the -- some of the more specifics for this joint further down in the document. And then in 2009-2010 there was -- some more digs were issued. And largely these were geared towards understanding SCC as well, so.

Now, this is post-Marshall this Phase 3, so it may not -- so we can get more trends and more digs from it to understand the trending of the tool, but I don't know that that criteria applies to that -- the initial 2005 vintage because this is post-Marshall at this stage. And so that's why the document was updated since.

BY UNIDENTIFIED SPEAKER:

Q. Have you trended results for Phase 1 versus Phase 2?
A. Yeah.
Q. You know, as far as --
A. Growth?
Q. Yeah, exactly.
A. Yeah. Yeah.
Q. Okay.
A. And percent over three years.
Q. At?
A. Ten percent over three years. That's all we were really seeing, not a lot.

MR. KEANE: So, we can walk through all the different feature types. The other one that's interesting is the metal loss because we had a high expectation of finding shallow SCC at corrosion metal loss. That's what we knew. We knew from our series of digs leading into that the tool would probably be finding SCC at these locations, that it wouldn't be deeper than 30 percent, and so, we largely just used a -- we modeled them as 30 percent deep so we could put them onto the chart so we could figure out where they were. But largely, we weren't doing digs specifically for metal loss, but we were using it from a density perspective in understanding the condition of the pipelines from there.

Yeah, so non-specifically selected -- so if you used 30 percent and 6 inches that -- it says, well, there's many with fitness for purpose less than hydro, but there's non-specifically selected specifically for that observation, right. Like, the -- if the metal loss -- if this feature classification was deeper, if it had a more prominent signal, then the next category up would be for GE to call it a crack field less than 12½ percent. So, this is -- these are shallow crack fields according to GE.

BY UNIDENTIFIED SPEAKER:

Q. Now, how do you know that? GE just told you that?

A. Through our -- nope. This is through our own knowledge of how the ultrasonic systems work.

Q. Oh, okay.

A. So -- and how GE's classifications work, so. So, that's -- this is information that's going into our dig criteria. Why are we doing this? Well, we expect that this is shallow SCC, so we want to be able to -- once again, we want to be able to plot it up our charts if we can find it. We want to be able to understand if we've got digs with -- or joints with a whole bunch of stuff on there, we want to be digging some of this so we can characterize it properly.

Q. But it says many with -- hydro and then it says none specifically selected.

A. That's right. So, we didn't -- we weren't specifically taking a dig to go and mitigate a metal loss feature. So, we choose our digs sites and making sure that along the way that we were calibrating and understanding what these feature types were. So, this -- if you use 30 percent and 6 inches, it was very conservative is the point.

Q. Okay. That's what resulted in that -- hydro?

A. That's correct.

Q. Okay.

A. Because it's not a 6-inch interacting crack feature, right? That's the reality of it. It might be 30 percent deep for a wee little bit, but it's not 6 inches interacting. So, it doesn't even come close and you'll see that through the actual fitness for purpose. So, you'll see the depths that, no we were right on the 30 percent depth and we were also right in that -- it's not interacting, which is why GE's not calling it crack fields. There's just nothing in there yet. So, max depth was actually 20 percent there, so there you go.

MR. CHHATRE: Why are you finding metal loss?

MR. KEANE: Isn't that a confusing term? No, we're not calling it. GE calls it. That was -- GE's term was ML and that confused lots of industry for quite a while because they shouldn't -- so over the evolution of analysis and reporting procedures from GE this doesn't exist anymore. There's not a feature classification called ML. And now it's just called a crack field.

UNIDENTIFIED SPEAKER: And you're saying there were many with FFP less than --

MR. KEANE: If you used this incorrect criteria. And so, if I -- but maybe I overstate the incorrect, but I'm trying to put emphasis on that we assumed a 30 percent deep total length of 6 inches for all these features and we knew that that wasn't right. But we knew we wanted to get them up on our charts so we could see them, so we could trend them out. So, it's not -- we certainly didn't believe that these were 6 inches interacting crack length.

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: Yeah. We just wanted them on the plots. And we made note of that, that they are in the plots and that's -- right? That's why we're going to see them, so.

BY UNIDENTIFIED SPEAKER:

Q. So, what does GE do on a CD tool run where they do see metal loss?

A. Currently?

Q. Yeah. Well, if they've removed the metal loss --

A. Yeah.

Q. -- classification, but, you know, the tool is running by areas of metal loss and --

A. They see --

Q. -- it probably looks like metal loss, you know --

A. Yeah. They call it crack field. We have done a lot of digs to find metal loss on 6B.

Q. So -- well, we don't have to talk about it now. It just seems like maybe that's almost a step backwards.

A. Well, yeah, in some ways, but also it speaks to the reasons and -- the reason why we don't add corrosion depth and crack depth together because it's just -- all of our trending has never supported that it needs to be done because the crack took sees the full -- the full penetration of the crack. So, whether it be a shallow crack in deep corrosion or a deep crack in shallow corrosion it sees the same thing, so we've got a lot of trending to show that. That's why GE sees this feature and can't tell it apart from this feature. It's the same type of understanding, so it's --

Q. Okay.

A. It's an unfortunate thing for us because we end up doing a lot of digs that we don't need to be digging. We dig up -- the corrosion team's -- a lot of their shallow corrosion for them, but that's okay. That's what we do.

UNIDENTIFIED SPEAKER: A little bit off topic, but you mentioned there were two vendors. Do both vendors report categories using the same terminology?

MR. KEANE: Largely the same, yes.

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: Yeah, very similar. Yeah, so in here the trending results max depth of 20 percent. So, approximately half was found as metal loss, half was SCC. So, about typical of our experience, so -- for us this was nothing to bat an eye at. This was not a concern. This is per expectation. Metal loss, shallow SCC, yeah, we got it out there.

It might be easiest to just scroll down now to the document and then we can start walking through some of the programs themselves. This gets cumbersome to read through, so. But maybe as an observation you can see that it's -- there's lots of these other descriptors of interest, they're rolling defect mill marks, surface breaking laminations, laminations possibly with contact at girth weld, possibly contact at surface, curved, striking, what do they all mean?

UNIDENTIFIED SPEAKER: They just don't fit a category and that's why they --

MR. KEANE: Well, they're -- it's an additional descriptor that's applied to the category, so it's a --

UNIDENTIFIED SPEAKER: Which category are those --

MR. KEANE: It could be anything. So, it could be a crack-like feature with a comment beside it that says striking.

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: Well, what does that mean to us? And so -- provided by the ILI analyst to indicate an atypical ultrasonic signal. Oh, well that's good. So, notes, investigate all unless fitness for purpose indicates otherwise. So -- good, right? So, what are we going to do with these striking things? We're going to dig. Well, how many are there? Well, all of these. Look at them. There's 11 striking ILI features, select all. Thirty-seven striking geo features, none selected. Well, a striking geometry feature? There's nothing there. Thanks, right? That wasn't very useful for us. One striking notch-like feature. That's not selected -- no flow, so it describes --

MR. CHHATRE: Do you have any idea what the typical cost for a dig is?

MR. KEANE: A typical cost for a dig?

MR. CHHATRE: And I realize it could vary from location to location, but --

MR. KEANE: Yeah, and timeframe also. So, the current cost for digs are -- they range I would say somewhere between 125 and 200,000. Jay, does that just ring a bell?

MR. JOHNSON: I would have said, you know, a base cost is $100,000.

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: To dig a segment?

MR. KEANE: No. To dig one joint.

MR. JOHNSON: To do a dig.

MR. KEANE: A pipe.

UNIDENTIFIED SPEAKER: Yeah, a joint.

MR. KEANE: Oh, yeah, yeah.

UNIDENTIFIED SPEAKER: I'm sorry.

MR. KEANE: So, we did 142 digs on this one back in the day.

MR. CHHATRE: And what is the typical cost for an ILI run?

MR. KEANE: Around -- you know, we --

MR. CHHATRE: I mean from where you call it --

MR. KEANE: By the time it comes to our door, somewhere around the 3 million mark for a crack tool inspection.

MR. CHHATRE: And that is from (indiscernible) use -- pig inception to pig discharge point? Each one of them?

UNIDENTIFIED SPEAKER: Trap to trap.

MR. KEANE: Trap to trap section, yeah.

BY MR. CHHATRE:

Q. What was that? One?

A. Yeah.

Q. The cost is what?

A. Well, it depends on length and it depends on many things, but --

Q. Right. I understand, but that's why I'm saying --

A. -- but I wouldn't be surprised somewhere in that 1.6 to $3 million range, 1.5 to 3 million. It depends a bit there so. And the best one to answer those questions would be somebody like Gary Summer (ph.).

Q. Okay.

A. So, if you have -- if you want specific questions for ILI costs --

Q. No, I was trying to get a feel --
A. Yeah, yeah.
Q. -- of the costs we are looking at when I see so many digs.
A. Yeah.
Q. I'm just trying to -- do a rough calculation in my mind as to what's involved.
A. Yeah. With so many digs, yeah. And that's why those above us have big pockets.
UNIDENTIFIED SPEAKER: Not to get too far off topic, but do they change their price structure based on the pipeline? Like, you know, you got a brand new MD coated pipeline versus a PE tape coated pipeline?
MR. KEANE: So, that's part of the vendor agreements that we have with them and to my knowledge, no, we don't. So, the -- so they lose money when they run a line with a lot of features on it -- well, maybe not lose, I'm sure they don't lose, but -- but certainly they're happy when they run one of our new lines that has three features, yeah.
UNIDENTIFIED SPEAKER: Sure.
MR. KEANE: Thanks.
UNIDENTIFIED SPEAKER: Thanks. I wondered about that.
MR. KEANE: Yeah, so. So, the excavation program prior to excavation, so no immediate excavations were identified. Milepost 1806 contained a growth level with several crack-like

features on it that were deep. So, I'm just kind of skipping through it here, but it indicates that we took a -- we used the recent pressures at that location -- no, hold on here. We imposed pressure restrictions based on fitness for purpose divided by 1.25. And we recalculated that using the depth profile, so it just describes what we did for the one feature itself.

This document documented everything so you'll getting the full deal here. So, this phase of the program identified everything for the near term impact to integrity programs. The results of this will be fed into Phase 2, so this first go round had 42 girth welds on it for 210 features. So, we did -- put some additional pressure restrictions on -- just if I could give a quick summary. Here's the features that we were digging. You can see that there's a few of them that with the as-issued profiles and everything that stand out in the crowd here, so they're a little bit lower on the chart, so.

You can see that -- no surprise to those that know 6B well, but there's a lot more features downstream of these two stations here and less upstream. Concentration close to the stations, looking for trends, looking for observations within the dataset, joints of interest, what's going on, right. Close to the station, base metal stuff. So, here's an assessment of the 2008 when we did some additional assessments. So, we extended this dig site to encompass all of these girth welds. It ended up excavating out this large quantity of crack field and metal loss features.

BY MR. CHHATRE:

Q. Now, didn't -- would have any girth weld leak -- and when I say -- I mean leak, you know, leak, rupture, crack?

A. The girth weld? Yeah, we have had due to -- not due to SCC.

Q. No, but I mean --

A. Yeah, we have seen girth welds with cracks in them.

Q. And those cracks were manufacturing cracks that time?

A. Yes.

Q. MR. CHHATRE: Well, not manufacturing, installation --

A. Yes.

Q. -- cracks or they were --

A. They were manufacturing flaws.

Q. And so this line never went through virtual x-rays when you were constructing?

A. Off the top of my head, I'm sorry, I don't know.

MR. JOHNSON: Historically, the Enbridge specifications call out for 100 percent girth weld inspection by x-ray.

MR. CHHATRE: At the time of the --

MR. JOHNSON: Yes.

MR. CHHATRE: That's why -- how can you explain these cracks being present and not detected?

MR. KEANE: The girth weld cracks?

MR. JOHNSON: You can't go back on that from -- you know, you can't address, you know, what they did in, what, '68, you know, what their criteria was for the x-ray, what their quality control was.

MR. CHHATRE: But even going back and kind of like cross check these features with the x-rays?

MR. JOHNSON: You don't save x-rays.

MR. KEANE: X-rays don't last. They deteriorate quickly.

MR. JOHNSON: Actually, especially after five years. It'll give you -- it'll cause more problems in reading them than help you, so we keep them for one year. That's the requirements.

MR. CHHATRE: So, no microfiche or nothing like this?

MR. JOHNSON: No.

BY UNIDENTIFIED SPEAKER:

Q. Have you broken down the crack-like features that were dug internally connected versus externally connected?

A. Within this dataset or just generally speaking?

Q. Yeah, or -- yeah. I know there's -- the graph has the different dots, but those don't show up for a while. I'm just trying to get an idea of how many were internal versus external crack-like features.

A. Oh.

Q. I'm guessing that maybe on this one there were more external?

A. Yeah, certainly there'd be more external. I was wondering if I've got -- on those. Well, I don't think I know off the top of my head.

Q. All right. We don't need to get --

A. Yeah, there would be -- there certainly would be more external though by quite a bit, so.

Q. And I guess the reason I ask is that from, you know, experience on -- just in general with the CD tool it seems like if the tool is going to miss or mischaracterize a crack-like feature it seems like it misses more on the internally connected than the externally connected?

A. Hmmm.

Q. I don't know if you've seen that, but that's something I wouldn't mind fleshing out at some point.

A. Okay.

MR. CHHATRE: This is Ravi. What's your logic for that?

UNIDENTIFIED SPEAKER: It could be the way that the ultrasonic signal enters the pipe, you know. Because it's entering near where the defect is maybe it has a harder time catching it as opposed to being on the external radial position it's got a chance to -- along with it. That's a question I wanted to ask Sean.

MR. KEANE: Yeah, I -- I don't know off the top of my head --

MR. CHHATRE: But it would be much easier for GE to identify those when it's in the data rather than go back -- they can identify those.

MR. KEANE: For GE to look at the -- which portions?

MR. CHHATRE: Just internal versus internal, like --

UNIDENTIFIED SPEAKER: What were you asking? Crack-like?

UNIDENTIFIED SPEAKER: Right.

UNIDENTIFIED SPEAKER: I mean you can just alter the data.

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: There's a lot more -- there's a significant -- I only counted 17 internal crack-likes on 2005.

MR. KEANE: Yeah.

MR. CHHATRE: Okay.

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: Because I get 224 external crack-like features --

MR. CHHATRE: Okay.

MR. KEANE: So, yeah.

MR. CHHATRE: So, that's why they say that it's easier to miss internal versus external.

UNIDENTIFIED SPEAKER: Well, just thinking from previous failures, you know, over the last several years and it seems like they are -- have been primarily internally connected cracks.

MR. KEANE: Yeah.

MR. CHHATRE: Was it --

UNIDENTIFIED SPEAKER: Yes, it was.

MR. KEANE: Okay. Okay. So, the last -- the tail end of this document starts to get into some more trending. And so, the -- so the two charts below show a similar trend -- I have to refresh myself here a little bit. So, these were -- so I think -- yeah, this chart here showing the SCC that we dug up in 2008 is part of that -- the extension of those joints, so that 2008 SCC excavation. And then comparing it to all the other SCC we found elsewhere, so that's all that is.

So, on these depths, these unity plots, what you see is the maximum depth of the bin from the ILI side plotted out against the field maximum depth, so. So, and there's --

UNIDENTIFIED SPEAKER: By feature, that's what we're looking at here?

MR. KEANE: Pardon me?

UNIDENTIFIED SPEAKER: This is by feature?

MR. KEANE: Yeah, for each feature it's plotted out, yeah.

UNIDENTIFIED SPEAKER: For each feature, okay.

MR. KEANE: And so there's comments wherever there's non-conservative data, so anything non-conservative, anything above this red band, so tool tolerance band.

UNIDENTIFIED SPEAKER: So, in your mind would that indicate growth then from the 12½ percent?

MR. KEANE: Well, potentially. And so that's what we indicate here is -- so these ones are excavated 2½ years after the USCD inspections, so growth may have occurred since the tool call. So, it's -- you know, it's 12 percent coming up to this about 20 percent, right? Because here's the trending earlier on versus the trending -- it's kind of in the same range. It's really not that different.

BY MR. CHHATRE:

Q. Go back to earlier slide, please? Now, the comment was that the growth may have occurred?

A. Yeah.

Q. Now, you do have the growth rates, right, I mean for SCC or corrosion fatigue? You do have the growth rates for those two mechanisms?

A. Yes.

Q. CHHATRE. Now, how does those numbers jive with what you're measuring? I mean if you add --

A. Well, but that's -- I guess that's the point here, Ravi, is that when you look at the trending here, the -- so the earlier on digs versus these ones in 2008 -- so let's focus on this one, right? So, just over this red dot and this guy just over the red dot, well, I mean I think you're -- we're splitting hairs if it was the same trending or not. That's the problem is it's very close, so --

Q. But I --

A. The time interval is very short, so --

Q. I know, but I mean I was kind of looking at --
A. Yeah.
Q. -- some kind of validation to those numbers. If those numbers -- if your crack --
A. Yeah.
Q. -- assuming ILI is giving you accurate numbers --
A. Yeah.
Q. -- that -- is more than two years multiplied by your growth rate.
A. Yeah.
Q. And then there is some possibility of growth and then you can -- that your growth rate being correct.
A. GE's -- it would be walking at a pretty tight line there from a time perspective, so.
Q. Okay.
A. And I -- yeah, the ability for -- I mean the feature could have started off down here and grown to there in two years. Or did it go from here to here or was it always here? Right? There's a lot of variability in trying that assessment. I'd be very cautious in it.
Q. Okay.
A. Yeah. But certainly we didn't look at that along the way. So, here's the trending for -- I'm sorry, the graphs aren't labeled well.
Q. You don't --

A. It was really designed to be --
Q. To me then, then you shouldn't put that comment in there. Because if you are not sure the growth occurred --
A. Yeah.
Q. -- from which point to which point, you really are not sure, so you can't qualify that thing as probably due to growth.
A. No, no. We didn't say probably. We just say --
Q. -- something like growth in there.
A. Well, it says growth may --
Q. Put -- instead of growth.
A. -- may have, right? It doesn't say that's growth. It may have. Think about this, yeah, there's a trend.
Q. I know, but I'm saying you can't really have it both ways.
A. No, no, no. Yeah. Yeah, so -- and then for this top one it's important to note that -- so the deepest portion of this SCC here was -- it's about an inch long, which is at the detection limits for the tool, so --
Q. Yeah.
A. So, you know, we -- it's pretty close to the trending. It's just outside, but it's also less than an inch, so we weren't even sure, right?
Q. Okay.
A. But we still trended like that.
MR. KEANE: More training, more observations, more

comments specific to the different programs themselves.

BY UNIDENTIFIED SPEAKER:

Q. Which -- that second one, when was that?

A. This one?

Q. So, there's -- that one's from 2000 -- or no, the one before it was from 2008, the 2008 digs?

A. Yeah, so crack fields from the 2008 digs.

Q. And then --

A. And crack fields from other Phase 1 digs is here.

Q. Oh, okay.

A. Yeah, from all the other ones.

Q. Okay.

MR. KEANE: And then these are -- the metal loss features outside of the 2008 digs is shown here. And then these are the metal loss digs within that assessment area, so once again, a little big deeper. But is it -- did it go from there to here? Well, it's not one feature. Did it go from here to there? Well, it's just -- it's still consistent with the tool call, to be quite -- it's still consistent with our own expectations too, so. And then opportunistic digs, so in here there was another 81 joints dug as part of the corrosion programs. And on those joints there was crack features, so here's what they dug for us. So, that was very nice, thank you very much corrosion guys.

And then there's a Phase 2 program, which it's described a little bit in here. It's a little convoluted because we got mixed up with some timelines with timeframes associated with getting the programs out and with our tool runs, so we're trying to line things up. So, as soon as that -- when the 6A tool hit the valve we said, oh crap, that's going to impact our ability to get our 6B tool running, which was scheduled -- which was going in right away. So, then we wanted to -- more digs and so that's what's described in here. So, it's just continuous monitoring -- yeah, it's all part of that.

BY UNIDENTIFIED SPEAKER:

Q. So, with the 2010 run, you'd start a new document like this?

A. Yeah, that's -- no, well, we do something completely different now. It's more -- it's more defined. It's just different. It's got a different structure behind it, so.

Q. But you wouldn't update this document?

A. No.

Q. Next run starts anew?

A. Yeah, yeah. This was -- you can see it was very ad hoc kind of style. It was -- the programs were being developed and they were different, so there was documenting all the decision making and learnings along the way.

Q. But the information will be carried over to the 2010 document?

A. Absolutely. The information --

Q. I mean some of it at least.

A. The information within here formed all of the enhancements and improvements that are currently existing in all the process documents for all the crack -- systems.

Q. Okay.

A. So -- all part of that.

MR. KEANE: So, some of the inspection details and some of Phase 3 digs. I'm just going to kind of skip down a bit because this is more areas that you're familiar with now. So, trending highlights -- so no fitness for purpose outliers that exceeded the crack tools or crack programs -- safety factors, except for those on the field joints, depth trending for 25 to 40, depth bin is with vendor's reported tolerance, so 7½ percent bias. The 12½ percent bin was -- had a 9.28 percent bias, which you see on the chart in front of you. Less than 12½ was a 12.9 percent bias.

MR. CHHATRE: When you say bias meaning air or bias meaning --

MR. KEANE: Yeah, so here, this is -- so depth trending prior to July 26th, 2010, so it's little tricky to see on the screen here, but if we have perfect unity alignment between our USCD and our ILI field --

MR. CHHATRE: 35 is low, yeah.

MR. KEANE: Yeah, yeah. It'd be right on this dark blue line here.

MR. CHHATRE: Right.

MR. KEANE: Now, so there's 25 to 40, so we had one that was just a little bit outside of the tool -- or pardon me, just a little bit above tool tolerance, sorry, within tool tolerance. Here there are metal loss features kind of where we thought they would be, but nothing long and interacting, therefore safe from a fitness for purpose perspective.

Our 12½ to 25 feature are here, so we're seeing right up to the one tool tolerance only. And the less than 12½s had a little bit more, but there's, you know, a couple features of note, so D and A and a bit of description for where they are just below. We calculate fitness for purpose unity plots, and so, it's all -- it's all conservative and where it's non-conservative you can see that the values are well above their flow stress levels. So, once again, these -- you know, the accuracy and the validity of calculating stuff way up at this 1.4 or 100 percent SMYS, 105, 110 percent SMYS becomes a bit of a challenge, so we -- you kind of expect a bit of a scatter up here.

BY UNIDENTIFIED SPEAKER:

Q. So, where those values time adjusted at all?
A. No.
Q. No? So, the --
A. That's as we found them, yeah.
Q. As found --
A. Yeah.
Q. -- three to five years later?

A. Yeah. Yeah, we didn't try and back grow them and shift them on the curves or anything, no. So, if we -- if we dug this one in 2010 and we thought it was here then that's where we'd plot it. We wouldn't have shifted it and said, well, it should have been over here.

Q. So, is it all features regardless of the classification? Like if there was --

A. Yeah.

Q. -- 25 to 40 then it -- okay.

A. Yeah. So, everything that you see here is shown here.

MR. KEANE: This stuff on the zero line that's because the field was defined as nothing. So, it's not unusual that we do digs and we find a non-crack feature because sometimes a corrosion will reflect something, right? Or sometimes you'll have some sort of geometric reflection occurring, so that's what these are.

Some more specifics about those details, so feature A and feature D. There's nothing too crazy about them. You can read about them after. And then some trending -- yeah, well, here's the trending for the two on the failed joint. We didn't really know, but we just kind of threw numbers out there. Deep, so it sort of stands out in the crowd. And then some more trending based on the additional digs completed to date, so some of the more recent times. So, now, it's been five years and we start to expect some growth and so it's not unusual that we'd see some. But largely, everything is still within the -- aligning with our 2005 trending, even though it's 2010-2011 some of these digs are done.

MR. JOHNSON: So, had the tool been able to run in November/December 2009 --

MR. KEANE: Yeah.

MR. JOHNSON: -- would the features on the failed joint most likely have caused an early call to you from the vendor or --

MR. KEANE: Yeah, that would be our expectation that they would have called us on that, so it should have been greater than 3.

MR. CHHATRE: Based on this graph or based on graph previous to this?

MR. KEANE: Regardless. If -- because we originally had a tool in the line, right? And so, if we would have had that tool in the line and the vendor had analyzed it, Jay was asking would I think that the ILI vendor would have called us with an immediate priority dig -- yes, I think they would have.

BY UNIDENTIFIED SPEAKER:

Q. Wait, was the crack -- the failed joint was a -- or the failed feature was that 51-inch long crack?

A. That's correct.

Q. So, what would be different?

A. If --

Q. You said over 3 inches. Well, it was already over 3 inches.

A. Sorry?
Q. You said you would get a call because it would be longer than 3 inches.
A. No. No, no, no. Greater than 3 millimeters, greater than --
Q. The depth.
A. -- their saturation point.
Q. Yeah, okay.
A. Greater than the saturation point. Not length.
Q. Okay.
A. But just depth.
MR. CHHATRE: But the rupture feature, how deep was it?
UNIDENTIFIED SPEAKER: In millimeters -- about 80 percent, 85 percent.
MR. CHHATRE: So, a lot deeper than your saturation field?
MR. KEANE: Yeah.
UNIDENTIFIED SPEAKER: More than -- right?
MR. KEANE: Yeah. Oh, absolutely. Much deeper. Yeah. So, this is --
MR. CHHATRE: In 2005 does it show the saturation field in there or does it show -- would it tell me -- there's on signal scattered or --
MR. KEANE: Echo loss?
MR. CHHATRE: Echo loss.

MR. KEANE: Echo loss doesn't exist for crack features because --

MR. CHHATRE: Okay.

UNIDENTIFIED SPEAKER: It's sheer weight.

MR. KEANE: Right. Exactly, we're sheer weight, so --

MR. CHHATRE: Yeah, you're sheer weight, but --

MR. KEANE: So, we're bouncing sound down like this and if nothing bounces back we go, good, there's nothing there.

MR. CHHATRE: Oh, I see.

MR. KEANE: Right? So, we need a reflector, so as soon as you put a reflector in the sound bounces down and hits that reflector and comes back and you go, oh okay, that's what's there. Thank you. So, unlike wall measurements where the absence of signal coming back tells you something, yeah. So, they get -- they can learn from absence and presence of their signals, but we only can learn from presence of the signal. Absence doesn't mean anything necessarily.

UNIDENTIFIED SPEAKER: The saturation on that would have been greater than 40 percent, is that what --

MR. KEANE: Yeah, greater than 40 percent would have been their saturation point back in 2005.

So, we did break out some of the other trending and these plots were provided to us from DNV. So, of course, we had DNV go back and take all the ILI data and trend -- all the NDE reports, you guys take a look, did we miss something here, right?

So, they went through and they re-trended everything you could imagine. And so, they plotted out for us and you can -- it's the same stuff. But we broke --

UNIDENTIFIED SPEAKER: And these were built from what you provided? This report?

MR. KEANE: Yeah, that's correct.

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: Yeah. Now, the cracks and corrosion trending -- so this is just a subset that we filtered out because we were wondering, and I'm sure others had too, but what's our ability to size cracks and corrosion and corrosion and how does all that work? And so the blue dots on this graph show just the field cracks only. And then the red dots show the cracks and corrosion. So, you can see that -- not a lot of difference between the two. In fact --

MR. CHHATRE: Can you repeat that again?

UNIDENTIFIED SPEAKER: Yeah, what --

MR. KEANE: Yeah, the red --

BY MR. CHHATRE:

Q. Field crack and --

A. Yeah, so the red -- the red squares are the -- if there's only -- if there's a crack and corrosion, red squares crack and corrosion. So, there's the metal loss and a crack at the bottom of it.

Q. Okay.

A. The blue diamond is only a crack with no associated metal loss on the surface.

Q. Okay.

A. Okay. So, if there's only a crack with no metal loss on the surface then those are the blue trends. Now, remember that this is all of the data including all our most recent digs, so there's some -- you know, we expect that there's going to be some growth here from the previous -- excuse me, from the previous plots. So, that's what you're seeing here.

But -- but if you look -- the important part is are you -- are we seeing an ability or inability of the tool to see cracks and corrosion. And the answer is no because that's still catching the right components. We're still seeing the right total penetration of crack and corrosion. And that's been our understanding previously -- this is consistent with our experience, so.

UNIDENTIFIED SPEAKER: So, it's -- is it common to see cracks without any corrosion in the -- in your experience?

MR. KEANE: Well, yeah, defining corrosion is part of the discussion that Ravi was talking about earlier, what initiates how much corrosion is present before we call it corrosion. So, is a little bit -- is this much surface -- just like the table, is that corrosion? Not to the ME tech.

UNIDENTIFIED SPEAKER: Right.

MR. KEANE: To Ravi's detailed technical perspective, yeah that's corrosion because you've got something there. So, what came first the chicken or the egg? Well, to the ME tech that's a smooth surface, that's just a crack. So -- but if there's -- if he can -- if he could -- I would say, if he could feel it he's going to call it corrosion. And so, that's crack and corrosion. And we've looked at the combined depths, the total depths every which way and the trends speak for themselves.

BY MR. CHHATRE:

Q. Does the ME technician describe to you guys what kind of corrosion he's seen, the crack and corrosion? Does he tell you what kind of corrosion --

A. Well, we get the photos at site, so he takes photos, typically --

Q. Well, do those photos tell you? Do you think --

A. Well, he --

Q. Do you think it's -- loss that I'm looking at?

A. We seen general metal loss and we see -- we'll see it within pits as well. We'll see both, yeah.

MR. KEANE: So, the rest of the report -- oh, there's the last slide, there you go. So, this is just if we were going to try and derive some sort of form of unity -- you know, can you put a scatter to this or put a line through that plot? I wouldn't put a line through that plot myself, so -- but anyway.

MR. JOHNSON: Well, you did and it just didn't work out.

MR. KEANE: Well, someone said -- oh, yeah -- we put a line through a plot. And we went that doesn't make any sense, but that's okay. So, there's a line on the plot. There you go.

UNIDENTIFIED SPEAKER: Put a circle on it.

MR. KEANE: Pardon?

UNIDENTIFIED SPEAKER: I'd circle it.

MR. KEANE: Yeah. Yeah.

UNIDENTIFIED SPEAKER: Or put a square around it or something.

MR. KEANE: Yeah, so.

MR. CHHATRE: Oh, correlation would be good, you know. Correlation would be very good. I guarantee you that correlation -- because equal numbers are not inside.

MR. KEANE: But you're right though at times -- sometimes stats can work --

MR. CHHATRE: Oh, I can tell you --

MR. KEANE: It's horrible if you can -- you can misuse it so much, but you can, so anyway, that's sometimes just -- that's the way to display it for us.

So, there you go. That's a lot of stuff. Yeah.

BY UNIDENTIFIED SPEAKER:

Q. Now, we have some outliers that we see here, you know, from the unity -- you know, what we saw --

A. Yeah.

Q. -- well, at the rupture site. Have you seen any outliers like that in any of the other lines? Or is that -- or are those outliers outside of the -- what you've seen in the past?

A. Well, the rupture site is certainly outside of what we've seen in the past. From my experience, we had on Line 6A -- shortly after Marshall we found -- we were doing a dig and we found one feature that we issued a safety related condition to PHMSA. We said we're taking this line down in pressure until we can understand what's going on and -- because there was a significant outlier there. We needed to understand what it was.

So, now, the -- that outlier was -- contributed to a few different things, but largely that was the tool had -- it really had just undersized that feature for a few different reasons. And what we saw there was we were able to sleeve that feature -- we reran the tool and they picked it up, no problem. So, they characterized it as greater than 40 percent like it was.

Q. Okay.

A. And so --

Q. So, for some reason when the tool when through, it mis-sized that particular feature?

A. The first time, yeah. Yeah.

Q. The first time through?

A. Yeah. So, what GE did is they applied their latest greatest algorithms to sizing where they take a single -- it's not just you need three pixels in a row to have some sort of -- like a depth amplitude to figure out the depth, but they just take any single point. So, they applied that any single point algorithm for sizing and that bumped it up a little bit in depth, but not enough. And then they ended up basically recalibrating their saturation amplitudes. So, that means recalibrating how they set up the tool, the analysis processes. And that shifted right up to where it was supposed to be.

And so, when we looked at the old data that's what they could to do get it there, but on the rerun it was there already, so we just fully leveraged that rerun data and went from there.

MR. CHHATRE: And that's trying to fill the data, but that -- was that trying to -- that way when the run was made? I mean you're saying --

MR. KEANE: No, so there's corrections made -- as part of the analysis process for the ILI tool one of the early steps that they have to do is they have to set up their -- what they call their saturation amplitudes. I think that's the term. And they -- that's based on a whole bunch of stuff that is beyond my expertise. But I understand the importance of that at point, that they need to do this and it's an understanding of how much amplitude's coming back. And it's based on a lot of different science.

So, they're looking at the overall amplitudes coming back far back in time and different -- scenes and all their history, everything that they've built upon. But they didn't get it right on the first tool run, and so that was the -- we made -- they had to reissue that report for us. They had to fix it and we did -- we did a rerun.

MR. CHHATRE: This was -- another run was run on that ruptured section?

MR. KEANE: Yeah. Yeah, that's correct.

MR. JOHNSON: Not the ruptured section.

MR. KEANE: No, that wasn't a rupture. That wasn't a rupture.

MR. JOHNSON: This was Line 6C.

MR. KEANE: Yeah. Yeah. It wasn't as deep as Marshall or anything, but it was -- it was deep. It was deep enough that it made us issue a safety related condition.

MR. CHHATRE: And did that change any of the indications?

MR. KEANE: Yeah, it did.

UNIDENTIFIED SPEAKER: It changed the whole report, right?

MR. KEANE: Yeah. We had to reissue the report. Yeah, the report was wrong.

UNIDENTIFIED SPEAKER: Because of the saturation --

MR. KEANE: Because of that combined with a few added little things along the way that -- it largely came down to the -- the tool just wasn't calibrated right, so -- we found it as part of the dig results. They just weren't looking right. We found this feature and went, whoa, it's not right, so --

MR. CHHATRE: So, how much confidence would you place in

2005 ILI on there --

MR. KEANE: Well, the 2005 -- the dig results -- we had so many digs completed, that I think those have to speak for itself too, so --

UNIDENTIFIED SPEAKER: Right. If you got 142 digs.

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: You know, and they trend --

BY MR. CHHATRE:

Q. But this one they also had digs, right? I mean the one that did not measure the outlier and they corrected it, didn't you have the digs on that one too?

A. We were in the middle of -- we were digging.

Q. Right. Whatever digs you had, how did it compare?

A. Some of them were okay.

Q. Yeah, and so --

A. Yeah. Some of them were okay, but we weren't -- we didn't have 142 digs in, yeah.

Q. And so, how can you (indiscernible) numbers? So, how can you justify the numbers match as the accuracy of the tool then?

A. So, if -- we dig a statistically relevant sample set and when we do that, we use stats. So, we make sure that it's statistically relevant and we hadn't done --

Q. (Indiscernible)

A. We were just getting there, right, so we weren't there

yet. So, were we here -- did we have --
Q. So, in 2005, do we have statistically reliable numbers?
A. Yeah. Oh, yes.
Q. And if you were continue your dig without running it another time --
A. Yeah.
Q. -- what numbers would I need? We wouldn't know.
A. If -- sorry? If we were --
Q. You ran the tool again, right?
A. Yeah.
Q. Because of outlier?
A. Yeah.
Q. If you were not to run the tool until you finish your digs, all the digs that you're supposed to be doing --
A. Yeah.
Q. -- what statistics would I need? We don't know because you didn't do all -- finish all the digs, right? So, you do not know the numbers would have been statistically reliable. So, you're saying you need statistics to say the run was accurate or not?
A. No, no, no.
Q. Oh, okay.
A. When we do our -- here. This probably easier to show you. It's an ugly slide, but -- so in our feature selection criteria, so there's all these core components --

Q. Okay.
A. Blah, blah -- et cetera, et cetera. But at the end of the day, we use this tool performance validation, so a number of features to achieve 80 percent confidence level.
Q. Okay.
A. We use -- here's the general statistical formula.
Q. Right.
A. But it's proportional sampling --
Q. Okay.
A. -- to ensure that we've achieved at least 80 percent.
Q. Okay.
A. Yeah. And so once -- so that -- and that results in a number of digs. And once we've hit that number, then I would agree that, yeah, it's probably there, but --
Q. But my question is, when you -- when you asked GE to rerun --
A. Yeah.
Q. -- because of one or two outliers --
A. Yeah.
Q. -- how far were you -- you didn't complete your digs --
A. Yeah.
Q. -- to reach -- to use that formula and find out if you are within the 80 percent or not. I thought you said you were in the middle and you didn't complete?
A. Yeah. I don't know where we were within the program

itself.

Q. So, you really cannot say that you either would or would not have made a very similar dig to 2005 digs?

A. Yeah.

Q. Right? In 2005 you made -- you made the 80 percent statistics.

A. Yes.

Q. You could have made 80 percent statistics if you were to complete all the digs before GE ran the tool second time. You could not have, but I mean -- you do not know. You can't use dig as a criteria then necessarily to qualify the accuracy of the tool then? You don't have enough data to say that. You do not have the data of that run that you had GE run again.

A. Yeah.

Q. You didn't complete your digs, so you really can't compare -- you cannot say that my dig match 80 percent in my criteria, what I could have said the two.

MR. JOHNSON: They had already blown the criteria by missing it.

BY MR. CHHATRE:

Q. No, I mean the comment made was because you made the 80 percent (indiscernible) -- 2005 run is accurate. I mean that was kind of a comment.

A. For the 2005 dataset?

Q. Right.

A. For -- yes, for Line 6B --
Q. Right. Because of --
A. -- we had dug --
Q. -- because of --
MR. JOHNSON: But then he's talking about another one, not 2005.
MR. KEANE: That's right.
MR. JOHNSON: He's talking about the one on 6A where they had the big outlier right away.
MR. CHHATRE: Right. And the comment I'm making is because you guys did not complete all the digs you were planning to --
MR. KEANE: Yeah.
MR. CHHATRE: -- you cannot say that again in that erroneous run, if you would, you would not have met this criteria.
MR. JOHNSON: Yes, because when they came back with the new criteria it showed that there was --
MR. CHHATRE: No, no -- your dataset has completely changed now when you do the second run.
UNIDENTIFIED SPEAKER: But they still have the original data, so they could actually go back and do that statistical analysis.
MR. KEANE: But I don't know --
MR. JOHNSON: Why would you do that?
MR. KEANE: No, the --

MR. CHHATRE: (indiscernible) do the digs.

MR. KEANE: Sorry, the --

UNIDENTIFIED SPEAKER: But they're allowed to do --

MR. KEANE: Sorry. I think there might be a misunderstanding of the way we used this. We dig enough sample population to ensure that it's representative of the rest of the feature list. Is that -- right?

MR. CHHATRE: No, I'm -- I have a different understanding.

MR. KEANE: Yeah.

BY UNIDENTIFIED SPEAKER:

Q. I think there might be a misunderstanding. It's kind of the QA/QC process being implemented on the Line 6A feature, right?

A. Yeah.

Q. Because it's -- it came back as not at all what was expected. You go through your QA/QC process, go back to the vendor because it's a significant outlier, and the vendor says this is our problem, right?

A. Right.

Q. And reanalyze and recalibrate and, you know, re-report.

A. Yeah.

MR. JOHNSON: And in the interim you take a pressure restriction to ensure safety.

MR. CHHATRE: That's fine. But in 2005 --

UNIDENTIFIED SPEAKER: You take a bunch more.

MR. KEANE: Yeah.

MR. CHHATRE: In 2005 what's the reassurance that the --- was good. There may not be an outlier.

MR. KEANE: Yeah.

MR. CHHATRE: But there still could be a misaligned tool and it just happened that you made 80 percent.

MR. JOHNSON: No. All the digs matched to the tool run.

UNIDENTIFIED SPEAKER: They trended within --

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: -- tool tolerance basically, right?

MR. JOHNSON: Yes.

MR. KEANE: That's right.

MR. CHHATRE: Okay. I guess I'm going to -- that's fine.

UNIDENTIFIED SPEAKER: But actually --

MR. KEANE: Okay.

MR. CHHATRE: The second run you had you didn't complete your dig, so how can you say that you would not have met, is my question?

MR. JOHNSON: Well, when you don't early on you don't continue digging assuming you'll get better numbers. You have to reevaluate right away.

MR. CHHATRE: No, but that's not what I'm saying. All I'm saying is, if you were to do that and if those were to match this then your argument of your digs in 2005 matching would fail then because the same thing would have happened in --

MR. JOHNSON: We're on two different pages.

MR. KEANE: Yeah -- yeah, yeah.

MR. CHHATRE: Okay. All right.

MR. JOHNSON: All right.

BY UNIDENTIFIED SPEAKER:

Q. I would actually, Sean, like to ask you about the Line 2 leaker by Deer River?

A. Um-hum, yeah.

Q. In relation to the Line 6A one that we just talked about was that the same algorithm type of issue or is that a totally different --

A. Oh, no that's --

Q. -- different problem?

A. That's different. Yeah, the Line 2 Deer River leak is a very short flaw and we're just breaking it open through metallurgical investigations right now, so.

Q. Okay. Because that one was -- the amplitude wasn't properly --

A. No.

Q. It didn't properly size the depth, right?

A. That's right, yeah. Yeah. It's -- we know it's a short flaw, but we need to figure out how short it is, so it's --

Q. All right. I was just curious.

A. Yeah.

BY UNIDENTIFIED SPEAKER:

Q. Well, GE also reanalyzed the crack line versus crack field in 2005, right? Didn't you go back with this set of data?

A. Yes.

Q. And they since said, I believe, that it should have been analyzed as a crack field?

A. That's correct.

Q. So, that's another algorithm change? Is that the same sort of thing? Or did they just do a more detailed analysis of that one feature?

A. Yeah, they just -- they just said that they should have characterized it as a crack field. That was just a mistake.

Q. So, nothing changed within the GE --

A. No.

UNIDENTIFIED SPEAKER: Is that what they said or did they say if they had used today's methodologies it would have been characterized as a crack field?

UNIDENTIFIED SPEAKER: Well, that's what I'm asking.

MR. KEANE: I'm not sure of their exact wording there.

UNIDENTIFIED SPEAKER: Okay.

MR. JOHNSON: We'll ask GE.

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: Yeah, that's -- that's important.

UNIDENTIFIED SPEAKER: Well, who requested GE to -- that would have been your group, right?

MR. KEANE: Tom Zimmerman.

UNIDENTIFIED SPEAKER: Oh, Tom? Tom did that? Okay.

MR. JOHNSON: I don't know that.

MR. KEANE: Yeah.

MR. JOHNSON: I don't doubt if Sean's saying that, so.

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: Yeah.

UNIDENTIFIED SPEAKER: And then secondly, the little N here is -- it says target number of features. So, that's just overall features or is that by category?

MR. KEANE: So, we do this by -- it's a few different ways here. So, we do it by category first to determine how many within each category. And then we do -- we prioritize within each category to ensure that we have proportional weighting of each of the different --

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: -- wall or, pardon me, depth ranges. And then we ensure that -- it's weighted so that we get more of these and less of these, so -- we're digging more of the deep features, so it doesn't necessarily (indiscernible) -- it's called important sampling along the way too, so we want to make sure we're digging the important stuff. We want to be as precise in there as possible. So --

UNIDENTIFIED SPEAKER: Okay.

MR. KEANE: Okay.

UNIDENTIFIED SPEAKER: Okay. Next PI -- 30 --

MR. JOHNSON: So, are we going to be -- it's almost 6:00.

UNIDENTIFIED SPEAKER: Is it?

MR. JOHNSON: Yes.

UNIDENTIFIED SPEAKER: Okay. Let's go off the record.

(Whereupon, the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF: ENBRIDGE - LINE 6B RUPTURE IN MARSHALL, MICHIGAN
Interview of Sean Keane

DOCKET NUMBER: DCA-10-MP-007

PLACE: Edmonton, Alberta, Canada

DATE: December 7, 2011

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording.

____
Liz Summers-Fisher
Transcriber
(Parts 1 and 2)

____
Anne VanDereedt
Transcriber
(Parts 3,4, and 5)