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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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THERMAL-HYDRAULIC SUBCOMMITTEE

AND

METALLURGY AND REACTOR FUELS SUBCOMMITTEE

+ + + + +

TUESDAY

SEPTEMBER 21, 2021

+ + + + +

The Joint Subcommittee meeting was convened via Videoconference, at 2:00 p.m. EDT, Jose March-Leuba, Chair, presiding.

COMMITTEE MEMBERS:

JOSE MARCH-LEUBA, Chair

RONALD G. BALLINGER, Member

CHARLES H. BROWN, JR. Member

GREGORY H. HALNON, Member

DAVID A. PETTI, Member

JOY L. REMPE, Member

MATTHEW W. SUNSERI, Member

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AGENDA

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P R O C E E D I N G S

2:00 p.m.

CHAIR MARCH-LEUBA: So the meeting will now come to order. This is a joint meeting of the ACRS Thermal-Hydraulics and the Metallurgy and Reactor Fuel Subcommittees. I am Jose March-Leuba, the Chairman of the Thermal-Hydraulics Committee.

Because of COVID-19 concerns, this meeting is being conducted remotely. Members in attendance are Ron Ballinger, Charlie Brown, Greg Halnon, Dave Petti, Joy Rempe, and Matt Sunseri. Has anybody else logged in recently? Maybe they'll come later.

Today's topic is Framatome's Topical Report ANP-10349P, Revision 0, entitled GALILEO Implementation in LOCA Methods.

In November 2020, we wrote a letter for a different report, ANP-10323P, which relates to Framatome's fuel rod thermal-mechanical methodology for non-LOCA events. So this review of the LOCA methodology completes the GALILEO fuel thermal-mechanical methodology.

Portions of our meeting will be closed to the public to protect proprietary information. We will have an ongoing, an opportunity for public comments before we start the closed session of the

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1 meeting.

2 The ACRS was established by a statute and
3 is governed by the Federal Advisory Committee Act,
4 FACA. As such, the Committee can only speak through
5 its published letter reports. Any comments raised by
6 members today are their individual opinions.

7 The ACRS section of the U.S. NRC public
8 website provides our charter, bylaws, agendas, letter
9 reports, and full transcripts for the open portions of
10 all full and subcommittee meetings, including the
11 slides presented here.

12 The designated federal official today is
13 Zena Abdullahi.

14 A transcript of the meeting is being kept;
15 therefore, speak clearly and state your name for the
16 benefit of the court reporter. Please keep the
17 microphone on mute when not in use and don't use video
18 feed to minimize bandwidth problems.

19 Note that we have scheduled a full
20 committee meeting in early October to write a letter
21 on this topic.

22 Member Ballinger, since you are the co-
23 chair of this subcommittee, did you want to add
24 something to the intro remarks? Ron? We may have
25 lost him.

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1 MEMBER BALLINGER: No, I think I'm fine.
2 I actually have two screens with Team on it, one that
3 works and one that doesn't. So --

4 (Laughter.)

5 CHAIR MARCH-LEUBA: Okay. Let's keep
6 going, because my next paragraph says that I know that
7 both the staff and Framatome have a large number of
8 slides in the closed session. Please don't read every
9 bullet and try to address the main points because
10 we're scheduled to finish in three hours. The slides
11 are part of the official record, and they speak for
12 themselves.

13 At this point, let's request Ngola Otto
14 from the NRC staff to make the introductory remarks.
15 Ngola?

16 MR. OTTO: All right. Thank you. Good
17 afternoon, Subcommittee Chair and Subcommittee Members
18 and staff. I'm Ngola Otto. I'm the project manager
19 for the Framatome Topical Report Review. And I work
20 in the Office of Nuclear Reactor Regulation.

21 And presenting today for the staff will be
22 Matthew Panicker, who is a technical reviewer. And
23 he's going to do both the open and the closed session
24 presentation.

25 I would just like to thank you for the

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1 opportunity to present the review of Framatome Topical
2 Report ANP-10349 and the NRC staff evaluation of,
3 review of the, staff evaluation, including a review of
4 GALILEO fuel performance code in S-RELAP and in
5 realistic large-break LOCA and small-break LOCA
6 evaluation models.

7 The staff's draft safety evaluation was
8 issued in August and contains no open items. And we
9 plan to issue the final safety evaluation by the end
10 of October.

11 We look forward to today's meeting, which
12 supports the ACRS review. And we're just, we want to
13 say thank you for the opportunity to present.

14 And at the end of your review process, we
15 definitely would be, expect the letters similar to the
16 letter that we got for the GALILEO topical report
17 review. So thank you. I'll turn it back over.

18 CHAIR MARCH-LEUBA: Thank you, Ngola. So,
19 at this point, we'll give the floor to Framatome. I
20 believe we have some introductory remarks by Morris
21 Byram.

22 MR. BYRAM: Yes, this is Morris Byram.
23 Good afternoon. I'm product manager for the topical
24 report implementation of GALILEO and Framatome's LOCA
25 evaluation models. We're happy to be here today with

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1 the ACRS subcommittee to support your review.

2 This topical is one of many of the
3 Framatome advanced fuel methods, many of which have
4 been approved or almost approved. This and the other
5 AFM codes will support the industry's need to move
6 higher, move to higher enrichments and higher fuel
7 burnups.

8 It's been good to see some of the ACRS
9 members engaging in many of our pre-submittal meetings
10 with the NRC of the AFM efforts. And so we look
11 forward to the future engagements with ACRS on the
12 Framatome advanced fuel methods.

13 Andrei Burghilea will be our presenter for
14 both the open and closed sessions today.

15 CHAIR MARCH-LEUBA: Is Andrei going to be
16 sharing the screen?

17 MR. BYRAM: I think that Ngola is going to
18 present the slides.

19 CHAIR MARCH-LEUBA: Okay.

20 MR. OTTO: I'll go ahead and share right
21 now. Please let me know if you can see the split
22 screen.

23 CHAIR MARCH-LEUBA: Not yet. Yes, I can
24 see the screen now.

25 MR. OTTO: Okay.

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1 MR. BYRAM: I can see them. Andrei, are
2 you good? I think maybe Andrei is on mute.

3 MR. BURGHELEA: Can you hear me now?

4 MR. BYRAM: Yes.

5 MR. BURGHELEA: All right. Yes, we can
6 see the slides. Thank you.

7 MR. BYRAM: Okay. Great.

8 MR. OTTO: Your volume is a little low
9 from where I am.

10 MR. BURGHELEA: Let's see. Is this
11 better?

12 CHAIR MARCH-LEUBA: Yes, much better.

13 MR. BURGHELEA: Okay. Thank you.

14 MR. BYRAM: Ngola, are we ready for Andrei
15 to start presenting?

16 MR. OTTO: Yes, if he can.

17 MR. BURGHELEA: Okay. I'll go ahead then.
18 My name is Andrei Burghelea. I'm an engineer with the
19 LOCA group at Framatome.

20 This is the open session of our
21 presentation on the GALILEO implementation in LOCA
22 methods. Next slide, please, Ngola.

23 So, in terms of content, I'm going to go
24 briefly over a topical report overview, an
25 introduction and background, and implementation of

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1 small-break LOCA and large-break LOCA methods, and the
2 summary. Next slide.

3 So, for introduction, in the current LOCA
4 methods, we have two approved methods, one for small-
5 break, one for large-break.

6 The small-break LOCA is the EMF-2328,
7 approved a long time ago, which has been recently
8 supplemented with Supplement 1PA in December 2016. It
9 is based on RODEX2 as a fuel performance code and is
10 CFR 50, Appendix K type of method, so it's a
11 conservative method.

12 The large-break LOCA model is the
13 realistic large-break LOCA based on EMF-2103P,
14 Revision 3, approved in June of 2016. The current
15 fuel performance code in this evaluation model is
16 COPERNIC. And it is a realistic or best-estimate
17 Plasma 17 (phonetic) method --

18 CHAIR MARCH-LEUBA: Andrei, sorry, sorry
19 to interrupt you at this moment. The approval of
20 RODEX2 and COPERNIC, is that part of the EMF-2328 and
21 2103? Is that what that --

22 MR. BURGHELEA: No, no, they are, they do
23 have distinct topical reports that are separate from
24 the two. This is just for the LOCA methods. So
25 RODEX2 has an X and an F topical report that's even

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1 older than 2001. And COPERNIC2 has a different
2 topical report separate. I can't remember the number,
3 but yeah.

4 CHAIR MARCH-LEUBA: So, when we issue a
5 topical, the topical report, 10349, the approved
6 version with the SER, that will be attached to the EMF
7 reports for LOCA? I mean, that will be an applicable?

8 MR. BURGHELEA: Correct. So the purpose
9 of this is to add GALILEO to LOCA methods and to
10 supplement the two existing methods, the realistic
11 large-break and the small-break LOCA EM, to include
12 GALILEO. So this topical report would be a supplement
13 to both EMF-2328 and EMF-2103, Revision 3.

14 CHAIR MARCH-LEUBA: So a licensee that
15 commissions you to perform a LOCA calculation can
16 choose to use RODEX2 or GALILEO? I mean, both will be
17 applicable.

18 MR. BURGHELEA: Technically --

19 CHAIR MARCH-LEUBA: It doesn't replace.

20 MR. BURGHELEA: Yes, technically the old
21 topical report will remain active. I think the main
22 goal of ours is to push towards adopting GALILEO in
23 all the new applications that we will be making from
24 now on. And at some point, obviously, RODEX2 will
25 become obsolete.

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1 CHAIR MARCH-LEUBA: Okay. Thank you.

2 MR. BURGHELEA: Okay. And just briefly,
3 to mention again, so both methods are based on, are
4 approved for working with three loop and four loop
5 plants and combustion engineering plants. So they
6 apply potentially only to bottom reflood plants only.

7 And the GALILEO topical report was
8 mentioned before, was recently approved in November of
9 2020, is ANP-10323P, Revision 1. Next slide, please,
10 Ngola.

11 So, for the small-break LOCA portion of
12 the topical report, the regulatory requirements we
13 take into consideration are NUREG-0800 and Appendix K
14 of 10 CFR 50.

15 The EM requirements described in the
16 topical report include the analysis, purpose,
17 transient class, power plant class, the figures of
18 merit.

19 And in deriving the assessment database,
20 because this is a fuel performance code, the only LOCA
21 test that we have to include nuclear fuel is actually
22 the LOFT series of tests.

23 So, for small-break LOCA, we included the
24 L3-6, L8-1 sequence of tests. And those were
25 previously part of Supplement 1 to the EMF-2328.

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1 We also describe in the small-break LOCA
2 topical report the EMF changes, provide the results of
3 the assessment for the LOFT small-break LOCA tests
4 that we mentioned. And we provide a sample problem to
5 demonstrate how the method behaves with GALILEO in
6 comparison with the previous code RODEX2. Okay. Next
7 slide, please.

8 The large-break LOCA portion of the
9 topical report is very similar in structure. The
10 regulatory requirements are similar, just add the Reg
11 Guide 1.157 (audio interference). And because of the
12 relative (audio interference). Okay.

13 CHAIR MARCH-LEUBA: Andrei, you can keep
14 going.

15 (Audio interference.)

16 MR. BURGHELEA: Can you hear me?

17 CHAIR MARCH-LEUBA: We hear you -- yes,
18 now we can hear you.

19 MR. OTTO: Yes.

20 MR. BURGHELEA: Okay. Thank you. Sorry
21 about that.

22 So the realistic large-break LOCA section
23 of the topical report is very similar, slightly
24 different regulatory requirements. There are two
25 additional regulatory guides which apply to this

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1 method, 1.157 and 1.203.

2 And 1.203 give us a graded approach to the
3 evaluation model development and assessment process
4 that we applied for this supplement of the topical
5 report given the low complexity of the implementation,
6 also, the same EM requirements, as we saw before for
7 the small-break that are described in the topical
8 report, and again, the assessment phase includes the
9 series of LOFT large-break tests, the L2-3, L2-5, LP-
10 026, and LP-LB-1. Also, again, these test were
11 previously included in EMF-2103, Rev. 3.

12 The topical report describes the
13 evaluation model changes due to the GALILEO
14 implementation and provides the results of the LOFT
15 large-break LOCA tests mentioned above. And we also
16 provide a demonstration sample problem. Okay. Next
17 slide, please.

18 So, in summary, this is a fairly
19 straightforward process in replacing COPERNIC or
20 RODEX2 with GALILEO, which is an acceptable fuel
21 performance code.

22 It's an EM evolution that adds one fuel
23 performance code with the same functionality to the
24 current methods. You will see that the analysis
25 workflow remains unchanged for both methods.

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1 The assessments against the benchmarks
2 show good results. And again, the comparison to
3 current approved methods show good agreement.

4 CHAIR MARCH-LEUBA: This question might be
5 more appropriate for the closed session. But does the
6 COPERNIC RODEX methodology update fuel properties as
7 a function of time?

8 MR. BURGHELEA: Function of time --

9 CHAIR MARCH-LEUBA: Just say if you want
10 to address it in closed. Yes.

11 MR. BURGHELEA: Yes, they do. It's
12 calculated dynamically during the transient, yes. And
13 --

14 CHAIR MARCH-LEUBA: Okay.

15 MR. BURGHELEA: Yeah.

16 CHAIR MARCH-LEUBA: Thank you. Thank you.
17 So, Andrei, are you finished with your presentation?

18 MR. BURGHELEA: Yes, I think so. If you
19 go to the next slide, I think that was about it for
20 the open session. There's some acronyms that we used
21 in the slides before, yeah.

22 CHAIR MARCH-LEUBA: Members, any questions
23 for the open session of the Framatome presentation?
24 Okay. I'll take that as a no. Is the staff ready
25 for, to present their open session?

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1 MR. OTTO: I'll stop sharing. And I'll
2 switch to the other slides. Are you ready, Matthew?

3 MR. PANICKER: Yes.

4 MR. OTTO: Okay. Let me -- so you can go
5 ahead and present whenever you're ready, Matthew.

6 MR. PANICKER: Okay --

7 CHAIR MARCH-LEUBA: We still cannot see
8 the slides. But, Matthew, you can start with your
9 introduction.

10 MR. PANICKER: Yeah --

11 MR. OTTO: So you can't see the slides as
12 yet?

13 CHAIR MARCH-LEUBA: I cannot.

14 MR. PANICKER: I cannot see any.

15 MR. OTTO: Oh, okay. Let me -- sorry. I
16 apologize.

17 CHAIR MARCH-LEUBA: Now, now we see.
18 Okay.

19 MR. PANICKER: Yeah, this is the NRC
20 staff's evaluation of Framatome Topical Report ANP-
21 10349 where GALILEO replaces the old methods in
22 realistic large-break LOCA, as well as in the small-
23 break LOCA. Next slide, please.

24 This is an outline we have from the staff,
25 some background, regulatory evaluation of GALILEO as

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1 implemented in S-RELAP5 and thereby use it for that
2 LOCA analysis, and then GALILEO implementation also in
3 S-RELAP5, which is the thermal-hydraulics code used
4 for small-break LOCA methodology, and then a slide
5 regarding the revision.

6 Actually, the process involves reality of
7 349P topical report and then reality of virtual audit,
8 as well as RAs, the virtual audit enabled us to look
9 at all the documents for considering a longer period
10 than an in-person audit. Next slide, please.

11 So, as was said before, the EMF-2103,
12 Revision 3, the latest version of realistic large-
13 break LOCA analysis used a combination of S-RELAP5 and
14 COPERNIC, which is the previous generation of fuel
15 performance code for initialization conditions and
16 also for thermal-hydraulics analysis.

17 And a small-break LOCA, which is the
18 approved EMF-2328, and its supplements used S-RELAP5,
19 RODEX2 combination for initialization conditions for
20 the thermal-hydraulics code.

21 In 2020, staff approved a modern fuel
22 performance code, which is the GALILEO code, which is
23 in ANP-10323, Revision 1. The GALILEO code models the
24 thermal mechanical area of the fuel rods during normal
25 operation and transient scenarios.

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1 This has a regulatory, the basis for the
2 review with respect to the regulatory aspects, 10 CFR
3 50.46, the acceptance criteria for ECCS, which is a
4 limit term, basically, limit term, high generation
5 (phonetic), as well as the chemical reaction.

6 Part 50A also is the basis for us
7 calculating UVC35 (phonetic). Chapter 6.3, cooling
8 system of the SRP is used as a guidance for the
9 review. Chapter 15.6.5 of the SRP for loss of coolant
10 accidents provides the guidance of portfolio reviews.

11 In summary, the GALILEO implementation is
12 in S-RELAP5 and large-break LOCA events. The
13 regulatory replaces COPERNIC in realistic large-break
14 LOCA analysis for S-RELAP5 thermal-hydraulics fuel and
15 t-h conditions.

16 The LOFT, in support of the LOFT tests
17 used to assess the basis, base of the supplemental
18 large-break LOCA evaluation model and benchmarked
19 using coupled S-RELAP5/GALILEO.

20 Similar, and a similar, and a sample
21 problem similar to the one used originally in 2103 has
22 been repeated to prove that the results coming from
23 use of GALILEO is the same as, almost the same as the
24 one from COPERNIC.

25 The results of the LOFT tests and sample

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1 problem indicate reasonable agreement. And we can see
2 that in the closed session. The next one, please.

3 GALILEO replaces in the small-break LOCA
4 analysis the RODEX2 with GALILEO for t-h calculations.

5 Also, in order to prove the
6 reproducibility of results, the LOFT tests were used
7 to assess the base for the supplemental small-break
8 LOCA. The supplemental small-break LOCA EM result is
9 in the 10349 benchmarked using the coupled S-
10 RELAP5/GALILEO.

11 A sample problem was, again, used to prove
12 the reproducibility of results. Both LOFT tests and
13 sample problems indicate reasonable agreement between,
14 when GALILEO is used and when RODEX2.

15 So some of the staff's recommendations
16 are, we reviewed the process and the results from
17 supplemental evaluation model for both large-break
18 LOCA and small-break LOCA replacing COPERNIC and
19 RODEX2. Both LOFT test results and the sample problem
20 results show there is a reasonable agreement between
21 GALILEO and the two conditions.

22 CHAIR MARCH-LEUBA: Matthew, if I can
23 interrupt you here, I want to make a couple points.
24 The first one is a minor thing of language. When I
25 read the SER conclusions and your presentation, you

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1 keep saying that GALILEO replaces RODEX2 and COPERNIC.

2 MR. PANICKER: Yes.

3 CHAIR MARCH-LEUBA: And that is the intent
4 of Framatome, to replace it. But in reality, it
5 doesn't replace them. It supplements. They keep the
6 option of using either of the three codes in the
7 future.

8 MR. PANICKER: Yes.

9 CHAIR MARCH-LEUBA: So, if I may
10 recommend, and maybe I'll remind you later, the SER
11 language should be more specific, because it clearly
12 says it -- I mean, you are speaking on slide number 6.
13 GALILEO code replaces RODEX2. It doesn't. When we
14 write SERs, we need to be a little more specific of
15 what we're doing --

16 MR. PANICKER: Okay.

17 CHAIR MARCH-LEUBA: -- and what we're
18 approving. And this is just language. Okay.

19 Now, a more important, a more relevant
20 comment, and this is a comment, not a question, is the
21 fact that we keep doing what I call a code to code
22 comparison. We are comparing the GALILEO results with
23 RODEX results and GALILEO results with COPERNIC
24 results.

25 And code to code comparisons are a dirty

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1 word. I mean, this is a four-letter word. We should
2 never approve them. We never like them.

3 In reality, what Framatome has done is
4 compared it against the LOFT tests. And that's --

5 MR. PANICKER: Yes.

6 CHAIR MARCH-LEUBA: -- what makes these
7 validation acceptable.

8 My concern is creating a precedent for the
9 future with this language. Here we don't have
10 absolutely any problem.

11 But we are in the process of reviewing a
12 large number of advanced reactors with modern fuels,
13 things that don't really have a significant
14 experimental database.

15 And if we start kind of approving code to
16 code comparisons, we're opening ourselves to somebody
17 coming up with a sophisticated Monte Carlo analysis
18 and use that Monte Carlo analysis to validate
19 mandatory methods which are simpler, or same thing
20 with thermal-hydraulics.

21 Somebody does a CFV analysis, which is
22 very sophisticated and very good quality, and uses to
23 validate my analysis code. That would be 100 percent
24 code to code comparison and in my opinion would not be
25 good.

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1 So I would like that we emphasize the fact
2 that the benchmark and the reason we are accepting
3 GALILEO is because it reproduces the LOFT experimental
4 data.

5 MR. PANICKER: Yes.

6 CHAIR MARCH-LEUBA: The RODEX and the
7 COPERNIC calculations that show the same thing adds
8 icing to the cake. But it's not sufficient.

9 So I would like that we don't create a
10 precedent, that we keep an opening to an advanced
11 reactor to use code to code benchmarks. Okay. So --

12 MR. PANICKER: Okay. But they have the
13 same codes. They use two different techniques to
14 validate the results, right --

15 CHAIR MARCH-LEUBA: Yeah, but at the end
16 we are comparing against experimental data. And we
17 need to emphasize -- it may not be possible always,
18 but whenever possible --

19 MR. PANICKER: Yeah.

20 CHAIR MARCH-LEUBA: -- or, I mean, I'm
21 tending to say always you should use experimental data
22 to validate your fuels.

23 MR. PANICKER: Okay. All right.

24 CHAIR MARCH-LEUBA: All right. Keep
25 going.

1 MR. PANICKER: So the --

2 MR. LUKES: Matthew, may I interrupt?
3 This is Bob Lukes, the branch chief for the Nuclear
4 Fuels and Methods branch.

5 Jose, I just want to say thank you for the
6 comment. And I'll take that comment back to the
7 branch and make sure -- I agree with the comment. And
8 I'll just make sure that that information is
9 distributed to the fuels branch so they can make sure
10 we address that in all of our reviews. Again, thanks,
11 Jose. I appreciate it.

12 CHAIR MARCH-LEUBA: Yeah, thanks.

13 MR. PANICKER: Okay. All right. The last
14 bullet there is -- the next slide, please, Ngola.

15 Yeah, the last slide is the Framatome
16 shall publish the approved version of ANP-10349P as a
17 supplemental topical report to the final approved
18 versions of 2103 and 2328.

19 But I just heard that the Framatome
20 personnel said that they will have the option of using
21 also the COPERNIC and RODEX2 for -- but this is a
22 supplemental clear (phonetic). So, if any of your
23 licensee wants to use this, they are to use this TR,
24 as well as the two previously approved topical
25 reports.

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1 So that's all my presentation is in the
2 open session.

3 CHAIR MARCH-LEUBA: Yeah, let me, since we
4 are still in the open session, let me give you another
5 comment.

6 Yeah, there are two topical reports that
7 have the GALILEO name on them. The one we are
8 listening to today is what I call the LOCA topical
9 report. The one we addressed last year is what I call
10 the non-LOCA. And so I'm giving you the numbers. One
11 is 10323P. But I call it a non-LOCA. Okay.

12 In the non-LOCA topical report in the SER,
13 there was actually three sections which address the
14 code applicability ranges. And in limited conditions
15 can offset, you can only apply GALILEO in this
16 applicability range.

17 On the LOCA report that we've reviewed
18 today, I don't see the SER addressing the code
19 applicability ranges. I would love to see it at least
20 included by reference on the current topical report,
21 say the applicability ranges that are applicable for
22 the non-LOCA topical report are applicable to LOCA
23 also, or not, I mean, whatever they are. But we need
24 to address.

25 For example, we know that it only applies

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1 to Westinghouse and CE plants because of the bottom
2 refueling (phonetic). We know that other plants to,
3 it applies to M5 and Z2 cladding.

4 That should really be specified on the SCI
5 in my opinion. What do you think? And it could be
6 just by reference, say the same code applicability
7 ranges that were applicable for the non-LOCA topical
8 report apply here. It's only one sentence.

9 MR. PANICKER: Okay --

10 CHAIR MARCH-LEUBA: Just a suggestion.
11 And this might be a -- go ahead.

12 MR. PANICKER: The code applicability is
13 only for the fuel and the M5 cladding?

14 CHAIR MARCH-LEUBA: On the review of
15 10323P, there was a number of code applicability. And
16 it's, there are three sections, 1.1, 1.2, and 4 if I
17 remember correctly. And I won't read them to you now
18 because I won't be able to find it.

19 But if you review the old SER, the non-
20 LOCA SER, November 2020, you will find those
21 applicability ranges. And --

22 MR. PANICKER: What is the system of codes
23 used there --

24 CHAIR MARCH-LEUBA: Say again.

25 MR. PANICKER: What is the system of codes

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1 used in the non-LOCA --

2 CHAIR MARCH-LEUBA: Oh, it's the same as
3 S-RELAP and GALILEO, yeah.

4 MR. PANICKER: Okay.

5 CHAIR MARCH-LEUBA: It's -- sorry. S-
6 RELAP and GALILEO is only that it applies for all the
7 transients that are not LOCA.

8 MR. PANICKER: Okay, yeah.

9 CHAIR MARCH-LEUBA: And my question to you
10 is, what are the code applicability ranges for the
11 LOCA portion of the GALILEO/S-RELAP5 use? My
12 suspicion is they're the same and wouldn't really
13 happen.

14 MR. PANICKER: Yeah, we'll have to check
15 on that one.

16 CHAIR MARCH-LEUBA: Yeah, I think a good
17 SER should have those limitations.

18 MR. PANICKER: Okay.

19 MR. BURGHELEA: If I may, this is Andrei
20 Burghelea.

21 CHAIR MARCH-LEUBA: Yes.

22 MR. BURGHELEA: I just wanted to add that
23 the 10323 GALILEO topical report is not actually a
24 non-LOCA. It's a thermal mechanical analysis.

25 MR. PANICKER: Yes.

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1 MR. BURGHELEA: And, yes, and non-LOCA is
2 a separate topical report. I don't know if it uses
3 GALILEO or not. But it's not the same with 323.

4 MR. PANICKER: Yes, 10323 is GALILEO. And
5 the other one is one of our reviewers reviewed it.
6 But I don't know about the computer for what -- what
7 about the use of (unintelligible).

8 CHAIR MARCH-LEUBA: Yes. Something like
9 that I remember. But we're not reviewing that yet.

10 MR. PANICKER: So you think the range of
11 applicability for non-LOCA, is it not slightly
12 different or is it the same as LOCA range of
13 applicability?

14 CHAIR MARCH-LEUBA: I'm asking you if the
15 fuel for thermal mechanical code, the topical report,
16 the 10323P --

17 MR. PANICKER: Yes.

18 CHAIR MARCH-LEUBA: -- has some range for
19 applicability --

20 (Simultaneous speaking.)

21 MR. PANICKER: I agree that, no, I agree
22 to that one, yeah.

23 CHAIR MARCH-LEUBA: Yeah. Our evaluation
24 of this topical report is begging for a range of
25 applicability.

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1 MR. PANICKER: Okay. I will --

2 (Simultaneous speaking.)

3 MR. PANICKER: I will check the range of
4 applicability for GALILEO in regard --

5 (Simultaneous speaking.)

6 MR. PANICKER: -- and then look at the
7 Framatome LOCA range of applicability and see where
8 they agree or if they don't agree, I will put an
9 appropriate sentence or sentences in the SER.

10 CHAIR MARCH-LEUBA: Yeah.

11 MR. PANICKER: That's what --

12 CHAIR MARCH-LEUBA: You may have to get on
13 the phone with Framatome or --

14 MR. PANICKER: Yes.

15 CHAIR MARCH-LEUBA: I mean, it doesn't
16 deserve an audit. But certainly -- or even an II.
17 But get on the phone and say where can I find this
18 range of applicability. And they'll let you know.

19 MR. PANICKER: It should be in the EMF-
20 2103 final approved version and also EMF --

21 CHAIR MARCH-LEUBA: See, on 10323 it has
22 three sections with the ranges of applicability.

23 MR. PANICKER: Right.

24 CHAIR MARCH-LEUBA: But you have to make
25 sure they are applicable to the 349 that we're doing

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1 now.

2 And while we're talking about this and we
3 have Andrei also on the phone -- and please tell me if
4 we need to move to the closed session for this
5 question. We keep mentioning that one of the big
6 advantages of GALILEO is to go to higher enrichments
7 and burnup. Do we have any validation for that? I
8 haven't seen it. Maybe we can talk about this in the
9 closed session.

10 MR. BURGHELEA: Yes, that would be the
11 most appropriate.

12 CHAIR MARCH-LEUBA: Okay. So, Matthew,
13 are you finished with your presentation?

14 MR. PANICKER: Yeah, that's all. That's
15 it.

16 CHAIR MARCH-LEUBA: Okay. Thank you. So
17 this concludes the open session of this meeting. And
18 we are going to be moving to a closed session to
19 discuss proprietary information.

20 Any members has a question in the open
21 session for either Framatome or the staff?

22 Hearing none, I would like to open the
23 floor to members of the public. Anybody attending the
24 meeting with, via Teams, you can just unmute yourself
25 and make a comment.

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1 Hearing none, if you are using the phone
2 to connect, you will have to push star 6 to unmute
3 yourself and make a comment.

4 I don't hear any comments from anybody.
5 So we will be in recess on this session. And we will
6 not come back to this Teams session. We will complete
7 the subcommittee on the closed session.

8 Now, I would like to ask everybody to move
9 to the closed session phone number or Teams invite
10 immediately so we can start the process of unmuting
11 people that have a need to know into that session. So
12 please do it now. And then we will take a 15-minute
13 break to 5 till 3:00 Eastern Time.

14 So connect to the new session. Let's
15 start the process. And we will restart at 2:55
16 Eastern Time. So we are on recess.

17 (Whereupon, the above-entitled matter went
18 off the record at 2:39 p.m.)

19
20
21
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24
25

GALILEO Implementation in LOCA Methods (ACRS SC Open Session)

Andrei Burghelea

09/21/2021

CONTENT

Introduction and Background

SBLOCA

RLBLOCA

Summary

Introduction and Background

- Current LOCA topical reports:
 - SBLOCA
 - EMF-2328P-A (March 2001) and EMF-2328 Supplement 1P-A (December 2016)
 - Current fuel performance code – RODEX2
 - 10 CFR 50 Appendix K
 - RLBLOCA
 - EMF-2103P-A Revision 3 (June 2016)
 - Current fuel performance code – COPERNIC
 - Realistic
- Applicable to Westinghouse (3 and 4 loop) and Combustion Engineering plants
- Purpose of new topical report is to add the fuel performance code GALILEO to LOCA methods
 - ANP-10323P-A Revision 1 (November 2020)
 - Supplementing the RLBLOCA EM and SBLOCA EM to include GALILEO
 - Support future Framatome objectives (addressed separately)
 - Increased enrichment and burnup
 - Chromia-doped fuel and Chromium coated cladding

SBLOCA

- Regulatory Requirements
 - NUREG-0800
 - 10 CFR 50 Appendix K
- EM Requirements
 - Analysis purpose, transient class, power plant class
 - Figures of merit
- Assessment Data Base
 - Only LOFT tests include nuclear fuel
 - LOFT Small Break Tests L3-6 / L8-1
- EM Changes
- Assessment Results for LOFT Small Break Tests L3-6 / L8-1
- Sample Problem

RLBLOCA

- Regulatory Requirements
 - NUREG-0800
 - RG 1.157
 - RG 1.203 – Graded Approach to EMDAP
- EM Requirements
 - Analysis purpose, transient class, power plant class
 - Figures of merit
 - PIRT Review
- Assessment Base
 - Only LOFT tests include nuclear fuel
 - LOFT L2-3, L2-5, LP-02-6 and LP-LB-1
- EM Changes
- Assessment of LOFT LRBLOCA Tests L2-3, L2-5, LP-02-6 and LP-LB-1
- Sample Problem

Summary

- Straight forward process COPERNIC/RODEX2 \Rightarrow GALILEO an acceptable FPC
- EM evolution adding one FPC with the same functionality current methods
- Analysis workflow unchanged for both methods
- Assessments against benchmarks show good results
- Comparisons to current approved methods show good agreement

Acronyms

- EM – Evaluation Model
- FPC – Fuel Performance Code
- LOCA – Loss-of-Coolant Accident
- LOFT – Loss of Fluid Test
- LBLOCA – Large Break LOCA
- RLBLOCA – Realistic LBLOCA
- SBLOCA – Small Break LOCA
- TR – Topical Report

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**NRC STAFF EVALUATION OF FRAMATOME
TOPICAL REPORT
ANP-10349P, REVISION 0, GALILEO
IMPLEMENTAION IN LOCA METHODS**

OPEN SESSION

**Mathew Panicker
Nuclear Methods and Fuel Analysis Branch
(NRR/DSS/SNPB)**

**ACRS Subcommittee Meeting
September 21, 2021**

PRESENTATION OUTLINE

- Background
- Regulatory Evaluation
- GALILEO Implementation in S-RELAP5 and RLBLOCA
- GALILEO Implementation in S-RELAP5 and SBLOCA
- GALILEO Implementation in LOCA EM - Conclusion

BACKGROUND

- Framatome's Pressurized Water Reactor (PWR) Realistic Large Break LOCA [RLBLOCA] (EMF-2103 Revision 3) used S-RELAP5/COPERNIC combination for initialization conditions for thermal hydraulics (T-H) Code.
- Framatome's PWR Small Break LOCA [SBLOCA] (EMF-2328) used S-RELAP5/RODEX2 Combination for Initialization Conditions for T-H Code.
- In 2020 NRC approved modern Fuel Performance Code GALILEO in ANP-10323-P Revision 1.
- The GALILEO code models the thermal-mechanical behavior of the fuel rods during normal operation and transient scenarios.

REGULATORY EVALUATION

- 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems (ECCS) for Light-Water Nuclear Power Reactors"
- 10 CFR Part 50 Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criterion (GDC) 35, "Emergency core cooling"
- Chapter 6.3, "Emergency Core Cooling System," of the Standard Review Plan (SRP) provides guidance for performing the system review of the ECCS.
- Chapter 15.6.5, "Loss of Coolant Accidents," of the SRP provides guidance for performing reviews of loss of coolant accident (LOCA) analyses

GALILEO IMPLEMENTATION IN S-RELAP5 AND RLBLOCA

- NRC staff review included a virtual audit of all related documents and requests for additional information (RAIs).
- RAIs concentrated on GALILEO/S-RELAP5 Hybrid scheme and SBLOCA sensitivity analysis
- GALILEO code replaces COPERNIC in RLBLOCA analysis for S-RELAP5 T-H fuel and T-H Calculations.
- The LOFT tests were used to assess the base for the supplemental RLBLOCA evaluation model (EM) and benchmarked using the coupled S-RELAP5/GALILEO.
- Sample problem is similar to the problem presented in the approved RLBLOCA evaluation and methodology TR was solved (Appendix B, EMF-2103-P-A, Revision 3).
- Results from LOFT Tests and Sample problem indicate reasonable agreement between GALILEO and COPERNIC.

GALILEO IMPLEMENTATION IN S-RELAP5 AND SBLOCA

- GALILEO code replaces RODEX2 in SBLOCA analysis for S-RELAP5 T-H fuel and T-H Calculations.
- The LOFT tests were used to assess the base for the supplemental SBLOCA EM and benchmarked using the coupled S-RELAP5/GALILEO.
- Sample problem is similar to the problem presented in the approved RLBLOCA evaluation and methodology TR was solved (EMF-2328 P-A).
- Results from LOFT Tests and Sample problem indicate reasonable agreement between GALILEO and RODEX2.

GALILEO IMPLEMENTATION IN LOCA EM - CONCLUSIONS

- The NRC staff reviewed the process and the results from the supplemental evaluation model (ANP-10349P) for both RLBLOCA and SBLOCA replacing both COPERNIC and RODEX2 with GALILEO.
- LOFT test and sample problem results show there is reasonable agreement between GALILEO and COPERNIC/RODEX2 for both RLBLOCA and SBLOCA analyses.
- Framatome shall publish the approved version of ANP-10349P as supplemental TR to the final approved versions of EMF-2103 and EMF-2328.