

# **Official Transcript of Proceedings**

## **NUCLEAR REGULATORY COMMISSION**

Title:                   Advisory Committee on Reactor Safeguards  
                              Digital Instrumentation and Control Systems

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UNITED STATES OF AMERICA  
 NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

+ + + + +

DIGITAL INSTRUMENTATION AND CONTROL SYSTEMS

SUBCOMMITTEE

+ + + + +

FRIDAY

APRIL 24, 2015

+ + + + +

ROCKVILLE, MARYLAND

+ + + + +

The Subcommittee met at the Nuclear  
 Regulatory Commission, Two White Flint North, Room  
 T2B1, 11545 Rockville Pike, at 8:30 a.m., Charles H.  
 Brown, Jr., Chairman, presiding.

COMMITTEE MEMBERS:

CHARLES BROWN, Chairman

RONALD BALLINGER, Member

DENNIS BLEY, Member

JOY REMPE, Member

STEPHEN P. SCHULTZ, Member

ACRS CONSULTANT:

MYRON HECHT

DESIGNATED FEDERAL OFFICIAL:

CHRISTINA ANTONESCU

ALSO PRESENT:

ROSSNYEV ALVARADO, NRR/DE/EICB

MARK BURZYNSKI, Rolls-Royce\*

NORBERT CARTE, NRR/DE/EICB

SAMIR DARBALI, NRR/DE/EICB

VIC FREGONESE, AREVA\*

BOB HIRMANPOUR, Southern Company

JOHN THORP, NRR/DE/EICB

CAMILLE ZOZULA, Westinghouse

\*Present via telephone





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## P R O C E E D I N G S

8:32 a.m.

CHAIRMAN BROWN: The meeting will now come to order.

This is a meeting of the Digital I&C Subcommittee. I'm Charles Brown, Chairman of this Subcommittee meeting.

ACRS in attendance are John Stetkar, Dennis Bley, Joy Rempe, Steven Schultz, Ron Ballinger and Myron Hecht, our consultant.

And Christian Antonescu of the ACRS staff is the Designated Federal Official for this meeting.

The purpose of the briefing is to review the staff's activities and discuss progress made to date on digital equipment computing platforms submitted for NRC review via topical report.

The Subcommittee will gather information, analyze relevant issues and facts, formulate proposed positions and actions as appropriate for deliberation by the full committee.

The rules for participation for today's meeting have been announced as part of this Notice of this meeting previously published in the Federal Register on March 24, 2015.

We have not received written comments or

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1 requests for time to make oral statements from members  
2 of the public regarding today's meeting.

3 Also, we have participants on the bridge  
4 line, I think, listening to the discussions. That's  
5 Bic Fregonese from AREVA, Mark Burzynski from Rolls  
6 Royce, Camille Zozula is from Westinghouse who's  
7 actually sitting in the peanut gallery and others from  
8 the public.

9 I think I got everybody else that I've been  
10 told about.

11 So, to preclude interruption of the  
12 meeting, the phone line will be placed on listen in mode  
13 during the discussion, presentations and committee  
14 discussions.

15 The bridge line will be opened at the end  
16 of the meeting to see if anyone listening would like  
17 to make any comments. People on the phone line should  
18 identify themselves by name at that time.

19 A transcript of the meeting is being kept  
20 and will be made available as stated in the Federal  
21 Register Notice. Therefore, we request that  
22 participants in this meeting use the microphones  
23 located throughout the meeting room when addressing the  
24 Subcommittee.

25 The participant should first identify

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1 themselves and speak with sufficient clarity and volume  
2 so that they may be readily heard.

3 To preclude disturbances and  
4 distractions, please silence all electronic devices.

5 We will now proceed with the meeting and  
6 with that, I'll say good morning and it's a beautiful  
7 day in the neighborhood and I will call upon -- got to  
8 have some humor, okay -- and it is a beautiful day.

9 MEMBER STETKAR: Was it a gray sweater?

10 CHAIRMAN BROWN: This is a dark gray  
11 sweater.

12 MEMBER STETKAR: Yes, but I mean Mr.  
13 Rogers.

14 CHAIRMAN BROWN: Well, I deviated a little  
15 bit from the norm here.

16 So, I will call upon Mr. John Thorp of the  
17 I&C Branch, the I&C Branch Chief, Division of  
18 Engineering, Nuclear Reactor Regulation Office to make  
19 an opening statement and introductions.

20 John?

21 MR. THORP: Good morning, Charles and  
22 Member of the Committee.

23 I'd like to introduce myself, John Thorp,  
24 Chief of the Instrumentation and Controls Branch in NRR  
25 and DE, Division of Engineering.

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1                   With me are some of my staff, Norbert  
2                   Carte, to my left, Rossnyev Alvarado and Samir Darbali.  
3                   And to the side table, we have our senior level advisor,  
4                   Steven Arndt and just behind him, another of my senior  
5                   staff, Richard Stattel.

6                   I think we're also accompanied in the  
7                   audience by member of I&C engineering staff from the  
8                   Office of Reactors.

9                   Good morning.           I appreciate the  
10                  opportunity for us to spend some time with you this  
11                  morning to describe for you some of the digital  
12                  instrumentation and controls topical reports that  
13                  we've reviewed or are in the process of reviewing.

14                 We want to familiarize you with the basic  
15                 design of the digital I&C platforms involved, what we  
16                 looked at or what we're looking at and where they may  
17                 be used, et cetera.

18                 So, here's the agenda, you've already seen  
19                 this, I'm sure. But we worked with this out with  
20                 Christina prior to today's meeting. It covers a total  
21                 of our topical reports.

22                 I'd like to -- you can see by the agenda  
23                 who the speaker will be for each of the given topical  
24                 reports. Norbert had the distinct pleasure of being  
25                 able to speak to two of them.

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1 So, moving on to the next slide.

2 I'd just briefly like to discuss the nature  
3 of the topical reports we've reviewed or are reviewing  
4 including those that we're going to describe for you  
5 today.

6 These reports essentially describe and we  
7 review the hardware and software design of components  
8 or complete digital I&C platforms that are or would be  
9 commonly applicable to all licensee plants who might  
10 chose to use them.

11 Their topical reports vary in scope,  
12 content and specificity. So the scope of the review  
13 we perform is essentially based on what the platform  
14 vendor provides to us.

15 The hoped for benefit of our evaluations  
16 of these topical reports and the resulting documented  
17 safety evaluation report on a platform is the ability  
18 for licensees to have that portion of a licensing review  
19 essentially already completed, reducing the review  
20 time required and, thereby, improving the review  
21 schedule, reducing as well, you know, the level of  
22 effort by my staff and reducing the cost to the  
23 licensee.

24 So, essentially, we're seeking a win-win,  
25 licensee and the agency.

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# EICB Topical Reports Update to ACRS I&C Subcommittee

John Thorp (NRC/NRR/EICB)

April 24, 2015

# AGENDA

Opening Remarks	Chairman C. Brown, ACRS
Introduction	John Thorp, NRR
Regulatory Context and Approach	Norbert Carte, NRR
Spline 3 Topical Report <ul style="list-style-type: none"> <li>- Background</li> <li>- Description</li> <li>- Key Review Criteria</li> </ul>	Rossnyev Alvarado, NRR
CPLD - Based SSPS Cards Topical Report <ul style="list-style-type: none"> <li>- Background</li> <li>- Description</li> <li>- Key Review Criteria</li> </ul>	Norbert Carte, NRR
Break	
HFC – 6000 Topical Report <ul style="list-style-type: none"> <li>- Background</li> <li>- Description</li> <li>- Key Review Criteria</li> </ul>	Samir Darbali, NRR
NuPAC Topical Report <ul style="list-style-type: none"> <li>- Background</li> <li>- Description</li> <li>- Key Review Criteria</li> </ul>	Norbert Carte, NRR
Conclusion	John Thorp, NRR
Closing Remarks	Chairman C. Brown, ACRS



# Topical Reports Being Presented

- Purpose: Regulatory Efficiency
- Rolls Royce Nuclear Spinline III
- Westinghouse CPLD – Based SSPS Cards
- Doosan HFC-6000
- Lockheed Martin NuPAC

# EICB Staff Presentation of Topical Report Reviews Outline

- A basic explanation of each design, how it works, and where it might be used in the reasonably foreseeable future.
  - A summary of each design from a technical engineering perspective - drawings and oral explanations that describe how each design processes signals, inter-divisional communications, interfaces between safety and non-safety signals.
  - Staff understanding of plans to implement these systems - new plants, retrofits, non-US markets, etc.

1           Now the topical reports we're presenting  
2           today, and you see on this slide, they represent four  
3           of the approximately 15 digital I&C platform equipment  
4           topical reports or major revisions thereto that staff  
5           has completed since 1995.

6           The staff is going to explain to you our  
7           consistent approach based in regulatory requirements  
8           in our evaluation of the material presented to us in  
9           these topical reports.

10          I want to emphasize, this is a pretty  
11          rigorous review focused on critical evaluation and, as  
12          with our other safety evaluations, we have to achieve  
13          a reasonable assurance determination and a conclusion  
14          in order to successfully issue an SER.

15          You'll hear about a range of digital  
16          platform topical reports, some that provide very  
17          specific detailed functions and purpose, others that  
18          are a collection of components sometimes loosely  
19          referred to as a box of Legos or a box of parts.

20          For platforms where the applicable vendor  
21          is seeking to maintain a wider degree of flexibility,  
22          that is the design is more general in nature and not  
23          fixed or specifically laid out as a complete particular  
24          system our resulting safety evaluation is thus more  
25          limited in scope.

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1           So, our review will produce a greater  
2           number of what we would call application specific  
3           action items in such a case. The effect of these large  
4           number of ASAI's, Application Specific Action Items, is  
5           essentially a translation to a later date of burden to  
6           the licensee who wishes to use a given platform in an  
7           application at their site since the licensee will have  
8           to provide responses and explanations for each of those  
9           action items.

10           CHAIRMAN BROWN: John, let me push just a  
11           little further on this so I understand.

12           These are things you can see at this point  
13           would be issues for specific applications when somebody  
14           comes in with an application they may be using it  
15           somewhat differently than you expected that doesn't fit  
16           any of those.

17           How does the review of this fit with the  
18           review that would occur at that point in time?

19           MR. THORP: Well, we take into account the  
20           SE that we'd already used on -- written on the given  
21           platform. So, they come in with a particular platform  
22           for which we've already evaluated, there's a comparison  
23           process that takes place. So, we look for any  
24           differences and any gaps as well as the ASAI's being  
25           responded to.

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1 CHAIRMAN BROWN: Let me just springboard  
2 from that for a second.

3 MR. THORP: Sure.

4 CHAIRMAN BROWN: The ASAs, did you  
5 provide a list, I've looked at the SEs and I don't  
6 remember, okay -- my age -- seeing a summary list of  
7 all the ASAs.

8 I saw some referred to through, you know,  
9 in the SE that you'd all mentioned. Hey, we covered  
10 this but we didn't do that, therefore, you're going to  
11 have to do such and such if somebody comes in an  
12 application. But I didn't see a summary list in the  
13 SE.

14 Is that -- is my assumption correct?

15 MS. ALVARADO: No, there is a list after,  
16 I think it's either before conclusions or after  
17 conclusions, a change by topical report. But there is  
18 a list --

19 CHAIRMAN BROWN: Well, I really missed it  
20 then.

21 MS. ALVARADO: -- summarizing generic  
22 items and then application specific items.

23 CHAIRMAN BROWN: Okay. All right, I'll  
24 go back and look at that.

25 MR. THORP: Yes, typically I think we try

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1 to collect all of those right at the end of the SE to  
2 make it easier for the, you know, the applicant to see  
3 what it is we're concerned about at the time.

4 CHAIRMAN BROWN: I saw a bunch of  
5 references but I just don't remember the ASAI's being  
6 explicit.

7 MR. THORP: Okay. So, well, with the  
8 concept of these ASAI's in mind, you're going to hear  
9 from my staff lead for each of these four topical  
10 reports that are noted on the agenda.

11 Part of this discussion is going to include  
12 the applicable, quote, unquote, key review criteria  
13 used during the review, which I believe is responsive  
14 to your original request for a familiarization  
15 presentation on the platforms.

16 Norbert Carte is going to describe the  
17 review scope and criteria in more detail in his  
18 discussions.

19 Finally --

20 CHAIRMAN BROWN: John, I just -- please,  
21 excuse me for a minute.

22 I guess one of the things, at least in my  
23 mind when we started wanting to have this meeting was  
24 that we are not going - this is me talking right now  
25 -- I did not look at it from the standpoint that we were

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1 going to, quote, give approval, disapproval, agree,  
2 disagree, whatever.

3 MR. THORP: Right.

4 CHAIRMAN BROWN: We're just reviewing --

5 MR. THORP: Right, this is an  
6 informational presentation.

7 CHAIRMAN BROWN: -- what you're all doing  
8 and then if an application comes in then we would be  
9 doing a more thorough review.

10 I mean we just didn't have the resources  
11 to go into it at that depth, even though we had -- it's  
12 good to have the topical reports, but --

13 So, it's my understand that our final Betty  
14 Crocker Good Housekeeping seal of approval on the  
15 overall thing would be based on its application in a  
16 specific design.

17 So, I just wanted to lay that on the table  
18 from my standpoint. If any of my member disagree with  
19 me on that? Okay.

20 MR. THORP: I think I agree with you.  
21 Thank you. Thank you, I think that's correct.

22 CHAIRMAN BROWN: Okay, thank you.

23 MEMBER REMPE: While you're interrupted,  
24 I'd like to ask a question.

25 I was at the NPIC HMIT meeting and I heard

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1 some discussion about this process. Could you remind  
2 us about how long it takes to go through a review of  
3 these topical and is the process getting more  
4 efficient, do you think? And is the time getting  
5 shorter or is that just so dependent on what they submit  
6 you can't really comment?

7 MR. THORP: It really varies and depends  
8 on what is submitted. It also significantly depends  
9 on the quality of the submittal and we have continued  
10 to emphasize to potential applicants that the need to  
11 have a good, thorough, quality input to us so that we  
12 can commence our review and do that in a timely fashion,  
13 that reduces the number of requests for additional  
14 information, et cetera.

15 Now, one way that we have done that is to  
16 encourage and I think potential vendor applicants for  
17 these topical reports have listened and heard us and,  
18 therefore, come to see us for what we call  
19 pre-application discussions at a phase zero meetings  
20 to discuss, you know, the scope and content that's  
21 needed in an application.

22 Some of them start out being somewhat  
23 unfamiliar with how to go about doing that, some of the  
24 folks that aren't the large vendors.

25 The nominal time frame, to get back to your

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1 original question is two years to complete the review.  
2 They can't be done faster, it's I think on average about  
3 a two year time frame but it sometimes takes some  
4 vigorous extra effort on our part to iterate with the  
5 applicant and obtain the information that we need

6 MEMBER REMPE: Okay. Thank you.

7 MR. THORP: And we are, with those  
8 comments that you heard at the RIC and at the NPIC HMIT,  
9 you know, we're consistently seeking to find ways to  
10 make the process more efficient.

11 So, just a little note for you guys, the  
12 information that my staff is going to present to you  
13 is at a nonproprietary level in this meeting. This is  
14 a public meeting. So, if you find a need to discussion  
15 information or have questions that broach or push into  
16 proprietary areas, then we would need to make that  
17 information the subject of a separate closed meeting.

18 CHAIRMAN BROWN: Well, just tell us if we  
19 look like we're touching on something.

20 MR. THORPE: We'll do our very best to draw  
21 the line because we have to preserve the interest of  
22 those who have sought that kind of proprietary  
23 protection.

24 MR. HECHT: Can I ask a question in advance  
25 with respect to that? Are questions on the order the

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1 size of the designs, particularly for the FPGA designs  
2 or those, you know, from terms of the number of gates,  
3 are those considered proprietary questions?

4 MS. ALVARADO: Yes.

5 MR. HECHT: Okay.

6 MR. THORP: Okay, next slide?

7 Okay, so I'll just -- one more slide for  
8 me and then we'll kick into with the real material from  
9 my folks.

10 So, we understand the committee's  
11 interested in becoming more familiar with the digital  
12 I&C platforms we've reviewed and that you're interested  
13 in various aspects of the platforms' design and how they  
14 work.

15 We're prepared to speak to you about the  
16 items described on this slide and believe that this will  
17 give you a good understanding of what we've looked at  
18 or are evaluating in the case of active reviews.

19 Relative to the last bullet, we aren't  
20 always given nor are we always privy to the vendor and  
21 licensee plans for the use of these various platforms  
22 but will relay what we've been made aware of as we've  
23 worked on them, recognizing that that's not necessarily  
24 information that's in stone or for sure.

25 We conduct an acceptance review in topical

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1 reports. Kind of so, Joy, a question that don't  
2 provide a sufficient level of clarity and detail to  
3 allow us to even commence a review have resulted in our  
4 not accepting the topical report or the applicant  
5 withdrawing the topical report until they strengthen  
6 the content of the document.

7 Now, what do we review and evaluate?  
8 Well, we seek to gain a technical understanding of the  
9 platform and the hardware and software associated with  
10 it. I'd like to emphasize that in our reviews, the  
11 questions and areas concerned flow directly from the  
12 regulatory requirements laid out in the Code of Federal  
13 Regulation and it's incorporated standards, the  
14 general design criteria, standard review plan and its  
15 incorporated branch technical positions and direction  
16 from the Commission in staff requirements memoranda.

17 We also take into account, of course, the  
18 guidance found in applicable regulatory guides which  
19 provides methods and approaches that the staff has  
20 already examined and considered acceptable approaches.

21 We evaluate alternatives to guidance,  
22 applying appropriate engineering judgment as we do so.

23 I hope our presentations will give you and  
24 help you gain an appreciation for the scope and content  
25 of our reviews on these platforms and I look forward

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1 to the discussion with you.

2 Norbert Carte will now speak in a bit more  
3 detail on the regulatory framework and what we've  
4 prepared to present to you on our digital I&C platform  
5 topical report reviews.

6 So, Norbert, go ahead and swap out there.

7 MR. CARTE: Okay. My name is Norbert  
8 Carte, I'm a Technical Reviewer in the I&C Branch, which  
9 I forgot to put after my name.

10 And today, I'll be talking a little bit  
11 about how we use topical reports. And so, it's framing  
12 the discussions to follow in terms of efficiency and  
13 regulatory criteria that can be addressed.

14 And in part, this is because topical  
15 reports have different scopes and those different  
16 scopes result in us addressing the regulatory criteria  
17 to a different degree, depending on the scope of the  
18 topical report.

19 And I'll also discuss the technical  
20 requirements and the key review criteria.

21 So, obviously, all the regulatory  
22 requirements must be met, though it's probably not  
23 efficient to talk about each and every regulatory  
24 requirement, some appear to be more significant for  
25 assuring safety and we want to talk about those in

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1 particular.

2 And then we'll talk about how those are  
3 assessed with each topical report.

4 So, again, as John emphasized, the point  
5 of a topical report is to increase regulatory  
6 efficiency to allow the review of an aspect, a detail,  
7 once and the crediting of that in multiple situations.

8 It reduces the burden on the staff. It  
9 also reduces the burden on the applicants from  
10 preparing that material.

11 There is always incumbent the  
12 responsibility to evaluate the applicability of a  
13 topical report for its intended applicant in a power  
14 plant. So that is done in the licensing phase.

15 So, basically, the industry proposes an  
16 approach to deal with a specific subject that is  
17 expected to be used more than once. So we don't like  
18 to do topical reports for one off applications. And  
19 it must be complete and detailed information.

20 Recently, we presented to the ACRS, well  
21 maybe not recently, ISG-06. And then ISG-06 discusses  
22 or encourages the use of topical reports in order to  
23 reach closure on certain aspects of license amendment  
24 applications for intended use in license amendment  
25 applications.

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1           So, in general, when we look at topical  
2 reports or at any process in the NRC, there's two  
3 aspects. There's the regulatory process and LIC-500  
4 is an internal office instruction that guides the  
5 process of performing reviews. It does not contain  
6 technical criteria.

7           The standard review plan contains the  
8 technical criteria. And so the attempt is to -- the  
9 focus mainly from the technical reviewers is on the SRP,  
10 the project managers use the office instruction more  
11 than we do. Their job is to keep us in line in terms  
12 of process.

13           So, when we look at the topical reports  
14 scope, each one can have a different scope but we can  
15 think of them as three major groups of scope.

16           And one would be a digital replacement  
17 card. So, this is a case where we have an old analog  
18 system installed in a plant. The components on those  
19 analog cards are no longer available so they are left  
20 to redesign the cards.

21           And in some cases, they have chosen to  
22 redesign those cards using digital components. Those  
23 tend to be fit, form and function identical  
24 replacements or that's the intent and slide in the  
25 existing racks.

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1 Yes?

2 CHAIRMAN BROWN: Does that -- when you  
3 talk about the digital replacements, does that imply  
4 since they're fit, form and function, if the old analog  
5 cards were analog in and analog out, obviously, you're  
6 going to get analog in, does that also mean analog out?

7 MR. CARTE: Yes.

8 CHAIRMAN BROWN: Even though you process  
9 within the card digitally?

10 MR. CARTE: Yes.

11 CHAIRMAN BROWN: Okay.

12 MR. CARTE: Well, to qualify analogs,  
13 there are -- analog are discrete inputs.

14 CHAIRMAN BROWN: Whatever.

15 MR. CARTE: Okay.

16 CHAIRMAN BROWN: But whether it's a  
17 variable signal or whether it's a discrete contact I'd  
18 think, that's the input but the output could be either  
19 one also. You don't deviate from its basic output  
20 function, in other words?

21 MR. CARTE: Correct.

22 CHAIRMAN BROWN: Okay. Thank you.

23 MR. CARTE: One detail which we'll get  
24 into a little later is typically with a digital card,  
25 there needs to be the ability to program the card and

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1 configure the card. So, these cards will have, in  
2 general, connectors on them that are used when the card  
3 is removed from the cabinet in order to configure or  
4 program the device. Sometimes the plant will have that  
5 capability, often it does not.

6 But they do have digital connectors that  
7 are not used while they're in operation or while they're  
8 installed in the rack because the old system didn't have  
9 the capability to connect to that.

10 Okay. So, one scope of cards, and I'll  
11 give some examples about historical ones and we'll also  
12 talk about today one of those digital replacement  
13 cards, the CPLD, a Complex Programmable Logic Device,  
14 based solid state protection system cards.

15 There's also a category of scope which we  
16 call system specific. So, an applicant has proposed  
17 a specific digital platform and a specific design for  
18 a specific function in a power plant. And one example  
19 of that was the NUMAC Power Range Nuclear Monitoring  
20 System Nuclear Monitor.

21 It's not described today, but it's an  
22 example of the system specific design. We don't have  
23 any system specific designs that we're talking about  
24 today. We're going to talk about one card and three  
25 application frameworks.

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1           So, an application framework is a general  
2           concept in software engineering for what has been  
3           termed a box of Legos. It is a set of components and  
4           a concept for using those components to construct an  
5           application.

6           So, sometimes that includes a software  
7           program manual. So, the plans for developing  
8           application specific applications and sometimes it  
9           does not, depending on the scope that the applicant  
10          requested.

11          So, today we will be talking about three  
12          application frameworks, the HFC-6000 which has been  
13          approved and it is going through an amendment process,  
14          the SPINLINE 3 which has been recently approved as well  
15          as the NuPAC process which is the in process of being  
16          reviewed.

17          So, in terms of just historical  
18          perspective, so in the formal -- well, let me back up  
19          just a little bit what's not here -- as the current form  
20          of the SRP took shape in 1997 and it didn't change much  
21          in 2007.

22          So, what you see or what you're familiar  
23          with the SRP was established at that time.

24          So, before that, AREVA had proposed a  
25          digital replacement module for some Bailey modules in

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1 their protection systems. That was a topical report  
2 reviewed and approved by the staff.

3 It had two microprocessors in it that were  
4 auctioneered or compared. And that was actually the  
5 installed in the Delta Flux Trip function at the Oconee  
6 Nuclear Power Plant. Now that and the other analog  
7 modules got removed with the TXS upgrade that was  
8 finished in 2009 or in '11 -- '11, okay.

9 Also in the past in terms of digital  
10 replacement cards, there is the ASIC based, the  
11 Application Specific Integrated Circuit based  
12 replacement module for the Westinghouse 7300 cabinets.

13 So, the 7300 cabinets perform the  
14 bi-stable functions for reactor trip and ESF functions  
15 and those were analog cards. Components were not  
16 available and Westinghouse designed a module to replace  
17 those cards. And that was approved in 2001 and that  
18 will become interesting when we talk later in some  
19 aspects.

20 In terms of system specific designs, I've  
21 already mentioned the NuPAC Power Range Nuclear  
22 Monitor. It does both the power range nuclear  
23 monitoring as well as the oscillation power range  
24 monitoring which was added subsequently to the initial  
25 functions. And there are various installations of

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1       that equipment.

2               So, in terms of application frameworks, we  
3       can divide the application frameworks into two  
4       categories because of their fundamentally different  
5       technologies involved in each.

6               One is the programmable logic device  
7       category and that would include the NuPAC application  
8       that we'll talk about today as well as the ALS platform  
9       that was previously approved by the staff.

10              So, the ALS was first used in the Wolf Creek  
11       main steam and feedwater isolation system. This was  
12       before There was a topical report, so then the topical  
13       report was submitted and approved.

14              And then the Diablo Canyon application  
15       will use that topical report as a basis of the License  
16       Amendment Request that is currently being reviewed by  
17       the staff.

18              So, in terms of microprocessor based  
19       applications, and these tend to look like programmable  
20       logic controllers. There's the MELTAC which is  
21       currently under review by NRR staff. It's going  
22       through its acceptance review. It has not been  
23       accepted.

24              It is proposed for use in the US-APWR which  
25       I believe has been presented to the ACRS.

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1           There's also the Triconex platform which  
2           was initially approved in 2001 and then was -- an  
3           updated version was reviewed and approved in 2012. It  
4           will be used in Diablo Canyon License Amendment Request  
5           which is currently under review.

6           Common Q is a little harder to explain. It  
7           was first approved in 2000. There were generic open  
8           items, plant specific open items. They then, in the  
9           series of submittals, they closed the generic open  
10          items except for one. And they also amended the  
11          application. And it also includes a software program  
12          manual. So, the last approval on that was in February  
13          of 2013.

14          So, the Common Q is used in the AP-1000 in  
15          Palo Verde for their core protection calculators which  
16          was both reviewed by the NRC.

17          There are some 50.59 uses of the Common Q  
18          platform. So, there are some digital installations in  
19          plants that we do not see. And one of those examples  
20          would be a post-accident monitoring system, a rod  
21          sequencer, rod position indications, those are  
22          examples that we have not looked at in license  
23          amendments.

24          In terms of another platform, there was the  
25          AREVA TXS platform. That was originally approved in

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1       2000. It was the base platform for the RPS/ESPS  
2       upgrade at Oconee.

3               We reviewed changes to the original  
4       platform as part of that licensing review for the Oconee  
5       application.

6               There is also a, well, I call it an  
7       application framework, but it's a little fuzzy. The  
8       Eagle 21 system, it was designed to be a replacement  
9       for the plant protection systems. It is a digital  
10      version of the Westinghouse plant protection system.

11              So, in the sense it's a system specific  
12      design but it's also a little bit of an application  
13      framework.

14              So, you didn't have to replace the whole  
15      system. Those cards were designed to fit in the 7100  
16      racks of the Westinghouse plant protection systems and  
17      there is at least one instance where only two trips were  
18      replaced. The other trips still rely on the Hagan  
19      module so it was almost a card replacement in that  
20      instance. But I think that required some modification  
21      outside the card chassis to do that.

22              MEMBER STETKAR: Norbert, you were on a  
23      roll, so I want to get to the TXS. You listed -- you  
24      said Oconee, RPS/ESPS upgrade, I'm familiar with that  
25      and 50.59. Is that for Oconee or is that for others?

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1 MR. CARTE: Yes, I think they have a hydro  
2 application at Ocone that was installed under 50.59.

3 MEMBER STETKAR: Okay, okay. I think for  
4 the QOE facility.

5 MR. CARTE: Yes.

6 MEMBER STETKAR: I didn't know whether  
7 that was, you know, comma and 50.59 for other plants  
8 because I wasn't aware of it at others.

9 MR. CARTE: Right. I'm not aware of any  
10 other installations but we're not necessarily aware of  
11 all installations that occur under 50.59, we as the  
12 design engineering staff. The region does have some  
13 oversight and they do look at these things, but that  
14 doesn't necessarily get tallied up into a master list  
15 of who's got what where.

16 MEMBER STETKAR: Okay.

17 MEMBER SCHULTZ: Norbert, it sounded as  
18 if, as you went through these, that in some applications  
19 the topical report has been revised as a result of the  
20 application, has that happened?

21 MR. CARTE: No. The problem with digital  
22 I&C topical reports is obsolescence of components. So  
23 it's not that they're, in general, they always get  
24 revised and it's not because there's things that are  
25 broken and they need to be fixed.

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1 But what happens is there is some,  
2 generally, some component becomes unavailable or some  
3 improvement gets made.

4 MEMBER SCHULTZ: I understand that part of  
5 it. I'm trying to understand the way in which the  
6 topical reports are applied. Because as it was  
7 originally -- as it was described earlier, these are  
8 fixed documents that are intended to be applied many  
9 times. And if you're revising them each time you have  
10 an application then it defeats some of the purpose.

11 MR. CARTE: Right. It's a little  
12 problematic. We approve a version of a module but that  
13 module can never stay fixed. The version number of  
14 that module is very difficult to remain fixed.

15 Some component gets changed, some process  
16 gets changed. That change gets evaluated but that new  
17 module can't have the same version number. It has to  
18 be updated to reflect that it's not the same thing that  
19 you shipped earlier.

20 So, component obsolescence results in your  
21 version numbers of modules never remaining fixed.

22 CHAIRMAN BROWN: With that in mind,  
23 relative to your comment, if a plant -- if an  
24 application is designed using one of the versions that  
25 they have approved using the topical report, and then

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1 the modules get revised later, three, four, five years  
2 down the stream because of component obsolescence, that  
3 module cannot be directly used in the old thing unless  
4 you all look at that again. Isn't that correct?

5 MR. THORP: They would have to conduct  
6 first a screening. But if you're talking about this  
7 is --

8 CHAIRMAN BROWN: I'm saying if you get --

9 MR. THORP: -- if you had a licensee that's  
10 been installed?

11 CHAIRMAN BROWN: Yes, a licensee has a  
12 version that is approved.

13 MR. THORP: Right.

14 CHAIRMAN BROWN: So, part of the licensing  
15 basis --

16 MR. THORP: So, now they talk with the  
17 vendor. The vendor says, hey, we've got this new way  
18 of replacing this particular piece that, you know,  
19 we're having some difficulty getting these parts and  
20 we want to put this new gadget, call it widget, on the  
21 board. It's going to do exactly the same thing for you,  
22 blah, blah, blah.

23 Well, that has to be explained to the  
24 licensee and the licensee has to evaluate that, screen  
25 it through 50.59 and if the 50.59 questions and criteria

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1 are not met, then they would have to generate a license  
2 amendment request, come back to us for our review.

3 CHAIRMAN BROWN: Okay. All right. Does  
4 that -- I just wanted to --

5 MR. THORP: Similarly, on a grander scale,  
6 the concept and the concern that we have for, you know,  
7 these technology vendors are always interested in  
8 trying to make things smaller, better, faster, cheaper,  
9 you know.

10 So, if they see a need in a given platform  
11 that they have that they're marketing a need to try to  
12 improve it and update it, what we've been pressing with  
13 NEI and with industry, with the vendors, is to identify  
14 a means that's systematic and clearly understood for  
15 them to examine any deltas, any changes that they've  
16 made to determine whether that has a potential of  
17 invalidating our SE on the platform and to set up a  
18 routine process by which we all understand this is what  
19 you need to go about in doing rather than waiting until  
20 the last minute for the licensee to try to catch it or  
21 whatever.

22 I want the vendors thinking about this and  
23 in sending us an update that they request our subsequent  
24 review.

25 And we also have to try to be efficient with

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1 this as well. I'm not interested in evaluating a bunch  
2 of sequential little iterations on a platform that  
3 nobody's taking on and put into their plant. I'll wait  
4 until somebody wants to put the application in their  
5 plant then we'll look at the whole thing again.

6 MEMBER SCHULTZ: That's why I asked the  
7 question. It's a real challenge to maintain the  
8 control over the process.

9 MR. THORP: It is, that's correct. And so  
10 we're --

11 MEMBER SCHULTZ: It's important that you  
12 do so.

13 MR. THORP: Yes. And in our interactions  
14 with NEI, they have agreed to and have identified a  
15 working group, but it's not their highest priority but  
16 they've got some folks in industry who are examining  
17 that.

18 At the same time, some of the major  
19 vendors, based on this same conversation that we've had  
20 with them in the past, have developed their own in-house  
21 means to ensure that they track and configuration  
22 manage the potential changes that they have or the  
23 changes that they want to develop in any platform they  
24 have so that they know when to come to us or to seek  
25 another review.

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1                   MEMBER SCHULTZ: That sounds more than a  
2 nice thing to do. That sounds like a necessary thing  
3 to do.

4                   CHAIRMAN BROWN: It's a requirement.  
5 It's my understanding it's a requirement. You've got  
6 to maintain configuration control and management of  
7 each.

8                   MR. THORP: So, they've developed actual  
9 procedures for doing this. What I want to do is have  
10 them get together and let's ensure that what they've  
11 got at least a minimum standard of how they go about  
12 doing this so that we can comprehend it and effectively  
13 process that.

14                  MR. CARTE: Right. But I might put that  
15 a little -- frame that a little bit. I guess I  
16 understood the question a little differently.

17                   But there are two scopes, there is one, a  
18 License Amendment Request and another is replacement  
19 module efforts installed.

20                   During the license amendment process, we  
21 do look at changes. That is our practice. After it's  
22 installed, they go through the 50.59 process. And as  
23 he said, we're discussing what those criteria need to  
24 be for when we need to be notified about changes.

25                  CHAIRMAN BROWN: Yes, I guess one of my

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1 follow ons to Steve's comment, again, is, and your  
2 details of clarification of it, some of these licensees  
3 may or may not have the same level of engineering or  
4 technical capability.

5 Some carry some on down the stream with  
6 them but they rely more, or at least that's what I get  
7 out of some of these meetings, they rely more on the  
8 vendors to tell them, is this okay or is it not okay.

9 And it seems to me that's a kind of a hard  
10 spot that you all have to deal with.

11 MR. THORP: Well, the ultimate  
12 responsibility for the safety of the systems or  
13 components that are put into place, original  
14 installation and modifications subsequent, lies with  
15 the licensee.

16 And so, they do have to make sure that that  
17 conversation with vendors is a good one. And the  
18 vendors I think understand this. But some of the  
19 issues that we've had to deal with have involved exactly  
20 that in which the vendor had an impression that changes  
21 they had made simply constituted a hardware change out  
22 and then resulted in a recommendation to licensees who  
23 were going to buy this component to simply do a 50.59  
24 screening and it was good to go.

25 So, that's a very short and simplified way

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1 of describing what we've seen in the past.

2 Now, I think, well, I'll leave it at that.  
3 But that is a concern.

4 MR. CARTE: Right. The vision on that is  
5 that the vendors are the experts on the hardware  
6 platform, the technology. They're responsible for  
7 evaluating and characterizing the changes that exist.

8 The applicant is responsible or the  
9 licensee is responsible for evaluating the effect of  
10 that and impact on their licensing documents and on  
11 safety.

12 CHAIRMAN BROWN: Okay. Before you leave  
13 this slide, you've talked about four different types  
14 of devices in There and there are some folks that don't  
15 necessarily know what all of those are.

16 You talked about FPGA, CPLDs in one  
17 framework and then you talk about microprocessors and  
18 then programmable logic controllers. They're kind of  
19 used as a mix and match.

20 And I read this a couple of places in your  
21 all's documents and I wanted to make sure I understood  
22 you all's distinction between an FPGA and a CPLD which  
23 are largely, in my understanding, I may be wrong so fix  
24 me, are programmed by a software to perform a series  
25 of stepped operations.

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1                   And that once you program them, that's the  
2                   way they are. It's not a -- they're not software based  
3                   in terms of their basic --

4                   I know you want to leap in, just wait  
5                   please.

6                   But they're not software based in the  
7                   manner that microprocessors are or, in some  
8                   circumstances, maybe even programmable.

9                   I'm trying to get a feel for myself. I  
10                  know microprocessors are very, very clearly, every  
11                  software, this software, that it's all buried in there,  
12                  PLCs. What are the differences between the PLCs and  
13                  the PLDs?

14                 MR. CARTE: Okay. These are fuzzy sets  
15                 and so it gets complicated as technology evolves.

16                 CHAIRMAN BROWN: That's why I asked.

17                 MR. CARTE: But, the programmable logic  
18                 devices is a term that I'm trying to use as a generic  
19                 term at some point it was a technology specific term.

20                 The idea is that is a device that consists  
21                 of gates that you program, that you configure or  
22                 connect.

23                 The difference between an FPGA and a CPLD  
24                 is sort of a measure of complexity. The FPGAs are an  
25                 order an magnitude or significantly more complex in

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1 complex programmable devices.

2 The concept about not having software is  
3 not a hundred percent accurate for FPGA. So an FPGA  
4 has a large number of gates on them. You can actually  
5 emulate microprocessors on the FPGA and run your  
6 regular software on those microprocessors.

7 CHAIRMAN BROWN: On the FPGA?

8 MR. CARTE: On an FPGA. That process is  
9 obviously discouraged, but it is the technology allows  
10 that. In fact, I just recently read an article where  
11 a guy on his own time used an FPGA to build a handheld  
12 Cray-1 computer.

13 So, the concept of an FPGA being hardware  
14 is definitely not valid. But you can implement  
15 microprocessors on an FPGA. So, it's a fuzzy class and  
16 we can get more into that different later.

17 But one of the main distinctions between  
18 a microprocessor and the programmable logic devices is  
19 the degree of parallelism in the device. So a  
20 microprocessor tends to have a small amount of shared  
21 resources and all process share those resources.

22 And on those devices, one technique that  
23 I've heard of in the past, to assure that those  
24 processes are working is a watchdog timer.

25 Another concept occurs in an FPGA and

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1 complex programmable logic devices which are highly  
2 parallel devices. So, if you were to strobe a watchdog  
3 timer based on a CPLD or FPGA, you're only really  
4 confirming that a very small fraction of the circuit  
5 on that card is working.

6 So, watchdog timers don't have the same  
7 effectiveness on programmable logic devices because of  
8 their inherent parallel nature and you look to other  
9 sorts of checks to assure that things are fully  
10 functional, aliveness checks and self-testing and  
11 things like that.

12 So, there are certain technological  
13 differences, but these are basically fuzzy categories.

14 Now, when we talked about programmable  
15 logic controllers, that's an industry -- that's a term  
16 that came out of the automation industry.

17 So, computers have not always been  
18 reliable and in some senses for industrial  
19 applications, they took out the unreliable pieces. So  
20 they took away the displays, the display controllers,  
21 they took away the keyboards. They, in general, take  
22 away network connectivity and create system which was  
23 very simple, a dumbed down computer that was less prone  
24 to fail. Without a hard drive, it's not sensitive to  
25 -- as sensitive to vibration.

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1           And so a programmable logic device is  
2 really an industrial hardened computer that has a  
3 certain architecture, no screen, no hardware, no hard  
4 drive, no keyboard, implements mainly logic.

5           CHAIRMAN BROWN: But it has ROM and RAM in  
6 it?

7           MR. CARTE: Yes.

8           CHAIRMAN BROWN: Okay. So, it is a  
9 software -- I understand your point.

10          MR. CARTE: Yes.

11          CHAIRMAN BROWN: Let me back up to your  
12 FPGA just to make sure I understand the FPGA, CPLD  
13 routine.

14                 I guess in the designs we've looked at on  
15 the FPGA side, they have not been or at least they have  
16 been advertised to not have been in this fuzzy area  
17 where they implement or emulate a Cray computer.

18          MR. CARTE: Right.

19          CHAIRMAN BROWN: They have been straight  
20 through hardware type, as you say, you discourage this  
21 other methodology?

22          MR. CARTE: Right. I think for a while  
23 people tried to bill FPGAs as hardware devices and in  
24 that attempt, they have never tried to emulate a  
25 microprocessor an FPGA because that would undermine

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1       their position.

2               So, no one has ever proposed that that I'm  
3       aware of to the NRC and we would not encourage that.  
4       However, FPGAs are very complex and, therefore, they  
5       have some of the same issues that software does in terms  
6       of the inability to completely test them as well as the  
7       reliance on software development tools.

8               So, we consider the software -- and in  
9       general, you load a data file on to an FPGA. There are  
10      FPGAs where you burn in connections or break fuses.  
11      But the larger the FPGA is, the less likely you are to  
12      have those type of implementations. They tend to all  
13      require loading of data file these days.

14              And some have some sort of processing  
15      function in there to translate and map that data file  
16      into local memory locations.

17              So, they are essentially software devices  
18      and require the same level of controls as  
19      microprocessor based devices, same level of process  
20      development controls as microprocessor devices.

21              CHAIRMAN BROWN: So, any subsequent looks  
22      we may have at an application of FPGAs really requires  
23      the committee to have a better understanding of how they  
24      are implemented because of our concerns relative to  
25      processes that may or may not stop the operation in the

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1 multiple divisions since they now have, as you're  
2 characterizing it, they are fundamentally software  
3 based, software control type devices as opposed to  
4 burned gates which was literally what I was familiar  
5 with.

6 MR. THORP: There are software  
7 instructions that are burned in on the chip.

8 CHAIRMAN BROWN: Yes, but that's -- when  
9 I hear burn in on a chip, that means breaking fuses,  
10 doing whatever it is so that you've literally fixed the  
11 number of gates that you go through and every clock  
12 stroke, every clock, you know, leading it, trailing it,  
13 whatever it is, every clock initiation or tick that you  
14 have that as you step through the operation and move  
15 the data through it was fixed.

16 That's old days, that's -- you go back when  
17 I first looked at these things 20 years ago. Now you're  
18 saying their more complex and there are more different  
19 -- there are different ways of utilizing them.

20 MR. CARTE: Right.

21 CHAIRMAN BROWN: Which now put them into  
22 the context of microprocessors where our concerns  
23 should possibly be more amplified.

24 MS. ALVARADO: Yes, but we haven't seen  
25 any application using or emulating these.

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1 CHAIRMAN BROWN: No, I appreciate that.

2 MR. THORP: Some of these have functioned  
3 like a microprocessor. They're software involved in  
4 the --

5 CHAIRMAN BROWN: I've always loved  
6 Norbert's approach in terms of fuzzying the -- you know,  
7 giving us the true scoop here on what is going on so  
8 we understand it. I'm just trying to make sure I  
9 understand a way that I can at least ensure that the  
10 committee understands what we're doing and why we  
11 should make certain observations as part of our  
12 reviews, that's all.

13 MR. CARTE: Right. The technology is  
14 evolving. So, what used to be a complex device is no  
15 longer considered complex.

16 There's also underlying technology  
17 differences. So there are fuse, antifuse type FPGAs  
18 which you gave a familiarity with.

19 But there's also devices where the file  
20 isn't loaded when you power up. So, when you -- the  
21 first thing the file does, the system does, is load the  
22 file at power up.

23 There's other systems or configurations  
24 where there's actually flash type memory in the device  
25 and it's an instant on device and there is no loading

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1 of file at power up. It's done at the factory.

2 So, there are various ways that these  
3 things are implemented and that's changing or evolving  
4 over time. So there isn't a good set of words you can  
5 use that'll always hold for categorizing these into  
6 particular complexity classes or processes.

7 I mean obviously fuse and antifuse are  
8 words that apply.

9 CHAIRMAN BROWN: No, you've helped out  
10 immensely in terms of my ability to ask questions.

11 MR. THORP: Well, you know, recognizing  
12 that there are different approaches that can be used  
13 in the design of these systems, we expect that to be  
14 explained to us and that's the kind of things we ask  
15 questions about when we conduct our reviews.

16 CHAIRMAN BROWN: Well, one of the designs  
17 you're going to be presenting to us is an FPGA based  
18 design. So, you've now raised the question of what are  
19 we seeing?

20 Because it has a lot of little watchdog  
21 timers floating around in it. Now, I don't know, so  
22 I've got some sense of -- because they're all called  
23 the same thing, I have some sense of comfort when I read  
24 it and now I've raised my level of discomfort, that's  
25 all.

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1 Hey, we need to move on here so we can at  
2 least for your part --

3 MR. CARTE: Right. Actually, you're two  
4 presentations in that vein today. One is a complex  
5 programmable logic device which is fundamentally  
6 simpler.

7 CHAIRMAN BROWN: That's the card  
8 replacement?

9 MR. CARTE: Yes. And the other was an  
10 FPGA which is fundamentally more complex. One we've  
11 completed the review, the other we're still in process.  
12 So, there's different amounts of information you'll be  
13 able to get in that.

14 CHAIRMAN BROWN: Okay, thank you.

15 MR. CARTE: Okay. So, the technical  
16 requirements fall into these basic categories.

17 The first bullet I just want to mention is  
18 that A figure of standard has been moved from  
19 50.55a(a)(1) to 50.54(jj) and 50.55j. And that's the  
20 A criteria for quality standard. So it'll be designed,  
21 erected, constructed in accordance with quality  
22 standards.

23 So, all of these requirements must be met.  
24 Some of them have greater safety significance than  
25 others. What we do in general is or the role of the

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1 SRP in general is to look at all the requirements, look  
2 at all the guidance regarding those requirements and  
3 distill it down to a set of guidance for the reviewer.

4 So, it attempted to harmonize all those  
5 different requirements into one set of review criteria  
6 for the reviewer to follow.

7 Chapter 7 has a unique organization. It  
8 has a set of review criteria based on function such as  
9 reactor trip or engineering safety features. It also  
10 has a set of criteria by topic such as BTB 717 for  
11 development processes.

12 So, we would look at the development  
13 process criteria for reactor trip system and in the ESF  
14 system. So, the reason it was developed that way is  
15 to try and reduce the amount of repetition in the SRP.

16 MR. HECHT: Can I ask a question about the  
17 quality review process and how it differs between  
18 software development and FPGA development? Is this an  
19 appropriate time or should I wait until --

20 MR. CARTE: Well, we can wait a little bit.

21 But so, quality has actually two  
22 definitions. One is a process. So sometimes we think  
23 of -- we use the word quality to refer to Appendix B  
24 and it also has other characteristics.

25 So, 603 talks about low failure rates and

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1 minimum maintenance requirements, the fact that -- and  
2 the GDCs talk about you'll develop things in accordance  
3 with codes and standards.

4 So, you'll specify the functions and  
5 you'll specify features that ensure high reliability,  
6 low failure rates.

7 So, in terms of process, software  
8 development processes, we don't really make much of a  
9 distinction between FPGAs and microprocessors.

10 Now, so we look at the same -- we apply the  
11 same criteria for software development processes  
12 whether it be FPGA or a microprocessor based system.

13 Now, there are technical differences  
14 between the two. So, you can't exactly apply the same  
15 criteria. You have to apply some engineering judgment  
16 in your evaluation of the implementation of that  
17 criteria.

18 MR. HECHT: Well, there are two steps in  
19 the FPGA process that I see are different than the  
20 software development process and one is the development  
21 of net lists and then finally it's the actual  
22 development of the files which fuse or antifuse the  
23 chips themselves and then there's the burning of those  
24 chips.

25 MR. CARTE: Right. But in some senses, I

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1 mean if you think of a process where you write in C code  
2 of VHDL, they're both essentially software. Then  
3 you're talking about a set of tools which translate that  
4 software representation and if you look at VHDL it looks  
5 just like software, right, it is software.

6 There are different tools that translate  
7 those functional requirements onto a specific  
8 implementation on the chip. And so, yes, there are  
9 fundamental differences in those tools. But, in  
10 essence, there are software, there are very large  
11 degrees of similarity in the development process all  
12 the way to the source code, the VHDL or C code.

13 In fact, there are tools where you can take  
14 a C code and burn it onto to a chip so you don't have  
15 to write in VHDL.

16 And so, the line is fuzzy. So you want to  
17 differentiate between the software instructions that  
18 you write and the underlying implementation. And yes,  
19 there are different tools and different processes.

20 MR. HECHT: Okay. So, if putting it  
21 another way, you would consider the net list generation  
22 and the files to burn the FPGAs as the equivalent of  
23 a compiler that you can kind of trust?

24 MR. CARTE: Correct. Compile, link and  
25 load essentially. We treat them as comparable tool

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1 sets.

2 MR. HECHT: Okay. And I guess the  
3 distinction is that when you're writing VHDL, that's  
4 a human process just like writing C is a human process,  
5 so that's where you spend most of your time?

6 MR. CARTE: Actually, we in a regulatory  
7 space, we don't review the source code in that sense.  
8 We try and keep our review at a higher level than that.  
9 We review the processes, review that they actually  
10 test, do code reviews and things like that, but we don't  
11 actually evaluate the source code.

12 MR. HECHT: Well, but you do do thread  
13 audits?

14 MR. CARTE: Yes. And that would go down  
15 to -- that can go down to the source code and it goes  
16 over to the test -- the testing of the requirements.

17 MR. HECHT: But you don't look at the tools  
18 and the quality of the tools that are being used below  
19 that or how do you assess that? You must assess that  
20 somehow.

21 MR. CARTE: The applicant has to assess  
22 the tools and to the extent that they rely on the tool  
23 or accredit the tool for meeting a safety requirement,  
24 then they need to qualify that tool for its ability to  
25 do that.

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1           To the extent that they can independently  
2 confirm the output of that tool, then they don't need  
3 to do that. So, there are different approaches that  
4 people take and some people look at developing a test  
5 suite in accordance with safety related requirements  
6 and they use that test oracle or suite to confirm the  
7 actual code works correctly.

8           So you have two independent Appendix B  
9 development processes. The other ways would be to use  
10 two independent non-safety related tools to compare the  
11 outputs against each other and then use those to  
12 confirm.

13           But there's different processes and it's  
14 hard to generalize but the requirement is that they  
15 evaluate the tool and if they rely on the tool, then  
16 they have to qualify the tool for what they rely on it  
17 for.

18           MR. HECHT: And do you provide -- is the  
19 regulatory guidance saying, for example, you and use  
20 two non-qualified processes to compare against each  
21 other versus --

22           MR. CARTE: Yes, yes. No, the regulatory  
23 guidance does not talk about that. The regulatory  
24 guidance just basically says that either you qualify  
25 the tool or you independently confirm its output.

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1 CHAIRMAN BROWN: Can we go on?

2 MR. HECHT: Yes, go ahead.

3 CHAIRMAN BROWN: Okay, thank you.

4 MR. CARTE: Okay. So, the specific  
5 review criteria we'd like to talk about today, we feel  
6 are more significant and that's why we'll talk about  
7 them.

8 Some of them are a little bit of a matter  
9 of interpretation. So, when we say design bases,  
10 there's two ways you can think about that.

11 You can think about the design bases of the  
12 plant and that's documented in the FSAR and you can  
13 think about the design bases of a system.

14 So, a system is built in accordance to some  
15 specification. There needs to be a one for one  
16 correspondence between what the system does or features  
17 it has and the documentation that describe the system.

18 So, that description, the documented  
19 description of the system and the reason for those  
20 features existence, we consider to be the design bases  
21 of the system which is different and distinct from the  
22 design bases of the plant.

23 So, what happens is, in general, when we  
24 compare, we're looking at topical report, we can assure  
25 that the equipment matches the description of the

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1 equipment, that the paper matches reality.

2 And in general, when they set up the  
3 criteria for that system, say in an equipment  
4 qualification, they will look at the worst case seismic  
5 loading that they anticipate, they will specify that  
6 as the design basis of the system.

7 The plant then, the licensee, has the  
8 obligation to ensure that the intended installation of  
9 that equipment is bounded by the qualification of the  
10 plant.

11 So, it's a two-step process. We ensure  
12 the equipment matches the paper and they ensure that  
13 the paper matches the needs of the plant.

14 So, single failure criteria is one of the  
15 important criteria. There are some requirements for  
16 redundancy explicitly in the GDCs and 603. However,  
17 redundancy is more strongly -- redundancy and  
18 independence are more strongly implied or required by  
19 the single failure criteria.

20 In other words, if you're not redundant,  
21 it's hard to argue that you can withstand a single  
22 failure.

23 So, the quality we look at is not Appendix  
24 B quality QA. We look at are the technical processes  
25 associated with software development appropriate for

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1 the tools that they're using? Are they crediting the  
2 tools in the right way? Are they evaluating the tools  
3 correctly?

4 So, in terms of equipment qualification,  
5 there tends to be two types of qualification, one which  
6 we call environment or can be called environment and  
7 the other would be performance. So, response time  
8 behavior is considered a performance requirement.

9 Environmental is a little of a fuzzy term.  
10 Sometimes people consider atmosphere different from  
11 radiation or seismic requirements.

12 So, for instance, GDS 2 talks about  
13 protection against natural phenomenon and GDC 4 talks  
14 about environmental design dynamic effects. So, in  
15 that case, we're thinking about environment in two  
16 different categories, things that are naturally  
17 occurring like earthquakes and things that are a result  
18 of accidents.

19 But in reality, there's a set of  
20 temperature radiation, humidity, vibration  
21 requirements placed on the equipment in a particular  
22 location and that's what's qualified, too, even though  
23 the descriptions come from different areas.

24 When we talk about independence, the  
25 criteria talks about independence between

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1 redundancies, between the equipment and the design  
2 basis events and you can do that by qualification  
3 testing and between the safety systems and other  
4 systems.

5 When we think about electrical  
6 independence in these areas, we think about electrical  
7 independence, we think about physical independence.

8 Generally, physical independence is  
9 addressed at the plant level where they end up  
10 installing equipment in different cabinets, in  
11 different rooms, different fire zones, depending on the  
12 level of physical independence that's required.

13 And that provides you immunity against  
14 things like fire or accidents that could occur, running  
15 a forklift into a cabinet, for instance.

16 We also consider communication  
17 independence and the independence between protection  
18 and control. So, we think about all these aspects when  
19 we think about independence.

20 We also consider the secure development in  
21 an operational environment. And the way we look at  
22 that is that there's no unwanted, undocumented,  
23 unneeded code in the system.

24 So, in essence, we're confirming that  
25 there's a one for one correspondence between the

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1 features of the system, characteristics features, and  
2 the design basis documentation for that system.

3 How that system is used and whether that  
4 meets the needs of the plant is evaluated at the time  
5 license amendment request.

6 We also sometimes look at diversity and  
7 defense in depth, if it is proposed. So, some  
8 applicants propose that they have enough inherent  
9 diversity in the system to eliminate consideration of  
10 common cause failure per the guidance in the Standard  
11 Review Plan Branch Technical Position, BTP 719, and  
12 some applicants do not.

13 But in the end, diversity in defense in  
14 depth is a plant level criteria that needs to be  
15 evaluated at the license amendment.

16 MEMBER BLEY: The previous bullet that you  
17 went through, does that imply you're actually rummaging  
18 through code or just descriptions of the code looking  
19 for unnecessary things that might be in there?

20 CHAIRMAN BROWN: The SDOE, is that what  
21 you're talking about?

22 MR. CARTE: Yes, there's two aspects.  
23 There's one what we do look at a little bit at the  
24 processes that they have in place for not introducing  
25 code as well as in general, there are code review

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1 requirements.

2 When you look at software development  
3 processes, you basically must code reviews. And so,  
4 someone is responsible for evaluating the code against  
5 the software design description. We check that they  
6 have done that and that evaluation should consider --

7 MEMBER BLEY: That's really looking at  
8 their documentation?

9 MR. CARTE: Yes, sir. We're looking at  
10 their documentation, their evaluation.

11 MEMBER BLEY: Okay.

12 MR. THORP: Those kind of things get  
13 discussed during our audits, threat audits and we try  
14 to see how they're handling the code, how they're  
15 protecting it, how they're ensuring that it doesn't get  
16 corrupted. You know, are there extra gadgets, you  
17 know, nice to have things that really don't belong there  
18 but maybe they offer to non-nuclear customers, that  
19 kind of thing.

20 MEMBER BLEY: Historically, there's been  
21 a lot of that.

22 MR. CARTE: Right. Well, effectively, or  
23 in summary, we evaluate that they did their job  
24 correctly. We do not do an independent review.

25 So, we predominantly are making sure that

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1       they have procedures in place and that they do their  
2       job thoroughly and if we find holes, we keep digging  
3       because we should not find anything.  If they've done  
4       a good job, we shouldn't -- in a short audit, we should  
5       not be able to find a single problem and, if we do, we  
6       just keep pulling the thread.

7                   MEMBER BLEY:  Okay.

8                   MR. CARTE:  Okay.  So, in essence, what  
9       happens is how the criteria are addressed depends in  
10      part on what is requested to be addressed in the topical  
11      report as well as the general categories that we've  
12      talked about.

13                   A digital replacement card, for instance,  
14      we'll never look at digital communications because the  
15      analog didn't allow for that.  So, it doesn't exist in  
16      those cards.

17                   The application framework, it's hard to  
18      determine exactly what you're going to -- how you're  
19      going to use that card, so some criterias are left open.  
20      System specific has the most information in it.

21                   And, again, when we talk about a License  
22      Amendment Request, it in essence, must address  
23      everything not addressed by the topical report.

24                   So, a topical report closes something,  
25      everything else is required to be addressed in the

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1 License Amendment Request. And, in general, they'll  
2 confirm what the TR bounds that the needs of the plant.

3 So, I tried to create a little bit of a  
4 matrix in terms of how these different criteria are  
5 addressed at the different types of review and I'm not  
6 sure I want to talk about all of them.

7 But one area that's interesting is, for  
8 instance, single failure criteria. A digital  
9 replacement card cannot met the single failure  
10 criteria. It is a component that is used in the system.

11 However, one of the aspects of the single  
12 failure criteria is that there are no undetectable  
13 failures. So, in general, all systems get a failure  
14 modes and effects analysis and that analysis is  
15 accompanied by some evaluation that identifies how each  
16 failure is identified so that the system does not have  
17 any unidentified failures in it.

18 So, in general, to address the single  
19 failure criteria, we look at the FMEA at the digital  
20 replacement card and at the application framework. If  
21 we had a system design, we can look at more details and,  
22 obviously, a license amendment, we can look at  
23 everything.

24 The criteria for quality is addressed  
25 similarly for all applications. We assure that what

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1 they did within the scope of the topical reports meets  
2 the quality criteria in the SRP.

3 There's nothing really system specific  
4 about quality. It's safety related, non-safety  
5 related but besides that, it's difficult to partition  
6 in terms of the quality of a reactor trip function  
7 versus and ESF function. There is no distinction.

8 Independence is also an interesting  
9 criteria to evaluate. So, for instance, in an  
10 application framework, since you don't know the  
11 application, you don't know the information, you don't  
12 know what information will be transmitted, all you can  
13 evaluate is the mechanism or communication. And for  
14 microprocessor based systems that tends to be a  
15 separate communication processor and dual port RAM.

16 In terms of digital cards, they meet the  
17 same functional requirements. There are really no  
18 independence criterias to check.

19 And I think that's really all that I wanted  
20 to talk about on this slide. But this give sort of a  
21 feeling that we address the same criteria differently  
22 depending on the scope of the application.

23 We have the acronym list and then I guess  
24 questions.

25 CHAIRMAN BROWN: If we have no questions,

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1 we'll move on to Rossnyev. Is she next?

2 We're about 20 minutes behind, so we will  
3 try to maintain some decorum in our questions, not  
4 decorum but --

5 MR. THORP: Well, we'll try to maintain  
6 that as well.

7 CHAIRMAN BROWN: -- quality in our  
8 questions here.

9 MS. ALVARADO: Okay.

10 CHAIRMAN BROWN: So, the floor is yours,  
11 excuse me.

12 MS. ALVARADO: I'm sorry.

13 I'm Rossnyev Alvarado, I'm a Technical  
14 Reviewer in the I&C Branch in NRR and I was the lead  
15 reviewer for the Rolls Royce SPINLINE 3 digital  
16 platform.

17 Next slide?

18 This slide just summarizes the outline for  
19 my presentation. It's pretty much based on what  
20 Norbert described previously.

21 Next slide?

22 So here is the background of the SPINLINE  
23 3 platform. We issued the safety evaluation in  
24 September of 2013.

25 This platform resulted from the evolution

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1 of several I&C systems that Rolls Royce have installed  
2 in France. And because of this, it was designed based  
3 on European Nuclear and Quality Standards like the  
4 IEC-880. Now it's IEC-6880, but at the time this was  
5 developed, it was still the old format.

6 MEMBER STETKAR: Rossnyev, are these, you  
7 said installed in France? These are in EDF plants,  
8 nuclear plants?

9 MS. ALVARADO: Yes.

10 MEMBER STETKAR: They're back fits for  
11 AREVA?

12 MS. ALVARADO: Well --

13 MR. THORP: They've actually been  
14 through, my understanding --

15 MS. ALVARADO: Several evolutions.

16 MR. THORP: -- several evolutions,  
17 several generations of SPINLINE digital I&C platforms.  
18 They also do, there's a segment of their business that  
19 is involved with neutron monitoring systems and things  
20 like that.

21 MEMBER STETKAR: Neutron monitoring is  
22 usually often on the side.

23 MR. THORP: So, they are through a  
24 majority of the EDF plants.

25 MEMBER STETKAR: Is that right? I didn't

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1 know that.

2 MS. ALVARADO: Yes, but going back to your  
3 question, in 2011, EDFs selected SPINLINE to replace  
4 the reactor protection system in at least 20 units in  
5 France. So, they're going through that replacement  
6 now as we speak.

7 MEMBER STETKAR: Thanks.

8 MS. ALVARADO: So, when we did our review,  
9 the French equivalent of the NRC, the regulators, they  
10 participated in our audit and we also talked and  
11 exchanged information with what we were reviewing and  
12 what they were reviewing.

13 So, they went with your guys when you went  
14 to France for the audit.

15 MR. THORP: Yes, they joined us for that  
16 week of the audit.

17 MEMBER BLEY: Is their approach  
18 reasonably similar to what we're doing?

19 MEMBER STETKAR: The review approach,  
20 right?

21 MR. THORP: Yes. I think they -- I can't  
22 give you a detailed explanation but I think that they  
23 expressed a lot of the same questions and concerns and  
24 wanted to look into a lot of the same things that we  
25 were looking into. So, that gave me a sense that there

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1 was a pretty roughly good parallel approach to things.

2 Now they may emphasize some things more  
3 than others that I'm not familiar with and I don't know  
4 whether our SL, who's perhaps more familiar with some  
5 of the things that they do over there.

6 MEMBER SCHULTZ: In timing, their review  
7 and our review is in parallel? When did this start?

8 MS. ALVARADO: It overlapped.

9 MR. THORP: Well, they expressed an  
10 interest knowing that we were going to do the audit.  
11 Right? So they --

12 MEMBER SCHULTZ: Not just the audit, I  
13 meant the topical review.

14 MS. ALVARADO: They overlap. They  
15 started before because --

16 MEMBER SCHULTZ: That's what I would have  
17 thought.

18 MS. ALVARADO: Right, because they were  
19 awarded this to Rolls Royce in 2011. But I cannot tell  
20 you exactly when they started.

21 MEMBER SCHULTZ: When was the topical  
22 submitted to us?

23 MS. ALVARADO: 2010.

24 MR. THORP: '09 or '10.

25 MS. ALVARADO: It's a long story.

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1 MR. THORP: It has an ugly history.

2 MEMBER SCHULTZ: Okay. So there's some  
3 work that was done in parallel and some that was not,  
4 I guess?

5 MS. ALVARADO: Right.

6 MR. THORP: Right. There was some fits  
7 and starts in the whole process of trying to get this  
8 particular platform evaluated.

9 MS. ALVARADO: So, the SPINLINE platform  
10 has been qualified and is accepted to use in safety  
11 related applications for U.S. nuclear power plant and  
12 it's now maintaining their QA program compliance with  
13 Appendix B.

14 Next slide?

15 So, I'm trying to present in this slide a  
16 summary of the description of the system. The SPINLINE  
17 is based on microprocessor technology. It's a modular  
18 system that can be configured in different sizes  
19 according to the application.

20 So, to do this, what we receive in the  
21 topical report with no specific system architecture,  
22 instead they describe the different components and how  
23 they can be put together for an application in specific.

24 So, what we did was evaluate these  
25 components and some of the suggested architectures but

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1 we didn't evaluate a specific architecture for the  
2 system.

3 So, the manner in which these components  
4 are put together and how they interact will have to be  
5 evaluated when we get a license amendment using the  
6 SPINLINE system.

7 MR. THORP: So, this relates to my comment  
8 earlier about the desire of the vendor to have a maximum  
9 flexibility so that they can tailor their product to  
10 the needs of customers that might have varying desires  
11 in the requests.

12 CHAIRMAN BROWN: Okay. I guess I  
13 understand when I looked at the topical report and it  
14 talked about the CPU and the actuator card and this and  
15 that and the voting card and on and on and on.

16 But, they did have a couple of figures  
17 which, if you look at them, both the single division  
18 figure as well as what I would call a 4-channel figure  
19 relatively conventional application. Now, they  
20 didn't identify on there which card was doing what in  
21 this ting.

22 So, when you all looked at this, did you  
23 all look at the application of this card in terms of  
24 how it is or did you just look at each card as an --

25 I'm trying to put this into perspective.

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1 I'm saying here's a car, I've got a carburetor, I've  
2 got some brakes, I've got a radiator and I've got --  
3 so we looked at the radiator, we looked at this, we  
4 looked at that. But that --

5 MS. ALVARADO: Right. We didn't look at  
6 those examples that they provided. They just provided  
7 those to illustrate how they can put these parts  
8 together.

9 So, all we did is what you're saying, like  
10 the different parts. You picked the example of a car,  
11 you know, do they have a carburetor, they have a motor  
12 and they have wheels and we just look at each one of  
13 them and then they put together sort of like this  
14 chassis that you see here in which they performed the  
15 testing and the equipment qualification and how they  
16 operate it. And that's what we evaluated. We did not  
17 evaluate that.

18 MR. THORP: So, the purpose and the  
19 function of each of these separate cards and components  
20 and how they typically fit together and how information  
21 is transmitted and processed was explained to us and  
22 I think in the functional description, you're going to  
23 hear from Ross how this thing is designed, the basic  
24 functional design.

25 CHAIRMAN BROWN: Okay. The reason I ask

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1 is because these do identify what they call one way  
2 communications. I think there's an internal network  
3 of some kind, is this the NERVIA one?

4 MR. THORP: The NERVIA.

5 CHAIRMAN BROWN: The NERVIA thing which  
6 was never stitched together into any understanding of  
7 how this thing munched around with all these cards. Is  
8 the one of the stations?

9 MS. ALVARADO: We will get there when we  
10 get to the communications.

11 CHAIRMAN BROWN: Talk a little bit about  
12 that?

13 MS. ALVARADO: Yes.

14 CHAIRMAN BROWN: But it's the one way  
15 communications was a thing of interest as well as they  
16 refer to the watchdogs on some of the components,  
17 particularly, I guess, the --

18 MS. ALVARADO: CPU.

19 CHAIRMAN BROWN: -- is it the UC25 N+ CPU?

20 MS. ALVARADO: That says video card.

21 CHAIRMAN BROWN: Oh, yes, I'm sorry.  
22 Well, that's just the name of the card. That shouldn't  
23 be too bad, I guess.

24 MS. ALVARADO: That's in the CPU card.  
25 Yes, we'll talk -- I will talk about that.

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1 CHAIRMAN BROWN: All right, I'm just --  
2 all I'm trying to do is get some concept because there's  
3 a couple of features relative to the discussion that  
4 were kind of interesting.

5 MS. ALVARADO: Right. And there is a  
6 system description in the safety evaluation where I go  
7 and try to describe that figure, but it was just -- this  
8 is what we can do.

9 CHAIRMAN BROWN: Okay.

10 MS. ALVARADO: The staff did not evaluate  
11 it.

12 CHAIRMAN BROWN: All right.

13 MS. ALVARADO: Because we didn't have  
14 enough information to evaluate it.

15 MEMBER SCHULTZ: Please interrupt us if we  
16 go into proprietary information.

17 MS. ALVARADO: Oh, I will.

18 CHAIRMAN BROWN: Please do that.

19 MS. ALVARADO: Don't worry, I will.

20 So this slide shows an example of a  
21 chassis. So, in the front of the chassis, what they  
22 have is what they call the main or daughter boards.  
23 These boards, what they do is signal conditioning.

24 Then in the back, they have the interface  
25 boards. And the interface boards, all they do is

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1 capture the signals from the sensors and perform some  
2 periodic testing, provide power supply if they need it  
3 and perform EMC filtering.

4 In between these two boards, is the  
5 backplane and they use the backplane, they has a bus  
6 for the backplane and that bus is the one that  
7 communicates the data from the I/O board to the CPU.  
8 This is separate than the NERVIA network and I'm going  
9 to talk about it when I describe the communication.

10 MR. CARTE: Can I interrupt just for a  
11 second? You know, one of the --

12 MS. ALVARADO: You cannot ask questions,  
13 you know. You're on this side of the table.

14 MR. CARTE: I'm using your slide, though,  
15 to answer a question that happened -- that Charlie  
16 asked.

17 In terms of what is a PLC, if you're looking  
18 at this box, this is the general thing what you'd expect  
19 to see when you see a PLC. So, it's a 19-inch rack,  
20 almost everything is 19-inch racks, they may have  
21 different heights but they basically have sometimes a  
22 card for a power supply. They have a microprocessor  
23 card, they have analog input cards and output cards.

24 This basic look and feel is what is a PLC.  
25 You can argue about -- get more precise but fuzzy,

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1       that's what a PLC looks like.

2               MR. THORP: I'm going to budget you on the  
3       use of the term fuzzy for the rest of the meeting.

4               MS. ALVARADO: Yes.

5               CHAIRMAN BROWN: But this is also a  
6       microprocessor based system here?

7               MR. CARTE: Yes.

8               CHAIRMAN BROWN: so, we'll unfuzzy that  
9       part of it.

10              MS. ALVARADO: Yes, but just a caveat,  
11       there are some of these cards that had FPGA on it and  
12       CPLDs and we evaluated them.

13              So, in the next slide, just to summarize  
14       this list, the boards that we evaluated that were  
15       submitted in the topical report and we look at, as I  
16       mentioned, some of these modules, the I/O modules, have  
17       programmable logic devices like CPLDs and FPGAs.

18              This is where fixed logics and they didn't  
19       change so they were part of the acceptance process that  
20       SPINLINE did for the operating system software.

21              So, we look at these logics and see what  
22       they do. But this is pretty simple what they do is  
23       pretty much conditioning of the I/O signals, that's  
24       what these logics are doing.

25              Next slide?

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1                   So, in this slide, I want to just briefly  
2 describe the software architecture and the  
3 configuration.

4                   A SPINLINE -- Rolls Royce uses a tool  
5 called Clarice as assistance software development  
6 environment to develop, build and configure the system  
7 software.

8                   So, they have, let's say, like two  
9 components, the OSS which is the operating system  
10 software and the application software.

11                  The application software will depend of  
12 their requirements for the data, particular  
13 application in a plant.

14                  The OSS is the one that we look at and they  
15 went through a very extensive verification and  
16 validation process.

17                  So, this software did not change with the  
18 application, this is fixed. This is what they have as  
19 the operating software.

20                  The operating software can be configured  
21 to use different I/O modules and this is the flexibility  
22 that they have depending on the application that you  
23 have. For example, if you need to use an actuator, then  
24 in your OSS, you would tell this configuration, this  
25 application doesn't have an actuator and the OSS will

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1 not look for that kind of thing.

2 And the way they perform this is that they  
3 have tables inside the OSS, well, I put it on the outside  
4 like this hardware configuration tables, for example,  
5 on the top.

6 What it does is it will tell the operating  
7 system what I/O boards are installed and where they're  
8 installed in the rack.

9 Now, you have the system data which is  
10 information that the OSS uses to determine hardware  
11 status and communication with the network status.

12 Then you have this interface table which  
13 is a table that is going to exchange the data between  
14 the operating system and the application software.

15 And last but not least, we have the  
16 application data which is application specific that the  
17 application software is going to need depending on the  
18 requirement that the licensee establishes.

19 MR. HECHT: Can I ask a question?

20 CHAIRMAN BROWN: Go ahead.

21 MR. HECHT: Okay. This is I think a good  
22 time to talk about the issue of obsolescence and changes  
23 and how the topical report might move off because, based  
24 on my reading of this document, this has a 68040  
25 processor on it.

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1 MS. ALVARADO: Right.

2 MR. HECHT: Which I remember being very  
3 excited about when it was new but I guess none of us  
4 are new -- some of us are not new anymore.

5 And I think it's growing long in tooth, is  
6 it not? What would be the process here when they  
7 replace that 68040 processor?

8 MS. ALVARADO: I cannot talk in terms of  
9 SPINLINE, right, because maybe they decide to maintain  
10 it. I don't know if they can.

11 But I can tell you what we've seen with  
12 Diablo Canyon, for example, and I think it will be  
13 something like that.

14 So, when we got the Triconex, the first  
15 time was in 2001, right, and that Version 9. In 2011,  
16 Invensys submitted Tricon Version 10.

17 So, what we did was evaluate the different  
18 between Version 9 and Version 10 and we evaluated that  
19 delta and did a safety evaluation based on the delta.

20 For Diablo Canyon, they are using Version  
21 10.2 or 10.3. So, what we did was like, okay, we  
22 approve Version 10. For Diablo Canyon, we are looking  
23 evaluated the deltas between what we approved in the  
24 platform, right, when we looked at the Version 10 versus  
25 what they are using for Diablo Canyon which is as 10.2.

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1 And there were just some changes in some cards and stuff  
2 like that.

3 So, I would think in this case, it's some  
4 sort of similar process. So, if the microprocessor  
5 were to be changed, then they will have to submit  
6 another topical report describing what they're using  
7 and we will have to evaluate the deltas because it might  
8 as well be that they're just changing the  
9 microprocessor, but then they are using the same I/O  
10 boards. So, I don't need to evaluate the I/O boards,  
11 I just need to evaluate the new microprocessor and if  
12 it works and communicates with the existing cards if  
13 that's what they are doing.

14 MR. THORP: So, I don't want to get into  
15 too much detail and stop me if I -- not that I have a  
16 lot of detail in my head, I was a supervisor, but I  
17 participated in this audit.

18 And we pulled threads and delved into this  
19 whole process significantly because we saw that there  
20 was, as you said, some things that appeared to be kind  
21 of long in the tooth in terms of the actual technology  
22 and I won't want to get into numbers and that kind of  
23 thing.

24 But we verified that they have a very solid  
25 approach and a plan in terms of life cycle maintenance

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1 of these systems where such that they're not too worried  
2 about obsolescence on this stuff.

3 And I can't get into the detail about how  
4 they prepared themselves to deal with that but they have  
5 and they're ensuring based on the number of plants that  
6 they've got these things installed in that they can  
7 fully satisfy the needs of these systems for well beyond  
8 their designed lifetime.

9 MR. HECHT: Okay, well, hypothetically --

10 MR. THORP: So, what I'm telling you is I  
11 guess, not that we would anticipate that they wouldn't  
12 change their design to make something newer, better,  
13 faster, cheaper, smaller like I talked about.

14 And so, we have processes to deal with that  
15 and to look at the deltas.

16 MR. HECHT: What I'm trying to do is I  
17 heard, in general, the process described. You  
18 evaluate the changes and based on those changes, you  
19 do that.

20 What I was hoping to get out of this  
21 discussion was here in the specific case, you've  
22 changed the processor, you get a different instruction  
23 set and maybe other differences in the processor  
24 besides merely the instruction set.

25 What criteria would be used in this case

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1 if they were to make a change in the process rather than  
2 just saying, in general, evaluate? I mean can you get  
3 into more detail saying how you would approach that  
4 problem?

5 MS. ALVARADO: That's what I just  
6 described with the Tricon, that's what we did with the  
7 Tricon. We have to go --

8 MR. HECHT: Oh, you said you sent from  
9 Version 9 to Version 10.2 but you didn't say if in  
10 Version 10.2 they took an 80.86 and put in something  
11 else.

12 MS. ALVARADO: Well that's getting into  
13 the details of what they did. I cannot discuss that  
14 but I can tell you that from Version 9 to Version 10,  
15 we did look at all the changes that they did and evaluate  
16 it.

17 MR. THORP: There was essentially a decade  
18 of time between Version 9 for Triconex and Version 10.  
19 So, rather than a focused sort of little delta review,  
20 we essentially did a full blown topical report review  
21 of Version 10 and reestablished sort of a baseline and  
22 wrote and SE reflecting that version.

23 MR. HECHT: So, they need --

24 MR. THORP: So, now with the little delta  
25 between Version 10 and the little improvements that

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1 they've made in 10.2, 10.3, we looked at those deltas  
2 as well for Diablo.

3 MR. HECHT: So, the answer is when you  
4 replace a processor, you write a new topical report?

5 MS. ALVARADO: The vendors do, yes.

6 MR. HECHT: The vendors do?

7 MR. THORP: The vendor has to decide how  
8 to treat that.

9 MR. CARTE: I mean a topical report is  
10 strictly a vendor pool thing. We review a topical  
11 report when we get one. If they choose to update it,  
12 fine. If they don't, fine.

13 Our next shot at is the license amendment  
14 if they do not choose to update a topical report. So,  
15 if they have not updated the topical report, then we  
16 will consider that in the license amendment process.

17 If they choose to update the topical  
18 report, that will make license amendment process  
19 quicker and we would evaluate at that time. The  
20 criteria is not different. It's one set of criteria  
21 for power plants. It doesn't matter whether it's in  
22 the initial application or an update.

23 So, when they changed processors, there  
24 was a set of regression testing that they had to do and  
25 a set of documentation that they have to do and that

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1 -- it's the same as the original set.

2 So, we would review it against the criteria  
3 that we would do review against the initial  
4 applications.

5 So, in essence, there's no difference in  
6 how we should review things. It's one set of criteria.  
7 It doesn't matter whether it's the topical report, an  
8 amendment to a topical report or a license amendment,  
9 it's one set of technical criteria.

10 CHAIRMAN BROWN: I'm going to have to --  
11 we're going to have move along here. Go ahead,  
12 Rossnyev.

13 MS. ALVARADO: Okay. Next slide?

14 So on this slide I'm just describing how  
15 the system operates. Right?

16 So, the first step is that when you pretty  
17 much turn on the system, the systems goes through an  
18 initialization process where it goes into initializing  
19 the code, verifying internal operation of the CPU, then  
20 it goes and initializes all the I/O boards. Right?

21 And it's using the hardware configuration  
22 table to identify the boards that are installed and  
23 start testing for communication with the I/O board.  
24 And then, it sets the hardware watchdog of the CPU board  
25 at this point.

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1           After the system is initialized, it goes  
2           into the cyclical mode of operation. Right? And it's  
3           showing it in the blue line in the arrows above.

4           So, we have the first step is the cycled  
5           time management. This is a function that the system  
6           has to manage the time of the system. So, when you are  
7           designing the system, you say, well, my predefined  
8           value for the operation is this many seconds of  
9           microseconds or whatever you want or milliseconds, I'm  
10          sorry.

11          If the cycle time is longer, then the CPU  
12          will stop and an indication will be shown to the  
13          operators.

14          Then the next function is test and  
15          self-test diagnostics. This is to detect different  
16          failures in the system. So, once as set of failures  
17          is detected or if there is there some sort of problem,  
18          the system will go into some sort of defined state.  
19          This defined state on how the errors are managed is  
20          application specific.

21          So, we didn't go into review of how the  
22          failures are managed because they said that it will  
23          depend on each application.

24          But if there is a problem with the watchdog  
25          timer, the CPU will stop. That we evaluated.

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1                   Then next step which I'm showing in a  
2                   bigger scale is the part of data acquisitions. So the  
3                   system pretty much --

4                   CHAIRMAN BROWN: Rossnyev, we said the  
5                   watchdog timer, you did evaluate that. Did you  
6                   evaluate what it does if it's not strobed or if it's  
7                   not reset?

8                   MS. ALVARADO: Yes, it will stop the CPU.

9                   CHAIRMAN BROWN: Well, it stops what, the  
10                  CPU?'

11                  MS. ALVARADO: Yes. It will stop the CPU.

12                  CHAIRMAN BROWN: Is that all it does?

13                  MS. ALVARADO: And it will drive the  
14                  output to define safe condition, like a predefined  
15                  value.

16                  MR. THORP: And that is relative to the  
17                  application.

18                  MS. ALVARADO: Right and then --

19                  CHAIRMAN BROWN: No, I understand that,  
20                  but I mean is the design of the system such that you  
21                  can establish whether it triggers an alarm or whether  
22                  it actually triggers a voting trip and a reactor trip  
23                  system where it says, hey, okay, I have to consider this  
24                  channel tripped or whereas if it's just an alarm, does  
25                  it have that capability to go --

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1 MS. ALVARADO: It has that capability, but  
2 again, it would depend on the application. But they  
3 --

4 CHAIRMAN BROWN: All I wanted to know was  
5 does -- I mean it has multiple ways that it can provide  
6 and output, that's all I was trying to look for.

7 MS. ALVARADO: Yes, right, yes.

8 CHAIRMAN BROWN: So, I think you answered  
9 that.

10 MR. THORP: We assured ourselves.

11 MS. ALVARADO: You get an alarm that can  
12 be sent to a plant computer system. They have an LED  
13 indicator that is if the system is operating right, it  
14 will stay illuminated. If the watchdog fails, that  
15 will go off.

16 And then, it will also drive the outputs  
17 to a safe condition.

18 CHAIRMAN BROWN: Yes, which could be, if  
19 it was a reactor trip function, it could be a voting  
20 trip?

21 MS. ALVARADO: Right or something like  
22 that, right.

23 CHAIRMAN BROWN: If it was a safeguard, it  
24 could be just an alarm. It could be whatever. Okay,  
25 that's all I -- I didn't see it explicitly covered in

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1 the discussion that's in the SER, the nature of the  
2 output.

3 So, go ahead, you're fine.

4 MS. ALVARADO: So, the system will acquire  
5 the data, right, it will go from the sensors and it is  
6 showing it in the bottom part how the data goes from  
7 the sensors eventually into the input boards then to  
8 the application software where it's processed and then  
9 the application software will create outputs if  
10 necessary to drive the actuators.

11 The next function will be the LDU data  
12 exchange which we did not look at. I looked at -- I  
13 evaluated from the point of view of the operating system  
14 but I didn't look at the LDU -- LDU means local display  
15 unit -- because, again, the configuration of the local  
16 display unit is application specific, so we didn't  
17 evaluate these.

18 I just look and from the part of the OSS,  
19 how data is collected and then how it can be exchanged.

20 So, I want to emphasize that these  
21 functions are executed in every cycle in the same order  
22 and are independent of input and external event.

23 The cycle time is fixed during this time  
24 and if this time is not met, then like I said before,  
25 the watchdog timer will time out and, as I described

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1 before, you have the LED will go off and then the outputs  
2 will go into a safe condition.

3 The system is continuously informed of the  
4 status of the communication interface. So, the system  
5 retains the ability to perform a safety function  
6 without reliance on data from the outside.

7 The SPINLINE system does not use interrupt  
8 to manage self-test programs. They use interrupt only  
9 when the system fails and needs to drive the outputs  
10 to a predefined safer state and this will be defined  
11 for an application specific.

12 Next slide?

13 So, in the next slide, I summarize the  
14 different system communications that we evaluated.  
15 I'm going to talk in detail about the first two but  
16 regarding the last two, there are some passive  
17 communication hubs and converters.

18 These components do not use embedded  
19 logic, they are just passive components, all they do  
20 is just pass the signal.

21 There are two serial links in the front of  
22 the chassis and these are RJ45 connectors and how these  
23 are used is a plant specific application.

24 Next slide?

25 So, on this slide I'm going to talk about

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1 the backplane bus communication, and simpler, it's  
2 called BAP which stands for backplane. This is a  
3 passive bus communication that the system uses to  
4 collect data from the I/O boards and transmit it to the  
5 CPU.

6 It's a master/slave bus with the CPU being  
7 the master and the I/O boards the slave, which means  
8 that the CPU will request information from the I/O  
9 boards and the I/O boards have to respond to the master.

10 The bus uses this connector, so you can see  
11 a mark XF1 and XF2 for data transmission.

12 The way the data flows is like from the  
13 input, they said like the input terminals that I have  
14 here, they go from the fuel sensors to the interface  
15 board, right, and from there, it goes into the main  
16 board or the daughter board through the XF2. That's  
17 with the red arrow that you have in the slide.

18 It goes into the main board where it goes  
19 through signal conversion or conditioning and from the  
20 main board through XF1 which is the one with the blue  
21 arrow, that's where it's transmitted through the  
22 backplane bus to the CPU.

23 It will be the opposite direction like  
24 reversing direction for the output board.

25 There's two of the boards that do not

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1 communicate with the backplane bus and these are the  
2 RTD, the temperature board. It doesn't communicate  
3 directly with the CPU using the backplane bus, it uses  
4 the analog card to communicate.

5 And the other one which I'm going to talk  
6 in more detail is the CPU board. The CPU board does  
7 not communicate directly for the NERVIA communication  
8 through the backplane bus.

9 The backplane bus uses a predefined  
10 configuration for data --

11 MR. HECHT: Could I ask a question? The  
12 NERVIA network you said it was a one way --

13 MS. ALVARADO: That's in the next slide.

14 MR. HECHT: Oh, I'm sorry.

15 MS. ALVARADO: Can you hold it until the  
16 next one?

17 MR. HECHT: Okay.

18 MS. ALVARADO: Okay. The backplane bus  
19 uses a predefined configuration for this data exchange  
20 and the operating system ensures that the communication  
21 between the CPU and the I/O boards occurs in a  
22 predefined time.

23 Next slide?

24 Here we are going for NERVIA.

25 Interesting, Member Brown is not here and

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1 he wanted to know about this.

2 MEMBER STETKAR: He'll be back soon.

3 MS. ALVARADO: Okay. He will be back when  
4 I'm done.

5 MEMBER BROWN: Speak slowly.

6 MS. ALVARADO: Okay. So, this is  
7 intra-divisional communication for these Rolls Royce  
8 using the NERVIA network which is a proprietary  
9 dedicated network. It was developed using the open  
10 system interconnection model.

11 As I mentioned, this is used to exchange  
12 information within a division, nonetheless, they can  
13 use it if they want it for division. However, Rolls  
14 Royce did not request approval for intra-divisional  
15 communication above the following new year.

16 So, they defined two components for the  
17 NERVIA which is what we call a station which is on your  
18 left side which is pretty much the part that is the  
19 NERVIA board and the NERVIA interface board. And then  
20 they have another one which is called the unit which  
21 is pretty much where CPU board is. Okay?

22 MEMBER STETKAR: So you said they have the  
23 capability for using the network for intra-divisional  
24 but as far as the topical, they didn't --

25 MS. ALVARADO: No, they didn't.

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1 MR. THORP: They didn't request our review  
2 of that aspect about the this.

3 MS. ALVARADO: So, they're not going to  
4 use it.

5 MEMBER STETKAR: They're not going to --  
6 they'll physical disable it?

7 MS. ALVARADO: Well, they didn't physical  
8 disable because you have the network there. It's just  
9 that they're not going to use it so when we get a license  
10 amendment, we have to be -- to evaluate that they're  
11 not using it for that purpose.

12 CHAIRMAN BROWN: But could it be used by  
13 mistake?

14 MS. ALVARADO: Yes?

15 CHAIRMAN BROWN: Could it be used by  
16 mistake?

17 MR. THORP: But there's an SDOE question.

18 MS. ALVARADO: Right, exactly. We'll  
19 evaluate it for that purpose.

20 MC. HECHT: Can I ask a question about the  
21 implementation and you'll tell me if I'm going into  
22 proprietary territory?

23 How is it that they get the guarantee the  
24 one way communication? Is that --

25 MS. ALVARADO: That is proprietary, yes.

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1 CHAIRMAN BROWN: That answers that  
2 question.

3 MS. ALVARADO: Yes.

4 CHAIRMAN BROWN: We'll move on, that was  
5 one of my questions.

6 MS. ALVARADO: Well, I mean they have ways  
7 to configure, as I was saying this station, they will  
8 configure the station to make it one way only. But,  
9 yes, that's proprietary.

10 MR. THORP: And they described for us in  
11 great detail in how they specifically manage data  
12 communication and cycle time and things like that.

13 CHAIRMAN BROWN: Is it proprietary  
14 whether it's software or hardware configured?

15 MS. ALVARADO: What is software?

16 CHAIRMAN BROWN: The one way  
17 communication? That's pretty high level, is it  
18 hardware or is it software configured?

19 MS. ALVARADO: It's software configured.

20 CHAIRMAN BROWN: Okay. I won't make no  
21 further comments on it.

22 MS. ALVARADO: Okay.

23 CHAIRMAN BROWN: We'll move on.

24 MS. ALVARADO: The NERVIA is an Internet  
25 based network that uses a time based token pass

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1 protocol. The way this works is the token is  
2 transmitted from one station to another and a station  
3 is allowed to transmit the data when that station has  
4 a token and it's only allowed to transmit the data for  
5 a specific period of time.

6 So, when a station is transmitting, the  
7 message is received by all other stations that are  
8 connected to the network.

9 The stations that are not transmitting are  
10 listening for messages and they have to wait until that  
11 period elapses and to get their turn in the network to  
12 transmit their messages.

13 The cycle time for transmission is defined  
14 during this time but this cycle time is also monitored  
15 by the station and it's communicated to the unit so the  
16 CPU will know about it.

17 The network station are always  
18 transmitting in the same order, so you define it when  
19 you are defining the network in your design for the  
20 station on top is the station one then the station two,  
21 so they will always transmit in the same order.

22 The network design establishes the  
23 sequence and is always defined during the design.

24 The NERVIA network does not have direct  
25 access to the backplane bus as I'm showing in this

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1 slide. Communications between the CPU and the NERVIA  
2 network always happen through the dual port memory  
3 which is static and doesn't change during program  
4 execution.

5 They have an arbiter which, and just before  
6 you ask, I cannot go into details because that part is  
7 proprietary. They have an arbiter that is responsible  
8 for monitoring this data exchange and that there is no  
9 data collision in the DPM.

10 Once the data is copying the station, this  
11 information is available to be broadcasted to the  
12 network.

13 I want to point out that the processor time  
14 for the unit is different than the station processor  
15 time. So, if the station were to fail, this will not  
16 affect the operation of the unit or of the chassis, it  
17 will continue to operate because they are separate,  
18 they have separate transmission times and operation  
19 times. They only way they exchange data is just  
20 through the DPM.

21 Both cycle times are fixed and are  
22 monitored and is always executed at the same time for  
23 both the processor and for the station.

24 If an application uses the SPINLINE, then  
25 the NERVIA network has to be evaluated as a part of the

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1 full response time for the system because then your  
2 response time will vary, depending if you use the NERVIA  
3 network or not.

4 I can just mention this going back, is,  
5 yes, a station, the NERVIA can be configured as a one  
6 way communication but that will go in to proprietary  
7 information.

8 The NERVIA processor performs different  
9 diagnostics to confirm the data. For example, it  
10 performs cyclic redundancy checks and the received  
11 message, it will flag erroneous data or if the data is  
12 stale so it's not used by the CPU.

13 And it's always checking for  
14 communications, so the NERVIA station has also watchdog  
15 timer.

16 Next slide?

17 So now --

18 MEMBER BLEY: Before you leave that slide,  
19 you talked about the communications and with the  
20 tokens. Is that essentially the same scheme that was  
21 the old IBM token ring bus communication protocol?

22 MS. ALVARADO: This is more like a star  
23 communication.

24 MEMBER BLEY: Okay.

25 MS. ALVARADO: So you have the token and

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1 I give the token to Samir because it's in order, it's  
2 always in order. Right? So now, when he has the token  
3 it's the only time that he can transmit.

4 MEMBER BLEY: It sounds the same, though.

5 MS. ALVARADO: Yes, it's --

6 MR. HECHT: On the software level it is.  
7 IBM did have that token ring.

8 MS. ALVARADO: Right, right.

9 MR. HECHT: But it's -- that was a physical  
10 layer difference.

11 MEMBER BLEY: Yes, that's right, it was a  
12 long time ago.

13 MS. ALVARADO: Did that answer your  
14 question?

15 MEMBER BLEY: Yes, thank you.

16 MS. ALVARADO: Next slide?

17 So regarding the key review criteria, this  
18 other criteria that Norbert described before, we look  
19 at independence for the communication comparability  
20 and SDOE.

21 Regarding redundancy and diversity, there  
22 are features in the system to implementing this but  
23 these are application specific, so we didn't review it  
24 and we left it as an applicant specific action item.  
25 It will depend on how the platform is used.

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1 Next slide?

2 In independence, we evaluated two  
3 different things, one was electrical independence and  
4 the other one was regarding communication  
5 independence. This summarizes our findings.

6 The SPINLINE platform meets the criteria  
7 for electrical independence. They did multiple tests  
8 and we looked at the tests and saw how they performed  
9 these and they met the criteria in IEEE 384.

10 The system provides digital communication  
11 that can support independence, it just depends on how  
12 this is used. So we will have to evaluate that for an  
13 application when someone submits a license amendment.

14 And we looked at the features for non-1E  
15 components but until we see how this is implemented,  
16 we couldn't evaluate it at this time. So, we'll have  
17 to see when a licensee submits a license amendment how  
18 this is implemented.

19 Next slide?

20 MEMBER SCHULTZ: So, does the SER  
21 associated with the topical specify provide guidance  
22 to the licensee as to what they need to provide  
23 specifically --

24 MS. ALVARADO: Yes.

25 MEMBER SCHULTZ: -- to satisfy the

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1 communication concern?

2 MS. ALVARADO: Yes, throughout the safety  
3 evaluation, there are a specific guidance that we say  
4 this is an application specific action item and then  
5 at the end of the safety evaluation, there is a chapter  
6 where it tells you in detail, you know, for  
7 communication, you need to look at the following  
8 actions.

9 MEMBER SCHULTZ: Okay, thank you.

10 MS. ALVARADO: So, yes.

11 Predictability and repeatability, we  
12 evaluated how data communicated and the response time  
13 characteristic of the system. But this is always going  
14 to depend of how the system is going to deal with an  
15 application.

16 But we do observe that the software runs  
17 sequentially, deterministically and periodically.  
18 The cycled time is fixed and the functions are executed  
19 in the same order.

20 So, the system is behaving in a  
21 deterministic way. The unit processor is independent  
22 of the station processors and data exchange between the  
23 unit and the station is to the DPM. Those are the ones  
24 that are very important to summarize.

25 Next slide?

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1                   Regarding SDOE, this slide summarizes our  
2 findings for the SDOE. But the software is configured  
3 in Rolls Royce in France. We looked at the different  
4 access controls that they have. They have a secure  
5 environment to do the software application.

6                   The software, once it is in a system, it  
7 cannot be modified by an operator when the system is  
8 running online because of the way the system is  
9 configured. And the system includes features that can  
10 apply to demonstrate protection against undesirable  
11 behavior of other connected system and prevention  
12 against inadvertent access.

13                  MEMBER SCHULTZ: So, there is -- is there  
14 something the licensee needs to do to take credit for  
15 that or is it --

16                  MS. ALVARADO: Yes, it is identified --  
17 because one of the things is like because of the  
18 flexibility of the system that they can install  
19 different I/O configuration, they have some --- they  
20 have the code for all I/O modules, right, so what they  
21 do is the deactivate the code that they're not going  
22 to -- for the modules that they are not using.

23                  So we identified this as an application  
24 specific item, look, depending on your configuration,  
25 you need to go and be sure that the code is deactivated

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1 and it's not going to create unevaluated.

2 MEMBER SCHULTZ: And with regard to the  
3 environment that is demonstrated to be secure, is that  
4 monitored in a certain fashion or is there -- what is  
5 provided to assure that that environment is stable over  
6 time?

7 MS. ALVARADO: Well, we looked at the  
8 software tools that they use and the --

9 MEMBER SCHULTZ: No, I know what you've  
10 done.

11 MS. ALVARADO: Right.

12 MEMBER SHULTZ: I know what you've done,  
13 but --

14 MR. THORP: You're talking about at the  
15 licensee's level?

16 MEMBER SCHULTZ: Exactly. Is that  
17 something for the licensee to do or is there --

18 MR. THORP: Well, they're certainly going  
19 to have to have their piece of that. This would be the  
20 secure operating environment, right, for this  
21 platform. And that would be something we would look  
22 at in their application to us about how they intend to  
23 install and use and assure SDOE at their facility.

24 MS. ALVARADO: Right, but what we look at  
25 is like how they do it at the like the applicant, in

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1       this case, Rolls Royce, how they control their  
2       software, who has access to the software.

3               MR. THORP: This is one of the --

4               MS. ALVARADO: When they are programming  
5       the logic, who are the people that have access to  
6       modifying the code and that they're following their  
7       configuration.

8               MR. THORP: This is one of the key aspects  
9       of the audit that we performed.

10              MS. ALVARADO: Right.

11              MR. THORP: At their facility.

12              MS. ALVARADO: And the last slide, this is  
13       just a summary of the different applications that can  
14       be done with the SPINLINE platform.

15              There is none installed in the U.S. and we  
16       don't know of any licensee -- no licensee have come to  
17       us saying that they want to use the SPINLINE. However,  
18       this is installed in several places in France and in  
19       Eastern Europe and also in operation in China.

20              And that concludes my presentation.  
21       Questions?

22              CHAIRMAN BROWN: Okay. Norbert, this is  
23       your opportunity to shine and be crisp.

24              MR. THORP: At this point, could I --

25              CHAIRMAN BROWN: I think we should take a

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1 break. We will -- since this is a break and we're  
2 running --

3 MR. THORP: A little late?

4 CHAIRMAN BROWN: Yes, I know, well, I went  
5 ahead and took my break. We will recess the meeting  
6 for 15 minutes until, actually 13 minutes until 25  
7 minutes of 11:00.

8 MR. THORP: Okay, thank you.

9 (Whereupon, the above-entitled matter  
10 went off the record at 10:21 a.m.)

11 MR. CARTE: So I'll be talking about the  
12 SSPS CPLD-based topical report. So when I talk about  
13 this, first I want to give a little background about  
14 the solid state protection system itself and then I'll  
15 talk about the topical report and the criteria applied.

16 So in terms of the SSPS, the first voting  
17 systems for Westinghouse plants were basically relay  
18 voting systems. For a plant that consisted of 14  
19 cabinets, testing took about four hours. There were  
20 about 1,000 conductors involved in the communication  
21 of status information at control board and plant  
22 computer. There are approximately 750 relays with  
23 4,000 contacts.

24 So in January of 1971, Westinghouse  
25 proposed the topical report solid state protection

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1 system that replaced these 14 cabinets with six  
2 cabinets, two trains, that is three cabinets in each  
3 train. And these cabinets consisted of an input  
4 cabinet, a logic cabinet and a relay cabinet.

5 The circuit boards all predominantly fit  
6 in the logic cabinet. Testing time was also automated  
7 with a semi-automatic testing board. And that reduced  
8 the testing time to approximately 10 minutes per train.  
9 And through multiplexing, they reduced the number of  
10 conductors to about 42.

11 So in 1974 that was approved and applied  
12 subsequently in new Westinghouse plants.

13 So this is a picture of the SSPS cabinets.  
14 The center two cabinets are the SSPS cabinets. The  
15 two, one on the left, one on the right, are the  
16 demultiplexers that the SSPS communicates with. So if  
17 we look at the cabinet, there is an input bay, each which  
18 is compartmentalized into four separate sections, one  
19 for each of the input channels from the plant protection  
20 system.

21 There is a logic bay. And in this logic  
22 bay there are some circuit cards. And these are the  
23 cards that were being changed in the topical report.  
24 There is also a relay bay. Now, these circuit cards,  
25 the status information from these circuit cards is

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1       communicated out to the plant control board through the  
2       demultiplexer cabinet -- and I will talk about that --  
3       as well as the plant computer through a separate  
4       demultiplexer.

5               Basically, one train communicates to the  
6       control board, the other train communicates to the  
7       plant computer. There is some coordination between  
8       the trains so that there the information is  
9       synchronized. In a later slide what we are going to  
10      see is we are going to see these, these same cabinets,  
11      one rotated clockwise at the top of the display and the  
12      other one rotated -- no, sorry -- counterclockwise at  
13      the top and clockwise at the bottom. But let me get  
14      into that.

15             So, in essence there are eight boards,  
16      circuit boards involved in these cabinets. One is the  
17      universal logic board which does the voting. The  
18      safeguard driver which drives the ESF relays, the  
19      undervoltage driver which powers your after-trip  
20      breakers, the semiautomatic tester which is used during  
21      surveillance testing, the clock counter board which is  
22      both used during surveillance testing and is used for  
23      status indication. And I will describe that a little  
24      bit more in detail. We also have a decoder board.

25             So what the clock counter board does is it

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1 has a clock and a counter and it increments, the decoder  
2 board translates that incremental number into  
3 addresses to use for multiplexing and testing purposes.

4 The memory board is the one non-safety  
5 board in this set-up. This is the board in the  
6 demultiplexer cabinet that holds the status  
7 information that is communicated from the SSPS  
8 cabinets. And the isolation board is --

9 CHAIRMAN BROWN: From/to where?

10 MR. CARTE: From the SSPS cabinets to the  
11 demultiplexer cabinets. And those, I will show that  
12 in the next slide.

13 CHAIRMAN BROWN: Thank you.

14 MR. CARTE: And then there is an isolation  
15 board which does 1E electrical isolation.

16 So when we talk about the SSPS in context,  
17 so the six cabinets that I talked about are here: input  
18 bay, logic bay, relay bay. The plant protection system  
19 consists of four channels here so the plant sensors get  
20 wired into the four different channels of the plant  
21 protection system. So Westinghouse plants generally  
22 have a one out of two trips for start-up and  
23 intermediate source range. They have two out of three  
24 trips and two out of four trips. So that's why they  
25 have four channels of information.

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1           Those binary inputs go into the input  
2           cabinets where there is isolation between the different  
3           channels and as well as between the circuit boards.  
4           And that binary status information then goes into the  
5           solid state protection system cards, the relay cards,  
6           the voting cards. And then depending, if appropriate,  
7           the safeguards or ESFS, RPS system gets  
8           actuated.

9           So when we talked about the different  
10          cards, in here we have the logic card as well as the  
11          driver cards. We have the isolation cards that  
12          communicate status information to the demultiplexer  
13          cabinet. We also have a connection between different  
14          redundancies. And that's through an isolator card in  
15          order to co-ordinate that each train is indicating the  
16          same information.

17                So if we --

18                CHAIRMAN BROWN: Before you leave that,  
19                understanding the left-hand channel 1, 2, 3 and 4, the  
20                vertical --

21                MR. CARTE: Yes.

22                CHAIRMAN BROWN: -- right outside the  
23                little half partial ring.

24                MR. CARTE: Yes.

25                CHAIRMAN BROWN: That's sensors coming in?

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1 MR. CARTE: Right. These are the sensors  
2 and this is the plant protection system.

3 CHAIRMAN BROWN: So that takes the ana --  
4 that's still all analog?

5 MR. CARTE: Yes.

6 CHAIRMAN BROWN: And it sends out this  
7 little bi-stable signal shown by these relays?

8 MR. CARTE: Yes.

9 CHAIRMAN BROWN: And under the master and  
10 slave relay thing?

11 MR. CARTE: Yes.

12 CHAIRMAN BROWN: So are those still  
13 contacts like that?

14 MR. CARTE: Yes.

15 CHAIRMAN BROWN: You said they were binary  
16 --

17 MR. CARTE: Yes.

18 CHAIRMAN BROWN: -- so I presume they're  
19 still the relay contacts?

20 MR. CARTE: Yes.

21 CHAIRMAN BROWN: And that's what and then  
22 so all this replacement goes into the solid state logic  
23 in the voting?

24 MR. CARTE: Yes.

25 CHAIRMAN BROWN: Okay.

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1 MR. CARTE: One qualification: the plant  
2 protection system, these four cabinets are not part of  
3 the review. In some plants they're analog, they're  
4 7300 cabinets, in some plants they're Eagle 21's such  
5 as Diablo Canyon where they're being ripped out and  
6 replaced with Triconex and ALS.

7 CHAIRMAN BROWN: Okay.

8 MR. CARTE: So they still produce binary  
9 signals for voting purposes.

10 CHAIRMAN BROWN: Okay, thank you.

11 MR. CARTE: And there's this, the input bay  
12 is the isolation for that.

13 CHAIRMAN BROWN: All right.

14 MR. CARTE: So this signal, there's sort of  
15 two configurations in which the ESF -- sorry, SSPS is  
16 used. One is in operation and the other is testing.  
17 So we'll talk about how the cards are used in operation.

18 The orange cards are basically the cards  
19 that process the safety functions, so the discrete  
20 inputs come into the ULD card which is voted. And  
21 depending on the vote, it actuates either the ESF or  
22 reactor trip breakers.

23 The blue cards are used for status  
24 indication. So in the upper left is the clock counter  
25 board. Using a clock and a counter it creates a

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1 sequential number which is decoded by the decoder board  
2 into addresses. And those addresses are used in order  
3 to provide multiplex information out to the memory  
4 board which is used for status indication on the main  
5 control board or on the plant computer.

6 That information is coordinated because  
7 the clock counter also sends the count out to a decoder  
8 board which sits in the demultiplexer cabinet in order  
9 to -- so that they both are sending and receiving  
10 information at the same address.

11 MEMBER BLEY: Is indication always  
12 non-safety? I was just curious why the number  
13 is non-safety. It's only used for indication.

14 MR. CARTE: That is correct. Plant  
15 computer and control board indication, yes. In  
16 general, I think that it is not required to be  
17 safety.

18 MR. THORP: I think generally  
19 speaking it is considered non-safety. Like the  
20 annunciators on the control board.

21 MR. CARTE: As long as the plant  
22 computer is not doing anything --

23 MR. THORP: Correct.

24 MR. CARTE: -- picking safety up.

25 MR. THORP: And I think, I think the

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1 plants -- this is just a philosophical point,  
2 real brief -- that they, they prefer to have  
3 their plant computers be non-safety related so  
4 that, so that they can update them more rapidly  
5 and use the plant computer for all the different  
6 purposes for which it could be used such as  
7 trending information and --

8 MR. CARTE: Main control board  
9 information --

10 MR. THORP: And, yes, illuminate  
11 control boards with the annunciators, for  
12 example. Those are considered non-safety  
13 related.

14 MEMBER STETKAR: Annunciators are, I  
15 mean the indications on the board are usually  
16 powered by safety-related.

17 MR. THORP: The actual indicators  
18 are, you know, process status like a  
19 steam-generated level or something like that.  
20 Those you would have your safety-related  
21 channel displays and those would be safety  
22 related.

23 MEMBER STETKAR: Yes. Equipment  
24 that starts is all safety. Those indications  
25 would be safety-related.

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1 MR. THORP: Right.

2 MEMBER STETKAR: Okay.

3 MR. CARTE: Okay. And so the other  
4 configuration is when it's in surveillance  
5 testing. So in that case the clock counter  
6 board or the count is basically input to the  
7 semiautomatic test board in order to generate  
8 all permutations and combinations of inputs.  
9 As well as the semiautomatic tester then looks  
10 at the response of the tested boards to assure  
11 that the outputs are correct.

12 So those are the two configurations  
13 in which the cards are used.

14 Okay, so in terms of -- so that's,  
15 that doesn't change; new boards, old boards,  
16 that's the way the SSPS system works. In terms  
17 of the programmable logic devices, some sort of history  
18 on that is needed.

19 So in February of 2001, we approved the  
20 ASIC base replacement module topical report. So this  
21 was an ASIC, had ASIC chips. These cards had  
22 personality modules. Neither the application nor the  
23 NRC review identified those components as containing  
24 software. Although if you look at the position today,  
25 we would consider that to be software because you are

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1 loading a file onto those devices.

2 So shortly after that approval, the PWR  
3 Owners' Group decided to develop new cards for the SSPS  
4 cabinets. And they decided to make that CPLD based.  
5 And they considered that to be hardware only. And in  
6 light of that recent ABRM decision, that was not an  
7 unreasonable position for them to take.

8 So in November -- so to put this in context,  
9 in November of 2006 industry came and talked to the  
10 Commission and said there was too much regulatory  
11 uncertainty with design C. That resulted in a steering  
12 committee and tasked working groups which resulted in  
13 the ISGs that we can talk about later or will come up  
14 shortly. As well as in March 2007 to March 2009, the  
15 Wolf Creek application or main steam and feed water  
16 isolation system came in.

17 So in that time frame we were discussing  
18 programmable devices and that the staff considered them  
19 to be, or considered the processes for them to be  
20 reviewed against the same criteria as software  
21 development processes. I believe that was first  
22 published in ISG-4 at Rev. 0, September 2006 -- seven.

23 To put that in context, in July 2010 to  
24 2013, the ALF topical report was reviewed in accordance  
25 with software development processes. Then in 2013,

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1 February, there was a CDBI inspection of Harris. This  
2 inspection identified that these cards were installed  
3 in a plant using only a 50-59 screening. And that was  
4 in August determined to be a violation.

5 In that year 2013 we had four meetings with  
6 the PWR Owner's Group, Westinghouse, to determine what  
7 the best path forward would be. And that, it was  
8 decided that a topical report would be the best approach  
9 for that. So in February of 2014, Westinghouse  
10 docketed a topical report for the CPLD-based SSPS  
11 cards.

12 So these cards basically, the old cards  
13 basically used Motorola high-threshold logic so that  
14 it was basically 15-volt logic. And it was at that time  
15 envisioned to be better for noisy shop floor  
16 environments which I guess is not really directly  
17 applicable but they made that decision.

18 The new cards were designed to be form,  
19 fit, function identical to the old cards. So the  
20 design basis of the new cards is the design of the old  
21 cards. There are eight new cards. Seven are  
22 installed in the existing SSPS racks; and those are  
23 listed below. As well as one is installed in the  
24 non-safety demultiplexer cabinets.

25 Now, with respect to these cards, the ISO

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1 card is the only one that we would not consider to have  
2 software. It was strictly electrical isolation, no  
3 CPLDs. The other cards all have complex programmable  
4 logic devices on them. The three cards that were most  
5 critical for performing safety function are the  
6 universal logic board, the safeguard driver board and  
7 the undervoltage driver board.

8 Those cards actually have two CPLDs on  
9 them. One is the main CPLD and the other is a test CPLD.  
10 So the test CPLD generates all permutations and  
11 combinations of inputs to test the main CPLD. It  
12 compares the main CPLD outputs with its model of what  
13 the outputs should be and, therefore, it is involved  
14 in continuous self test of all circuits involved on that  
15 card, on the main CPLD.

16 The cards also include a watchdog timer  
17 which if it times out it goes to both the main CPLD and  
18 the test CPLD, and if it times out there's also an LED  
19 on the card edge.

20 So the main enhancements on these cards  
21 are, as might be said, some improvements to single point  
22 vulnerabilities. So some drivers were duplicated,  
23 output drivers were duplicated, some power supplies  
24 were duplicated. And this was to make the cards more  
25 reliable, not an attempt to make any individual card

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1 satisfy the single failure criteria.

2 So on these three cards if -- three cards,  
3 if the test CPLD finds, fails one test and you get an  
4 E1 LED, a red LED that says you have failed a test, if  
5 you fail ten tests in a row you get an E10 LED that  
6 indicates the status of that card. These, these  
7 health-monitoring features are not connected to any  
8 control board indications, they are local only to the  
9 cabinet in terms of card edge LEDs.

10 So in terms of design basis, it's the  
11 original card design, the form, fit, function  
12 identical. There were some instances where that was  
13 not quite achieved but that's documented and  
14 identified. So some cards need to be replaced in  
15 pairs.

16 Single fire criteria was not evaluated, in  
17 essence because the cabinet itself addresses that  
18 criteria. Individual cards do not address that  
19 criteria.

20 MEMBER STETKAR: Can I interrupt you just  
21 a second? What you said about, you know, it fails ten  
22 functions you get some color light on --

23 MR. CARTE: Yes.

24 MEMBER STETKAR: -- card edge. Operators  
25 don't know about that. Does, if it fails ten times in

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1 a row what does the card do, just keeps processing?

2 MR. CARTE: It continues to perform its  
3 function, yes.

4 MEMBER STETKAR: Okay.

5 MR. CARTE: So, the issue is as a form, fit,  
6 function replacement the original cards did not have  
7 health-monitoring circuits to that extent and had no  
8 way to indicate them out. There are processes actually  
9 in the works, and that will probably come in for license  
10 review, license amendment request or a topical report  
11 in order to provide indications for these self-help,  
12 self-help monitors. But that would require some  
13 changes to the cabinets as well as to the control board  
14 in order to provide that indication.

15 So that needs to be, it's a separate item,  
16 but that was not envisioned at the time.

17 MEMBER STETKAR: They do not aggregate them  
18 into a general trouble alarm train, you know, Channel  
19 1, Train A, or something like a trouble alarm?

20 MR. CARTE: There is a trouble alarm but  
21 that puts you in half trip. And the decision was made  
22 -- and in fact all of these are wired that way. And  
23 all they have to do is remove a jumper and any of these  
24 would give them a half trip.

25 MEMBER STETKAR: But they don't do that.

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1 MR. CARTE: But they don't want the half  
2 trip --

3 MEMBER STETKAR: Okay.

4 MR. CARTE: -- on a single test failure.

5 MEMBER STETKAR: Good to know. Thank you.

6 MR. CARTE: Okay, so single failure  
7 criteria. The boards were evaluated in a couple of  
8 different ways to ensure, basically to ensure that they  
9 had no undetectable failure modes. And as well as to  
10 ensure that the test circuitry would not compromise the  
11 main functional circuitry. That was done by a look at  
12 the drawings on the audit.

13 The quality was reviewed against the -- it  
14 was based mainly on engineering judgment against the  
15 underlying regulations as opposed to software  
16 development reg. guides.

17 The equipment qualification, we looked at  
18 what we believed to be the bounding envelope for all  
19 Westinghouse plants and compared their qualification  
20 environment to that bounding envelope. And I think  
21 there were a couple points that we noted that needed  
22 specific evaluations by specific plants. But in  
23 general we thought the equipment qualifications bounded  
24 all known installations. But it is still the  
25 applicant's responsibility to ensure that when they do

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1 the install the cards.

2 These cards can be installed one card only  
3 or you can replace an entire train.

4 The independence criteria was the same as  
5 the independence criteria of the previous cards. The  
6 isolation card performs that function. No circuit --  
7 no CPLDs involved in that function.

8 The secure development operational  
9 environment was basically the cards have a CRC check  
10 number on them so they confirm the right version of  
11 software is installed on the cards at the time of  
12 manufacturing. In general, the plants don't have the  
13 ability to change that software. They don't have the  
14 tools. They don't have the equipment. So that is not  
15 changeable at the site.

16 In terms of diversity and defense in depth,  
17 we use BTP 719 criteria to evaluate their testing. And  
18 we felt that they met the criteria for eliminating  
19 consideration of common cause failure because they had  
20 effectively analyzed all permutations and combinations  
21 of inputs. There were a few combinations associated  
22 with the reset of the safeguard driver function that  
23 were not explicitly tested. However, they were  
24 evaluated and determined not to impede the safety  
25 function.

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1 I was trying to make up some time.

2 CHAIRMAN BROWN: No, you did fine.

3 MR. CARTE: Okay.

4 CHAIRMAN BROWN: And so I have a question.

5 MR. CARTE: Okay.

6 CHAIRMAN BROWN: The watchdog -- let me  
7 backtrack. Go to your -- where's the diagram.

8 MR. CARTE: This one or?

9 CHAIRMAN BROWN: Yes, that one. Okay, I'm  
10 on the wrong frame here. Come on. Windows 7.

11 In each of these you've got train A, train  
12 B.

13 MR. CARTE: Yes.

14 CHAIRMAN BROWN: And I guess there's a  
15 universal logic board --

16 MR. CARTE: There are several universal  
17 logic boards.

18 CHAIRMAN BROWN: Each train?

19 MR. CARTE: Yes.

20 CHAIRMAN BROWN: Okay. And there is a  
21 watchdog timer associated with those?

22 MR. CARTE: Yes.

23 CHAIRMAN BROWN: And you talked about the  
24 light illuminating. But one of the other things that  
25 was talked about in the device, it de-energizes the

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1 board interlock relay or something?

2 MR. CARTE: Right. There's an interlock --  
3 okay, so the normal warnings that exist with the  
4 semi-automatic test board is that once you're in test  
5 or once you pull a card you effectively go into a half  
6 trip condition. And those, that's the indication or  
7 availability that exists in the cabinet today.

8 Those warnings for watchdog E10 alarm are  
9 wired into that signal but they're not active -- you can  
10 activate or deactivate that half trip based on a jumper  
11 on the board. And so, yes, the capability exists to  
12 generate a half trip based on those functions. I do not  
13 believe that it's implemented in the plant because it's  
14 undesirable.

15 CHAIRMAN BROWN: A half trip would mean --

16 MR. CARTE: Well, if you get a --

17 CHAIRMAN BROWN: I mean even one out of two  
18 is a half trip, is a trip.

19 MR. CARTE: Well, a half trip would be that,  
20 right, the fundamental requirement is that you have two  
21 trains operable. But you can have one train inoperable  
22 for a short period of time in order to do surveillance  
23 testing. In that mode you are basically almost  
24 tripped. And if you get another signal or another test  
25 action from the other train, you trip.

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1           It's not that, it's not the, it's not the  
2           functional trip, it's more of a self-help trip. So if  
3           both trains indicate a health problem then you enter a  
4           tripped state. But it's not the functional trip state  
5           associated with --

6           CHAIRMAN BROWN: It's got to be found by a  
7           health evaluation.

8           MR. CARTE: Right.

9           CHAIRMAN BROWN: So if one of them's already  
10          got, if you converted the other train effective to a one  
11          out of one, or whatever tells it whether it's a health  
12          trip or whether it's a functional trip.

13          MR. CARTE: Right. They have that  
14          capability. And I don't believe that they are  
15          exercising that capability.

16          CHAIRMAN BROWN: Okay. I lost my other  
17          question.

18          MR. THORP: So the prior version of the SSPS  
19          cards was the same --

20          CHAIRMAN BROWN: No, I understand. You  
21          didn't change, functionally this is the same as when you  
22          were just all analog.

23          MR. THORP: Right.

24          MR. CARTE: Yes.

25          MEMBER SCHULTZ: Norbert, would --

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1 CHAIRMAN BROWN: How --

2 MEMBER SCHULTZ: I'm sorry, Charley, go  
3 ahead.

4 CHAIRMAN BROWN: Just one more. How does  
5 the operator know that the -- you said it's a card edge  
6 LED that goes off.

7 MR. CARTE: Right.

8 CHAIRMAN BROWN: And I think you asked that  
9 question but I didn't get all of it.

10 MR. CARTE: Previously the old cards didn't  
11 have any card edge LEDs. And so these were basically  
12 added for the timely identification and repair  
13 criteria. The operator does not know unless they go to  
14 check, but basically they do functional testing on a  
15 six-month staggered basis. So they're in the cabinet  
16 every six months to do surveillance testing.

17 The active trip testing I think is also on  
18 a four-month schedule. So they're in there doing  
19 testing every four months.

20 So there is an opportunity at least at that  
21 point to check the LEDs. They could check them more  
22 frequently but that was not specifically addressed in  
23 the topical report.

24 CHAIRMAN BROWN: But it takes ten triggers  
25 to get the watchdog LED to trip?

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1 MR. CARTE: Oh, no. There's several  
2 different LEDs. One is an E1, so you fail one test, it  
3 lights. So if you failed any test in the last six months  
4 you'll get that little light on.

5 CHAIRMAN BROWN: Okay, that's a test. So  
6 what about the watchdog? What about the watchdog?

7 MR. CARTE: Yes, because of the parallel  
8 nature of the CPLD, the watchdog essentially just  
9 confirms that those circuits are working. It --

10 CHAIRMAN BROWN: If it trips, what do you  
11 get? You get one light that lights up?

12 MR. CARTE: Yes.

13 CHAIRMAN BROWN: But you might not see it for  
14 six months? Or four months?

15 MR. THORP: I don't think it's --

16 MR. CARTE: Correct.

17 CHAIRMAN BROWN: It's only part --

18 MR. THORP: I don't know that we can predict  
19 exactly how the licensees are using these. We can  
20 probably try to find out but we don't know specifically  
21 how the operators -- like my experience is that our  
22 licensed operators would go down and examine into the  
23 cable spreading room to look at the RPS and S -- well,  
24 RPS is in the control room, but S class cabinets down  
25 in the cable spreading room and look for any indicators

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1       that there was some problem with any of the cards, any  
2       of them.

3               But that was viewed and viewable from the  
4       cabinet face. Now, I don't know whether it's a card  
5       edge --

6               MEMBER BLEY: If they're open cabinets.

7               MR. THORP: -- LEDs are something you would  
8       have to open the cabinet door and get in the back to see,  
9       in which case it would require --

10              CHAIRMAN BROWN: What it sounds like.

11              MR. THORP: -- a look by the  
12       instrumentation and controls engineers conducting  
13       their periodic maintenance examinations and tests.  
14       And how often those happen, it depends on the  
15       requirements that they're fulfilling, you now, for  
16       those surveillance tests and things like that. I  
17       wouldn't say that it was necessarily six months. I  
18       wouldn't say that it's a month. But it would depend on  
19       the licensee.

20              MR. CARTE: Right. Generally we know that  
21       their functional testing is about every six months.  
22       And so they're in their cabinet for that. And their  
23       trip breaker testing is every four months. So they're  
24       in the cabinet periodically, on those intervals at  
25       least.

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1 MEMBER STETKAR: If they're closed  
2 cabinets, people don't like for you to touch them.

3 MR. CARTE: Right. Right.

4 MEMBER STETKAR: And they won't.

5 MR. CARTE: Right.

6 MEMBER STETKAR: If they happen to be open,  
7 open racks then it's pretty easy to tell somebody to go  
8 look at the light. But a lot of them aren't, aren't open  
9 racks.

10 MR. CARTE: Right.

11 MR. THORP: And I guess the point is that  
12 prior cards they didn't even have card edge LEDs to tell  
13 them anything.

14 MR. CARTE: Right.

15 CHAIRMAN BROWN: Well, they didn't have --

16 MR. THORP: CPLD.

17 CHAIRMAN BROWN: -- solid state. They  
18 didn't have CPLDs in them either. And right now the  
19 purpose of the watchdog timer according to the  
20 Westinghouse P.R. says it's there to supply a confidence  
21 level that both the main and test CPLDs are operational.  
22 And I just question --

23 MR. CARTE: Right.

24 CHAIRMAN BROWN: -- you're not going to  
25 know it.

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1 MR. CARTE: Right. Well, one issue is that.  
2 And the other issue is that the problem is about parallel  
3 processing. In order to strobe that watchdog it goes  
4 through a subset of the circuits on the CPLD. All  
5 you're confirming is that that subset of circuits works,  
6 as well as a clock. You have to in order to check that's  
7 working you need a clock.

8 So you're not really confirming every  
9 function, you have to rely on the test CPLD which does  
10 all permutations and combinations to confirm the health  
11 of every function. And, yes, that only results in a  
12 card edge LED.

13 MEMBER BLEY: Are they different LEDs --

14 MR. CARTE: Yes.

15 MEMBER BLEY: -- or is it the same LEDs?

16 MR. CARTE: Different LEDs.

17 MEMBER STETKAR: Will the watchdog --

18 MEMBER BLEY: But nobody's watching them, so

19 --

20 MR. CARTE: Yes.

21 MEMBER BLEY: -- doesn't matter.

22 CHAIRMAN BROWN: With the old analog system  
23 how often did somebody actually perform a functional  
24 test on a train? I don't know.

25 MR. CARTE: The functional testing

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1 requirements has not changed. There was an intent  
2 originally and we did not review that. There was a  
3 desire to eliminate some of that functional testing  
4 based on the self-testing capability. And we did not  
5 review that. They did not ask for credit for that. No  
6 one to my knowledge has done that on the 5059.

7 CHAIRMAN BROWN: So under whatever  
8 administrative requirements there were to go perform --

9 MR. CARTE: Yes.

10 CHAIRMAN BROWN: -- the testing, that has  
11 stayed --

12 MR. CARTE: Yes.

13 CHAIRMAN BROWN: -- that has not changed  
14 with these.

15 MR. CARTE: Correct. That was not  
16 addressed by the topical report; right. And they can't  
17 change the tech specs without coming in for license  
18 amendment. So, yes.

19 CHAIRMAN BROWN: All right.

20 MR. HECHT: Can I ask a question about the  
21 SDOE comment you made? You said that they, that the  
22 cards will basically check the version of the software  
23 prior to running. And I was trying to understand which  
24 cards those would be here.

25 MR. CARTE: Right. So there are seven cards

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1 with CPLDs. Two of them have two CPLDs. So for each  
2 CPLD the version is checked and documented at the time  
3 of manufacturing. So you load the software, you then  
4 read back your CRC version of the software and then you  
5 can run through your complete functional test or  
6 manufacturing test of that card. And then it shows.

7 MR. HECHT: Oh, I see. So this is at the  
8 factory.

9 MR. CARTE: That's correct.

10 MR. HECHT: The software at the factory  
11 would read the cards.

12 MR. CARTE: Yes, load --

13 mR. HECHT: There is not run-time software  
14 at the plant when the cards are prepared.

15 MR. CARTE: Right. And these CPLDs are  
16 instant-on devices. So some, some devices you can load  
17 a data file at the power-up. These CPLDs have flash  
18 memory and they're loaded at the factory once and only  
19 once.

20 MR. HECHT: Okay.

21 MR. CARTE: Yes.

22 MR. HECHT: Yes, I'm sorry, that's what I  
23 thought and I didn't understand. Okay, I've got it.

24 MR. CARTE: So they load the software from  
25 a controlled file and that should be good enough.

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1                   MR. HECHT: But you could have processes  
2 with your load so you do a CRC check after you load it  
3 and then you do a full functional test so you know it  
4 loaded properly and you know it's working. And then it  
5 ships. And the licensee does not have the tools, unless  
6 they bought them separately, but they were not supplied  
7 with the product to make those changes, to make any  
8 changes.

9                   MEMBER SCHULTZ: With regard to the 5059  
10 implementation at Harris, was that considered to be an  
11 isolated instance or?

12                  MR. CARTE: No.

13                  MEMBER SCHULTZ: Did you go into the process  
14 with Westinghouse because something needed to be done  
15 with regard to appropriate implementation?

16                  MR. THORP: Well, there was, there was --  
17 it's an interesting question -- there were seven, I  
18 believe seven or eight other licensees who were in one  
19 stage or another of implementation of these cards.  
20 Some had not yet put any in. Some had only put a card  
21 in on one train. And I think that was the case of  
22 Shearon Harris, they put it in on one train, if I  
23 remember correctly.

24                  MEMBER SCHULTZ: Well, yes, we don't need to  
25 go into detail. I think it's a good example.

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1 MR. THORP: You know, the issue was it was  
2 useful, we thought the most useful thing rather than  
3 dealing with each plant individually, writing separate  
4 violations for each one and going through the whole  
5 "let's review your situation individually" --

6 MEMBER SCHULTZ: Right.

7 MR. THORP: -- would be, since they all are  
8 using the same product, to have the PWR Owners' Group  
9 and Westinghouse develop this topical report problem.

10 And that fixed the problem generically in  
11 combination with the development of what we call an  
12 enforcement guidance memorandum, an EGM. And we worked  
13 with the Office of Enforcement so that that provided a  
14 limited period and very specific criteria that needed  
15 to be met for a six-month time frame for those who were  
16 not -- were technically considered in violation but then  
17 would be able to satisfy the issue by conducting another  
18 5059 evaluation referencing the topical report and the  
19 --

20 MEMBER SCHULTZ: And somewhat it's parallel  
21 with the topical submittal and so forth? In other words  
22 -- well, we don't have to get into that detail right now.

23 MR. THORP: We completed our review of the  
24 topical report before the EGM was issued. So that it  
25 was a sequential thing.

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1 MEMBER SCHULTZ: Okay, I understand.

2 MR. THORP: So they, they had to hold and  
3 stand by. In one case a plant that had put these cards  
4 in had actually experienced a problem; it wasn't really  
5 related to the SSPS software or anything like that. But  
6 they pulled those cards, put back their old SSPS cards  
7 in place and then they held in place and waited for the  
8 outcome.

9 MEMBER SCHULTZ: Thank you.

10 CHAIRMAN BROWN: Okay. We will move on to  
11 Samir and the HFC-6000; correct? You gained a couple  
12 of minutes here thanks to Norbert.

13 MR. DARBALI: Yes. So good morning. My  
14 name is Samir Darbali. I am a clinical reviewer in the  
15 I&C Branch in NRR. I will be talking today about the  
16 HFC-6000 safety system platform.

17 Next slide.

18 This is a brief outline of what I'm going  
19 to be talking about.

20 Next slide.

21 So some background information. The  
22 HFC-6000 platform is a modular rack-mounted platform  
23 that is housed in cabinets and is intended to serve as  
24 a qualified generic digital I&C platform suitable for  
25 use in safety-related applications at nuclear power

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1 plants.

2 The platform was developed by HF Controls  
3 Corporation, or HFC, which is owned by Doosan Heavy  
4 Industries & Construction Company. The platform is  
5 based on product line developed by Forney Engineering  
6 which date back to the 1980s.

7 Possible applications and use of the  
8 HFC-6000 platform would include a reactor protection  
9 system, engineered safety features actuation safety  
10 functions, and a post-accident monitoring system.

11 Next slide.

12 This slide shows the components that are  
13 within the scope of the -- sorry about that.

14 So continuing on the background, the  
15 HFC-6000 topical report was submitted for review in  
16 March 2008. The technical review was contracted to Oak  
17 Ridge National Lab and NRC technical monitoring of the  
18 contract was performed by EICB.

19 The safety evaluation for the topical  
20 report was issued in April 2011 and included six generic  
21 open items related to equipment qualification testing.

22 Regarding operational history of the  
23 HFC-6000 platform, these systems are currently  
24 installed in 24 South Korean nuclear power plant units.  
25 However, none have been installed in U.S. nuclear power

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1 plants and currently there are no license amendment  
2 requests for installation in the U.S.

3 MEMBER STETKAR: Samir, I haven't looked at  
4 any of the data to get the acronym so I will call it the  
5 Korean 1400 new design certification. Is this system  
6 included in that, do you know?

7 MR. DARBALI: I don't have the specifics of  
8 which design is --

9 MEMBER STETKAR: I'm just trying to figure  
10 out how soon we might see it.

11 MEMBER BLEY: Yes, the reactors in Dubai?  
12 No, the Korean reactors; right?

13 MEMBER STETKAR: The Korean reactor has been  
14 submitted for design certification here.

15 MEMBER BLEY: Yes, for us. Yes. Yes.

16 MEMBER STETKAR: So I don't care about  
17 Dubai.

18 MEMBER REMPE: APR-1400.

19 MEMBER STETKAR: APR. Thanks.

20 MR. DARBALI: Right, I don't have any  
21 specifics on which design.

22 MR. THORP: I was kind of looking around,  
23 Charley, because I had seen Terry Jackson sitting back  
24 there before. But I think he's not here right now, so.  
25 I was going to ask him about it.

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1 MEMBER STETKAR: I was just curious because  
2 it sounds like a comment from --

3 MR. HIRMANPOUR: Bob Hirmanpour with  
4 Southern. DCD got accepted for review recently but  
5 they haven't done Common Q at this time.

6 MEMBER STETKAR: Common Q.

7 MR. HIRMANPOUR: Platform independent.

8 MEMBER STETKAR: As far as the DCD is  
9 concerned?

10 MR. HIRMANPOUR: Yes.

11 MEMBER STETKAR: Okay, thank you.

12 MR. DARBALI: Okay. This slide shows  
13 components that are within the scope of the topical  
14 report. The HFC-6000 is a generic application  
15 framework platform for which final configuration is  
16 dependent on an application-specific design.

17 The platform is composed of  
18 microprocessor-based modules providing control, input,  
19 output and communication functionality. The base  
20 platform consists of an equipment chassis housing tool,  
21 redundant controllers, dual ported memory,  
22 input/output modules and power supplies.

23 For safety-related use, internal  
24 redundancy is provided as part of the base platform  
25 architecture through redundant controllers, redundant

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1 inter-channel connections, redundant bus links to  
2 input/output modules and redundant power supplies.

3 Listed in the table are the 15 components  
4 that are within the scope of this topical report. The  
5 main components we'll be addressing in this  
6 presentation are the SBC06 controller module and the  
7 EPM06 dual=ported memory module.

8 This slide identifies some of the areas  
9 which are out of the scope of the topical report,  
10 including the application software which is necessarily  
11 specific to a plant system.

12 The following slide will better show what  
13 is and what is not within the scope of the topical  
14 report.

15 So this is sort of a busy slide but it  
16 illustrates an example of a 4-channel safety system  
17 architecture based on the HFC-6000 platform. The green  
18 box you see there illustrates one HFC-6000 rack in a  
19 redundant controller configuration. And by redundant  
20 controller I mean you can see in there there are two  
21 controllers, two primary, there's a primary and a  
22 secondary controller. And we will discuss redundancy  
23 later.

24 MR. CARTE: They are identical though?

25 MR. DARBALI: They are identical, yes.

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1           The red box identifies the scope of the  
2 topical report and illustrates how the HFC-6000 can be  
3 used to implement one redundancy in a parallel  
4 redundancy system architecture.

5           Intra-channel communications are included  
6 in the scope of the first topical report. However,  
7 inter-channel communications via the gateway  
8 controller are out of the scope of the approved topical  
9 report.

10           CHAIRMAN BROWN: Do you want to repeat that  
11 again? The intra-channel --

12           MR. DARBALI: Right.

13           CHAIRMAN BROWN: -- those are within?

14           MR. DARBALI: Correct.

15           CHAIRMAN BROWN: The inter-divisional  
16 communications are --

17           MR. DARBALI: Are out of the scope.

18           CHAIRMAN BROWN: -- are outside?

19           MR. DARBALI: Right.

20           MR. THORP: That would be application  
21 specific.

22           MR. DARBALI: Right.

23           CHAIRMAN BROWN: Yes, okay. I just wanted  
24 to make sure it sounded the same as what I read.

25           MR. DARBALI: Right.

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1 MR. THORP: Yes.

2 MR. DARBALI: Also, peripheral and field  
3 devices like sensors, voting logic, actuators,  
4 human/machine interface displays, and control  
5 interfaces are out of the scope.

6 Regarding communication links, the  
7 platform provides a redundant intercommunication link  
8 bus which is the ICL bus between the input/output  
9 modules and the controller modules. And also provides  
10 intra-channel communication link, which is the C-link  
11 to the right of the controller modules. These  
12 communication links will be further explained in the  
13 following slides.

14 I mentioned earlier that the gateway  
15 controller, which is the blue box that allows for  
16 inter-channel communication is out of the scope. But  
17 HFC came with an amendment to the approved topical  
18 report which does include that channel gateway  
19 controller. Now we, we're in the process of performing  
20 an acceptance review on that amendment to the topical,  
21 so we haven't reviewed it yet.

22 Next slide.

23 So this slide focuses on the contents of the  
24 green box we saw in the previous slide. The main  
25 equipment chassis, which is the box on the top right,

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1 provides two slots for SBC06 controller modules and one  
2 slot for a dual-ported memory DPM06 module. This  
3 redundant controller assembly constitutes the base CPU  
4 module for the safety platform.

5 In the CPU module configuration, one SBC06  
6 module acts as the primary or active controller and the  
7 other SBC06 module serves as secondary or standby  
8 controller. The main equipment chassis also has the  
9 capacity for a maximum of 11 input/output modules.

10 The expansion chassis, which you can see on  
11 the bottom right, has capacity for a maximum of 14  
12 input/output modules. The chassis backplanes receive  
13 operating power from the power supply module, which you  
14 can see on the left. Your redundant power cables get  
15 attached to a connector on the back of the chassis. The  
16 24-volt DC operating power and the 48-volt DC auxiliary  
17 power are routed to each module via redundant rails on  
18 the backplane.

19 CHAIRMAN BROWN: Question. Back on your  
20 previous slide --

21 MR. DARBALI: Yes.

22 CHAIRMAN BROWN: -- you show the  
23 green-dotted area.

24 MR. DARBALI: Right.

25 CHAIRMAN BROWN: And now flip over to the

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1 next page, page 8, and I show the green-dotted area.

2 MR. DARBALI: Right.

3 CHAIRMAN BROWN: Are those equivalent?

4 MR. DARBALI: Yes.

5 CHAIRMAN BROWN: One, the page 7, shows a  
6 primary and a secondary controller.

7 MR. DARBALI: Okay.

8 CHAIRMAN BROWN: And in page 8 it does not  
9 show --

10 MR. DARBALI: Yes.

11 MR. CARTE: Go to page 8.

12 MR. THORP: You see the little green boxes  
13 there, Charley?

14 CHAIRMAN BROWN: Oh, that's where it is?

15 MR. DARBALI: Right. So the green --

16 CHAIRMAN BROWN: It's located in the same  
17 chassis then?

18 MR. DARBALI: Right. So the previous slide  
19 was more synchriotic.

20 CHAIRMAN BROWN: I got it. Thank you very  
21 much.

22 MR. DARBALI: Okay. So right, so your green  
23 boxes are the SBC06 controller modules. And that --

24 CHAIRMAN BROWN: I got it.

25 MR. DARBALI: Okay. So going back to the

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1 power module, each HFC-6000 module performs diode  
2 auctioneering of the redundant power as well as voltage  
3 level conversion to obtain the operating power needed  
4 for onboard hardware.

5 The CPU module communicates with the  
6 input/output modules via redundant serial ICL traces on  
7 the backplane. ICL communications are shown in the  
8 figure below and to the left of the SBC06 modules. So  
9 those are the red ICL. And that's a communication to  
10 and from the input/output modules.

11 Redundant ICL connectors on the rear of the  
12 backplane enable expansion of the ICL bus to local  
13 expansion chassis by twisted pair ICL cable or to remote  
14 expansion chassis through an optical repeater.

15 The safety communications link indicated  
16 in the figure above the SBC06 modules is the C-link  
17 communication which interconnects with safety  
18 controllers to enable broadcast of data and status  
19 information among safety controllers within the same  
20 channel. In the following slide we'll discuss more ICL  
21 and C-link communications.

22 So again in this image you can see the two  
23 SBC06 controllers. On top of those you can see the  
24 C-link communication that performs broadcast  
25 communication between the two redundant controllers.

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1 Below you can see the ICL links that go from the  
2 input/output modules to the SBC06 controller modules.

3 The C-link is an Ethernet-based network  
4 employing a proprietary token-passing protocol to  
5 implement deterministic communications. The C-link  
6 provides a path for the transmission of data and  
7 information among SBC06 controllers within a channel.

8 And there's a separate subordinate  
9 processor within the controller module that serves to  
10 process these signals and buffer the main processor from  
11 communications.

12 The ICL, which is the one below and connects  
13 between the input/output modules to the controller  
14 modules is a serial bus used to interconnect these  
15 modules. This communication is accomplished using a  
16 master/slave polling protocol so only the controller  
17 can initiate communications. And that's also a  
18 separate processor that handles ICL communications.

19 Next slide.

20 MR. HECHT: Can I ask a question?

21 MR. DARBALI: Yes.

22 MR. HECHT: If you have the C-link why do you  
23 need the dual-ported memory?

24 MR. DARBALI: Right, and we'll talk about  
25 that. But basically the two controllers are redundant

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1 but only one acts as primary. The second one is  
2 secondary standby. So the dual-core memory has a CPLD  
3 chip that handles the failover transition.

4 So all of the data that the primary  
5 controller has is being passed to the secondary  
6 controller through the dual-ported memory.

7 MR. HECHT: Okay, so that's where the state  
8 data is kept?

9 MR. DARBALI: Right.

10 MR. HECHT: If you will.

11 MR. DARBALI: Right.

12 MR. HECHT: So why can't you -- why didn't  
13 they do that over the C-link? Or what does the C-link  
14 do -- I'll ask it the right way. What does the C-link  
15 do that the dual-ported memory does not do?

16 MR. DARBALI: It provides broadcast data  
17 between the two controllers. But it does not handle the  
18 failover mechanism.

19 CHAIRMAN BROWN: Just between primary and  
20 secondary.

21 MR. DARBALI: Right.

22 MR. THORP: It's information sharing but  
23 not, not --

24 MR. DARBALI: Right.

25 MR. THORP: -- information actuation in

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1 terms of having the secondary replace the primary if  
2 there's a failure on the primary.

3 MR. HECHT: But doesn't the dual-ported  
4 memory provide that information sharing function?

5 MR. DARBALI: Well, okay, it does but if you  
6 go back to your, to the big diagram that talks about the  
7 scope. Okay, so yes, the dual-ported memory handles  
8 communication between the two controllers. If you look  
9 at the blue box that says Channel A gateway controller,  
10 that also has a node to the C-link.

11 So if you were going to do inter-channel  
12 communications you would have to use the C-link as well  
13 through that gateway controller.

14 MR. HECHT: Okay, so it's the same  
15 information that's going to the C-link as in the  
16 dual-ported memory? Maybe I'm not -- maybe it's not --

17 MR. CARTE: No, I think the issue is that  
18 it's a bandwidth issue. So if you think about the  
19 dual-port memory is there to allow failover, bumpless  
20 transfer failovers, so in that sense the state of the  
21 primary controller needs to be reflected in dual-port  
22 memory. And to maintain that state you have a lot of  
23 communication that's going on. If all that  
24 communication was happening on the C-link you wouldn't  
25 get, you wouldn't be able to communicate any other

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1 information on the C-link because you would be using up  
2 all your bandwidth.

3 So I think that it's probably an  
4 architectural issue.

5 MR. THORP: So that's what is maintaining  
6 that tracking function. And that eats up a lot of  
7 information --

8 MR. CARTE: That would eat up all the C-link  
9 bandwidth. And it's used in that base so you have  
10 timing issues with that.

11 MR. HECHT: Thank you.

12 MR. DARBALI: So we're in slide 10.

13 So this drawing shows the processors and  
14 complex programmable logic devices for CPLDs that are  
15 part of the SBC06 controller module. So as you can see,  
16 the SBC06 module has three processors and four CPLDs.  
17 The dual-ported memory, which is the orange box on the  
18 bottom, has one CPLD.

19 The SYS or system processor, which is the  
20 top-left box, processes -- monitors overall status of  
21 the controller module, services watchdog timers and  
22 executes the application program code.

23 The ICL processor handles communication on  
24 the ICL to obtain field data from and send operational  
25 commands to the input/output modules.

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1                   And the C-link processor is responsible for  
2                   regulating messages sent over the C-link.

3                   And other functions that are performed by  
4                   the CPLDs is, for example, in the dual-ported memory it  
5                   manages failover mechanism. And in the controller  
6                   module, one of the CPLDs handles shared memory, which  
7                   you can see better in the next slide.

8                   CHAIRMAN BROWN: They're still using 386's?

9                   MR. DARBALI: Yes.

10                  Okay, so this slide shows you can see on the  
11                  top-right it's what you would see as the modules. And  
12                  in their redundant configuration you would have another  
13                  SBC06 controller to your right. And on the SBC06  
14                  controller, the blue highlight is the architecture  
15                  related to the system processor.

16                  On the top-left you see the architecture  
17                  related to the C-link processor. And on the bottom left  
18                  you see the red highlight which is the ICL processor  
19                  architecture.

20                  There is a shared portion in the middle  
21                  that's overlapped by all three, and that's a public  
22                  memory that's shared between all of them. And access  
23                  to that memory is controlled by that access controlled  
24                  CPLD.

25                  CHAIRMAN BROWN: That's still within one

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1 platform, all of one division, whatever you want to call  
2 it?

3 MR. DARBALI: That's all within one SBC06  
4 controller.

5 CHAIRMAN BROWN: Okay.

6 MR. DARBALI: So you would have the same  
7 architecture on all of them.

8 CHAIRMAN BROWN: That's a shared resource is  
9 what -- the public thing is a shared resource then?

10 MR. DARBALI: Yes. It's shared between all  
11 three processors. However, all three processors have  
12 their own private memory that's not shared. And the  
13 system processor is the only one that handles the  
14 application-specific code.

15 CHAIRMAN BROWN: Okay. Thank you.

16 MR. DARBALI: Next slide.

17 So in this slide you can see better the two  
18 redundant controllers and the dual-ported memory card  
19 in the middle. And so the -- it's a bit complicated,  
20 and that's why I highlighted the lines that go into the  
21 dual-ported memory. But what happens is the system  
22 processor strobes the watchdog timer. And when it --  
23 and that sends what is called a sanity signal.

24 Once it fails to strobe the watchdog timer  
25 it times out. It sends a not sane -- I'll try, an insane

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1 signal to the failover CPLD. And then there's a  
2 sanity CPLD on the controller. Once the watchdog timer  
3 times out there's going to be a flag and that no longer  
4 is going to be your primary controller.

5 So you're going to have bumpless transfer  
6 to the second controller and then that primary or PRI  
7 signal coming from the main controller, that's the  
8 yellow highlight, that's going to be false. So it  
9 provides the logic to transfer primary control of the  
10 controller.

11 MR. HECHT: Does that mean that there's a  
12 single point of failure here?

13 MR. DARBALI: What do you mean?

14 MR. HECHT: Okay. I would see two. And  
15 maybe this is a not a design review but maybe I would  
16 just ask if you considered that? Two cases of  
17 controller B spuriously wants to take over and what  
18 prevents it from doing that?

19 And then case two, controller A has failed  
20 but sanity CPLD doesn't want to let go?

21 MR. DARBALI: Well, control -- when you  
22 initialize both controllers, the first one to strobe the  
23 watchdog timer is going to take the primary. The  
24 secondary is not going to ask to become primary.

25 MR. HECHT: All right, fair enough.

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1 MR. DARBALI: As far as the sanity CPLD  
2 failing --

3 MR. THORP: Well, the acute failure is  
4 essentially in that controller; right?

5 MR. CARTE: Right.

6 MR. THORP: You'd have a problem with a  
7 controller and then you'd have a problem with the sanity  
8 side, so.

9 MR. CARTE: You've got to put this in  
10 context. This is one rack, one redundancy equipment.

11 MR. THORP: Right.

12 MR. CARTE: The rack is not designed to be  
13 single failure proof. This design is for high  
14 reliability bumpless transfer. It's not, it does not  
15 address the single failure criterion.

16 So there may be more than one possibility,  
17 and that's perfectly allowed for a single failure that  
18 disables this rack. And so it's -- reliability issue  
19 is not single failure criteria that is being addressed.

20 MR. THORP: Okay.

21 MEMBER STETKAR: Well, single failure  
22 criterion in the sense of plant application.

23 MR. CARTE: Yes. Right.

24 MEMBER STETKAR: But not in the sense of this  
25 architecture.

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1 MR. CARTE: I've heard the term single  
2 vulnerabil -- single point vulnerability to be more  
3 accurate.

4 CHAIRMAN BROWN: Well, if you go back to  
5 slide 7, there is within one channel of four there are  
6 two of these --

7 MR. DARBALI: Right.

8 CHAIRMAN BROWN: -- units. So that if the  
9 upper one within the green box turns to stone, I have  
10 no idea what the second one is doing because we haven't  
11 talked about it.

12 MEMBER STETKAR: Those two are the, those  
13 could be the function --

14 CHAIRMAN BROWN: Well, that's not what it  
15 looks like. It's got the same sensors, the same outputs  
16 and all of that.

17 MEMBER STETKAR: One could be a reactor  
18 clip, the other could be a safeguard.

19 MR. DARBALI: Right.

20 MEMBER STETKAR: So that's different.

21 MR. DARBALI: It's design specific.

22 CHAIRMAN BROWN: I understand that. But  
23 I'm just saying there is --

24 MR. DARBALI: Right.

25 CHAIRMAN BROWN: -- there are two of these

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1 redundant. There's redundant within one thing and then  
2 there is another pair of redundant.

3 MEMBER STETKAR: The bottom, outside of the  
4 green box in my interpretation is not redundant.  
5 Inside the green box --

6 CHAIRMAN BROWN: But it didn't say that in  
7 the report explicitly so I didn't read that.

8 MR. DARBALI: Right. What the report  
9 covered was communication between HFC-6000 racks within  
10 the same channel which would be also through this  
11 C-link. So that's another thing the C-link does.

12 But it doesn't say if it's going to be a  
13 redundant to the first iteration, first rack, or if it's  
14 going to be a separate function.

15 MEMBER STETKAR: It could be. I mean people  
16 have done -- it's a functional redundancy like low  
17 pressure versus, you know, high temperature or  
18 something like that. But that's, that's application  
19 specific; right?

20 The whole point is the channel A can be  
21 failed and still -- you know, that's the single failure.

22 CHAIRMAN BROWN: Well, I understand the  
23 point about the bottom part could be processing other  
24 functions, okay, and sending it out to whatever the  
25 topical report voting logic is for whatever controls you

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1 need.

2 MR. THORP: Reliability redundancy is  
3 between those two controllers --

4 CHAIRMAN BROWN: Yes. I got that.

5 MR. THORP: -- inside the green box.

6 MEMBER STETKAR: The single channel  
7 failure, the single failure in the sense of plant  
8 applications is out in channel 8 blue box, if you will.

9 MR. THORP: The single channel failure is  
10 the red box. So typically you have one battery-backed  
11 power for each channel, for instance; right? So you  
12 could lose power and lose all of these racks in that  
13 channel and that's your single failure. And then they  
14 have dual redundant power supplies, but that's the  
15 concept of a channel, that that whole box is vulnerable  
16 to single failures.

17 CHAIRMAN BROWN: The red box.

18 MR. THORP: Yes. The red box.

19 MEMBER STETKAR: The single failure box.

20 CHAIRMAN BROWN: We got that. But if you go  
21 up into the just the green, you can go back to that  
22 little, what is it, slide 12, and you have the way your  
23 report, it's not your report but that's your report, in  
24 the topical report, the control array goes, you know,  
25 the sanity check fails, fails overflow channel there to

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1 the controller B. Shut off controller B. Then it just  
2 stops.

3 MR. DARBALI: Right.

4 CHAIRMAN BROWN: Everything stops.

5 MR. DARBALI: Right.

6 CHAIRMAN BROWN: It didn't really define  
7 what "stops" means in any great detail, just other than  
8 it stops.

9 MR. DARBALI: Right.

10 CHAIRMAN BROWN: And so that's still open.

11 MR. DARBALI: Right.

12 CHAIRMAN BROWN: It's an open issue when you  
13 get to application --

14 MR. DARBALI: Right.

15 CHAIRMAN BROWN: -- specific stuff. I  
16 just, I was just trying to make that point.

17 MR. DARBALI: Right.

18 CHAIRMAN BROWN: That comment.

19 MR. DARBALI: The only thing it does say that  
20 if you have one of the two controllers fail, because the  
21 system allows you to do the maintenance failover if you  
22 wanted to work or take out your controller A module then  
23 you would do a maintenance failover to controller B. If  
24 one fails you get an LED light on your dual-ported memory  
25 module, you can't do that. You can't do a maintenance

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1 failover if one module fails.

2 MR. THORP: The system has to be healthy in  
3 order to try to exercise one for maintenance or testing.

4 CHAIRMAN BROWN: Yes, but it also says if you  
5 get a fail on the second one that the whole, the whole  
6 string just stops.

7 MR. THORP: It fails, yes.

8 CHAIRMAN BROWN: It didn't really -- But I  
9 just wanted to make sure I understood that point.

10 Okay, go ahead.

11 MR. DARBALI: Okay. Next slide.

12 So this slide highlights the cycle of  
13 operation of the SYS or system processor. So you can  
14 see there the cycles are set at 100 milliseconds. And  
15 it has eight tasks numbered zero through seven where  
16 zero, task zero through six are diagnostics and they  
17 take the first 10 milliseconds of the cycle. So you  
18 have about 90 milliseconds to run your last task, task  
19 seven, which is the application program.

20 Now, the -- Go ahead.

21 CHAIRMAN BROWN: That's interesting you say  
22 that because on page 118 of the report it talks about  
23 application loading can only operate up until 50 percent  
24 --

25 MR. DARBALI: Right.

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1 CHAIRMAN BROWN: -- of the total process.

2 MR. DARBALI: Yes.

3 CHAIRMAN BROWN: Not 70 -- not 90 percent.

4 MR. DARBALI: Right. So you have, you have  
5 90 percent --

6 CHAIRMAN BROWN: I mean this is a highly  
7 event-driven interrupt system, highly interrupt. It's  
8 got event-driven interrupts in it. And you've got,  
9 you've got limitations on the application code in terms  
10 of the application being --

11 MR. DARBALI: Right.

12 CHAIRMAN BROWN: -- able to be loaded into  
13 your processing time in order to meet these.

14 MR. DARBALI: Right. So you have 100  
15 milliseconds. Ten are taken over by your diagnostics,  
16 and then you have 90 milliseconds to run your program  
17 once from start to finish. Once that's done it's going  
18 to keep running your application program until the end  
19 of the cycle.

20 So --

21 CHAIRMAN BROWN: What defines a cycle then,  
22 not the 100 milliseconds?

23 MR. DARBALI: Yes. So it, let's say, takes  
24 you 10 milliseconds for your diagnostics, it takes you  
25 20 milliseconds to do your application task, you're

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1 going to keep running that 20 millisecond application  
2 task until the end of the cycle.

3 The 50 percent of the remaining 90 percent  
4 is an application-specific action item that's to  
5 guarantee you're running your application at least once  
6 completely.

7 CHAIRMAN BROWN: Every 100 milliseconds.

8 MR. DARBALI: Every 100 milliseconds. You  
9 need to allocate -- that application has to be 50 percent  
10 of the 90 milliseconds.

11 MEMBER BLEY: No more.

12 CHAIRMAN BROWN: No more than 55  
13 milliseconds.

14 MR. DARBALI: Right.

15 MR. THORP: In other words no more than 45  
16 milliseconds.

17 MR. DARBALI: Right.

18 MR. THORP: Otherwise it wouldn't be able to  
19 run its task necessarily on time --

20 MR. DARBALI: Right. So if --

21 MR. THORP: -- full through.

22 MR. DARBALI: So if it's 70 milliseconds and  
23 you run it once, the second time you run it, you start  
24 it, it gets paused. When you go to your next cycle you  
25 continue it but you're not running the full one. So you

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1 need it to be under 50 milliseconds -- or under 50 --

2 CHAIRMAN BROWN: Percent.

3 MR. DARBALI: -- percent of the remaining  
4 time for it to run at least once completely. And then  
5 you can run it and pause it, go to the next cycle,  
6 continue.

7 CHAIRMAN BROWN: But you're -- okay, let me,  
8 let me rephrase. If say you're application code ran 60  
9 milliseconds, that would mean you would go 10 with the  
10 diagnostic.

11 MR. DARBALI: Right.

12 CHAIRMAN BROWN: Sixty for the one complete  
13 running through it, all functions.

14 MR. DARBALI: Right.

15 CHAIRMAN BROWN: You'd have 30  
16 milliseconds into the leftover. It would start its  
17 application again but then it would stop, it goes into  
18 the next one, goes through 10 milliseconds of  
19 diagnostics, then starts someplace?

20 MR. DARBALI: Right.

21 CHAIRMAN BROWN: Where? At the end of the  
22 30 milliseconds?

23 MR. DARBALI: Right. It starts at the end  
24 of where you left off.

25 CHAIRMAN BROWN: There was another comment

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1 in here about the interrupt-driven part where it says  
2 there's a contact switch --

3 MR. DARBALI: Right.

4 CHAIRMAN BROWN: -- which if that gets  
5 triggered then what it does, it stops everything and  
6 re-starts the task control at the beginning of the  
7 sequence, not wherever it left off. That was on page  
8 117 of something. I think it was the SE. You all were  
9 very detailed in your description.

10 MR. THORP: And while Samir is looking at  
11 that, I will, I will inform the group that he's had to  
12 work harder than anybody here on this, in his efforts  
13 --

14 CHAIRMAN BROWN: I can understand that.

15 MR. THORP: -- because he didn't actually  
16 do the original evaluation of this. He's been doing  
17 homework to try to catch up on what was, what was  
18 approved before, so.

19 CHAIRMAN BROWN: Yes, we don't need to go  
20 resolve that. I'm just pointing out that --

21 MR. DARBALI: Right.

22 MR. THORP: No.

23 CHAIRMAN BROWN: -- I'm just bringing a  
24 number of issues that -- no, not issues, principles that  
25 have been stated in some of the past --

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1 MR. DARBALI: Right.

2 CHAIRMAN BROWN: -- past design reviews is  
3 that, number one, you wanted to avoid event-driven  
4 interrupts.

5 MR. DARBALI: Right.

6 CHAIRMAN BROWN: You wanted to avoid  
7 interrupts other than maybe there are some, there are  
8 good interrupts. You have to have some interrupts,  
9 some time-based interrupts to do some things.

10 MR. DARBALI: My understanding is when the  
11 topical reports talks about a contact switch it's the  
12 cycle. And the interrupt is not mentioned, from what  
13 I remember for this SYS processor, it's not mentioned  
14 as event-driven but time-based.

15 MR. THORP: Right.

16 MR. DARBALI: So the 100 milliseconds, or  
17 whatever your cycle is going to be, you have an  
18 event-based interrupt. That's going to stop your  
19 application from running, it's going to start again, and  
20 it's going to continue the next cycle.

21 MEMBER REMPE: It's a cycle.

22 MR. THORP: It's a cycle time interrupt, not  
23 really an event, but something else happened that  
24 interrupts it.

25 MR. DARBALI: Right. There are

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1 input/output modules that have event-based interrupts.  
2 But that's a separate one.

3 Again, if I can remember correctly, the  
4 contact switch is the cycle time and it's an event-based  
5 interrupt.

6 CHAIRMAN BROWN: Well, we went through this  
7 on the Common Q platform which has had a loading  
8 requirement in its topical report for the Common Q  
9 processor method. And we actually, they actually ended  
10 up running a test to verify that it would complete its  
11 -- if you exceeded the 70 percent loading requirement  
12 will it still work, or would it really work even within  
13 the 70 percent as it hadn't been done. And they, they  
14 came up with a test to do that. So I'm just identifying  
15 this as an issue, a downstream issue when we ever get  
16 to a specific application.

17 MR. DARBALI: Right.

18 CHAIRMAN BROWN: Which will probably have to  
19 be resolved when it was, in my estimation, if it ever  
20 came to fruition while I'm still alive.

21 Samir, we can go on, okay. I just wanted  
22 to bring it because that was a point that I noticed going  
23 through this.

24 MR. DARBALI: I have a paragraph from the  
25 topical. I just didn't know exactly from where but I

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1 can find out. But it says, "The HFC-6000 operating  
2 system uses the time-based interrupt from the realtime  
3 clock to trigger a contact switch. The contact switch  
4 results in suspension of the continuous loop execution  
5 of the application task to restart the task control  
6 sequence from the beginning. After the short interval  
7 to accomplish the execution of the utility task and any  
8 time-based routine, application task execution is  
9 resumed at the point of interruption."

10 CHAIRMAN BROWN: My point being, yes, the  
11 point being is you stop, you're in the middle of  
12 processing a trip.

13 MR. DARBALI: Yes.

14 CHAIRMAN BROWN: The time-based then comes  
15 through and stops the process.

16 MR. DARBALI: Right.

17 CHAIRMAN BROWN: Not a good idea.

18 Then it goes and does all this other stuff  
19 that it's supposed to be doing in this little thing.  
20 And then it says, Aha, I've got to come back and finish  
21 my reactor trip calculation and whether it's really a  
22 trip or not.

23 MR. THORP: This is this design. I don't  
24 know that we can conclude here in this forum that it's  
25 not a good idea.

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1 CHAIRMAN BROWN: I agree with you.

2 MR. THORP: Right.

3 CHAIRMAN BROWN: I'm just saying it's an  
4 issue. I'm just putting it on the table for downstream  
5 if we ever get around to doing it.

6 MR. THORP: A question to pursue.

7 CHAIRMAN BROWN: We would like to pursue  
8 that.

9 MR. THORP: Okay.

10 CHAIRMAN BROWN: That's if we ever get  
11 there. That's all.

12 MR. THORP: Thank you, Charley.

13 CHAIRMAN BROWN: So we ought to keep on  
14 moving here.

15 MR. DARBALI: Okay. Well, a key thing on  
16 this one that if the application task, that task seven  
17 is not completely performed from start to beginning at  
18 least once per cycle you do get a flag and a false  
19 identification.

20 Next slide.

21 MEMBER BLEY: Is that a permanent thing, the  
22 flag and the false indication? Or is that like the last  
23 one we were talking about where we get an LED --

24 MR. DARBALI: If it goes off.

25 MEMBER BLEY: -- on the card somewhere?

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1 MR. DARBALI: I'd have to go back and check.

2 CHAIRMAN BROWN: If there's a way to resolve  
3 these, if you go back and you do a platform reset, I mean  
4 you can go back and reinitialize and restart depending  
5 on how long it takes to do it. I mean if it takes 10  
6 minutes to do it like it does on some platforms, then  
7 that's a problem. But if it takes 30 microseconds,  
8 that's a different problem. It just -- anyway.

9 MR. DARBALI: Okay. So this slide lists  
10 some of the predictability and repeatability features  
11 of the design, deterministic behavior supported by  
12 design measures such as sequential execution of tasks,  
13 continuous loop execution of the application function,  
14 regular schedule for time-based routines, diagnostics  
15 that confirm the execution of the safety function, and  
16 deterministic communications with preconfigured  
17 architecture.

18 Also, the SYS or system processor, which  
19 serves as the safety processor, is buffered from  
20 communication transactions through the use of  
21 interposing communications processors, or the ICL and  
22 C-link processors.

23 MEMBER SCHULTZ: So, Samir, is this, is this  
24 a representation of the conclusions that were drawn from  
25 the -- in the SER from the review of these criteria?

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1 MR. DARBALI: It's part of it, yes.

2 MEMBER SCHULTZ: Part of it.

3 MR. DARBALI: Yes.

4 MEMBER SCHULTZ: I just wanted to understand  
5 what, because there is a time difference here between  
6 what we've heard this morning earlier about the review  
7 and the review criteria and then what presents here in  
8 summary fashion. You've drawn some information from  
9 the SER --

10 MR. DARBALI: Right.

11 MEMBER SCHULTZ: -- in here as an example  
12 --

13 MR. DARBALI: Right. There's a lot of --

14 MEMBER SCHULTZ: -- of what is being used.

15 MR. DARBALI: -- proprietary information  
16 in the determinism portion of the safety evaluation.

17 MEMBER SCHULTZ: That, there's that aspect  
18 too. Thank you.

19 MR. HECHT: Can I ask a question? This is  
20 a method, a process issue and your, and how you do things  
21 as opposed to Charley's question. But given the fact  
22 that there is some non-deterministic aspect of what  
23 happens when a task is interrupted by the time tick, how  
24 do you treat that?

25 MR. DARBALI: I believe the safety

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1 evaluation concluded that to be deterministic.

2 CHAIRMAN BROWN: There was a statement in  
3 one of the pages where they evaluated these, each of  
4 these little factors and then they made, drew a  
5 conclusion. I'd have to go back and find that  
6 particular part of it. It was very complete so it was  
7 a good, good discussion.

8 MR. THORP: Because it was cyclical and  
9 based on time, it was deterministic.

10 CHAIRMAN BROWN: Right.

11 MR. HECHT: It was cyclical and based on time  
12 but if there was an interruption of the last link task,  
13 it seemed to, seemed to be resumed rather than  
14 terminated, which would indicate that resumption could  
15 happen anywhere within that last task.

16 MR. THORP: We would have to get into the  
17 design to talk about the way it pauses and how it resumes  
18 right where it left off. And I don't know that we can  
19 do it.

20 CHAIRMAN BROWN: No, we -- yes, I agree. I  
21 mean I agree the point is along the lines I was talking  
22 about.

23 I just think I just wanted to get these  
24 points of the design out so that we could cover them when  
25 we come around at some other time if this comes up as

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1 part of our application. And you all have got right now  
2 a design of something docketed which I guess we are going  
3 to be looking at at some point in the future maybe.  
4 Maybe.

5 So I think we need to go ahead and roll on.  
6 Thank you.

7 MR. DARBALI: Okay, next slide.

8 This slide lists some of the SDOE features  
9 that are part of the design. For example, any firmware  
10 change requires physical replacement of the PROMs. And  
11 application software for the module can be installed via  
12 PROM replacement or download to dedicated flash memory.  
13 But either of these modification processes for  
14 application software are intended to occur while the  
15 module is out of service or out of the cabinet.

16 MEMBER SCHULTZ: Samir, with the SPINLINE  
17 discussion we had earlier there was a -- the audit that  
18 John described related to a secure development  
19 environment. Any indication that that was done here?  
20 Or was it at a time when the conclusion that, oh, it was  
21 burned in and can't be altered in the field was  
22 sufficient?

23 MR. DARBALI: Well --

24 MEMBER SCHULTZ: Things have changed in the  
25 last three or four years of that.

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1 MR. THORP: Think about the time frame of the  
2 review that was done on those.

3 MEMBER SCHULTZ: Yes.

4 MS. ALVARADO: I don't think they did an  
5 audit.

6 MEMBER SCHULTZ: Whether they did an audit  
7 or not I don't know.

8 MR. DARBALI: No, I think there was an audit.  
9 But again, Oak Ridge National Lab was the reviewer.

10 MR. THORP: Yes, so it might be something we  
11 can find out for you.

12 MEMBER SCHULTZ: I wanted to understand if  
13 we were maintaining a consistent review going forward  
14 in some fashion. I mean we don't have any applications  
15 here but it might be something to consider when it's  
16 related to this design.

17 MR. DARBALI: Section 3.6 of the safety  
18 evaluation to the topical report addresses secure  
19 development.

20 MEMBER SCHULTZ: Okay.

21 MR. DARBALI: And it's quite a few pages on  
22 that.

23 MEMBER SCHULTZ: All right.

24 MR. DARBALI: So I think that what I pointed  
25 out here covers more of the secure operational

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1 environment.

2 MEMBER SCHULTZ: Understood.

3 MR. DARBALI: But on the secure development  
4 there is, there is discussion on that.

5 MEMBER SCHULTZ: Thank you.

6 MR. DARBALI: The final slide.

7 So after NRC approval of the, review and  
8 approval of the topical report, HFC came with two  
9 amendments. If you recall, the original NRC safety  
10 evaluation had six generic open items related to  
11 equipment qualification. HFC came back with an  
12 amendment that addressed those items. And the final  
13 safety evaluation for that amendment was issued this  
14 week actually.

15 And there is a second amendment that the  
16 staff is performing an acceptance review currently.  
17 And that addresses new modules that HFC would like to  
18 incorporate into their design. Some of the modules are  
19 changing because of obsolescence. And, for example,  
20 the main SBC06 module that we have been talking about,  
21 those four CPLDs are being replaced now with one FPGA.

22 So the staff is currently performing the  
23 acceptance review for this amendment.

24 CHAIRMAN BROWN: Is that it? Any questions  
25 leftover here?

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1 (No response.)

2 CHAIRMAN BROWN: Okay, we will turn it back  
3 to Norbert to rescue the time line for the NUPAC.

4 MR. CARTE: Okay. So this is an application  
5 that is currently under review. So we'll go through the  
6 same structure: a little background, a little  
7 description, and discussion of review criterion.

8 So the background on this topical report is  
9 that it was originally docketed in 2011. It, due to  
10 other workload requirements we didn't start reviewing  
11 that until 2012 where we did the acceptance review that  
12 was issued in May of 2012. We issued the RAIs in May  
13 of 2013.

14 In 2014 the review was suspended to work on  
15 other higher priority items. Since there is no  
16 applicant associated with this topical report it falls  
17 to the bottom of the food chain.

18 In September of 2014 Palo Verde docketed a  
19 letter intending to use this application. And we will  
20 see how that develops. And they said they wanted to  
21 start doing that in 2016. So that might give us a  
22 greater sense of urgency.

23 So we recently just completed the first  
24 audit. And we anticipate there should be another audit  
25 in September or the fall. And we hope to have the final

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1 SE issued by June, depending on the timing of the  
2 docketed information. We may get documents as late as  
3 December of this year. And so that might be a little  
4 bit aggressive depending on how much we get in December.

5 So in terms of a high level description,  
6 this is an application framework. So it is a set of  
7 parts and concepts about how you use those parts. It  
8 does not have a microprocessor or any emulation thereof.  
9 There is no system-specific design associated with  
10 this.

11 It does have a digital communication  
12 mechanism. And we are looking at that mechanism. It  
13 does not address diversity and defense in depth; in  
14 other words they're not trying to claim 100 percent  
15 testing or inherent diversity.

16 It does not address electrical isolation so  
17 it was stated that they intend to use, if needed, fiber  
18 optics isolation modules, whatever is acceptable for  
19 electrical isolation outside the cabinet.

20 It also at this time does not include the  
21 power supplies for the racks.

22 The description of the topical report  
23 consists of three main items as three primary bullets:  
24 a chassis and backplane, and in that chassis is where  
25 the power supplies would be mounted; a generic logic

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1 module which is really a card assembly. It consists of  
2 two types of things, a logic mezzanine as well as I/O  
3 cards. It can hold up to eight I/O cards of six  
4 different types; as well as a real transition module.

5 So when I display that this is what it --  
6 the three pieces that we talked about: the rack and  
7 backplane, the generic logic module, which is an  
8 assembly. We'll get into that more later. As well as  
9 the real transition module for connecting the field  
10 inputs into the chassis.

11 So let me back up just for a second. So one  
12 of the things that you need about a FPGA design like this  
13 is that it is possible to implement a reactor trip  
14 function on one generic logic module card.

15 Some functions require a larger number of  
16 inputs and would require multiple cards. But you could  
17 go to a function by function implementation by card so  
18 that, therefore, if you have a problem you could remove  
19 one card and not impact the other functions, which is  
20 similar to the analog systems today. So it has that  
21 potential, although that isn't -- this is an application  
22 framework and the specifics would depend on the  
23 application.

24 So in this description of this card you  
25 basically see the pieces and parts on the left and the

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1 assembly on the right, which means so there's a carrier  
2 card which is a card that has sets of slots on it that  
3 you can plug in other cards to. The cards plug in  
4 horizontally and are called mezzanine cards for that  
5 reason, rather than perpendicularly.

6 So this is what it looks like. The carrier  
7 card that was on the previous slide, typical mezzanine  
8 cards. You see the connectors that connect into their  
9 location. The top card populated with a chip.

10 In terms of the logic card there are --  
11 there is a core logic which basically does the built-in  
12 test and communication functions as well as an  
13 application-specific logic which will implement the  
14 application program.

15 You put this stuff together and you get a  
16 generic logic module.

17 So in terms of what happens on this logic  
18 module, it supports various forms of unidirectional  
19 communication. So in the backplane each card has  
20 different infrastructure associated with eight one-way  
21 outputs and eight one-way inputs into the backplane.  
22 So this allows for communication to other cards in the  
23 rack. It also has some non-volatile memory on the card,  
24 but this non-volatile memory is protected by a physical  
25 disconnect of a write protect which is carried to

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1 outside the card through the backplane.

2 As we can see, on the card it has a core  
3 FPGA. This core FPGA is used to communicate to the  
4 other cards through the backplane or to the I/O cards.  
5 And those I/O cards can then get communicated external  
6 to the cabinet through the rear transition module.

7 There's also an application-specific FPGA  
8 which right now they built a test specimen in order to  
9 do their qualification testing. They haven't  
10 completed their qualification testing yet. But that's  
11 just so that they could do some E-cubed testing  
12 basically.

13 So this is an other logical depiction of  
14 that. Basically the point here is that the logic  
15 mezzanine communicates with the I/O cards. The I/O  
16 cards then feed through the midplane or backplane to the  
17 rear transmission -- transition module and out to the  
18 field to the field wiring.

19 So, okay, then we talk about criteria. So  
20 in terms of independence, the only criteria we can  
21 evaluate right now for independence is the serial  
22 communication through the communications card. And  
23 that's an RS-422 card. And the communication mechanism  
24 implemented at the application level is at a byte level  
25 so that it's a start bit, a stop bit, a parity bit. And

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1 each byte communicated is confirmed at that level.

2 The message level communication will be  
3 configured in the application. And there will have to  
4 be appropriate schemes in the application such as CRC  
5 checks of the message content, serial or sequence  
6 numbers on the message so that you can tell if a message  
7 is repeated as opposed to not incrementing.

8 So what happens on these highly parallel  
9 systems is you rely on built-in tests to a much greater  
10 degree than you do on microprocessor-based systems.  
11 Most microprocessors today have implemented some  
12 self-testing on the chip itself. And many  
13 microprocessors raise a flag to the outside of the chip  
14 once they fail their internal tests and have decided to  
15 halt. So that's one form of testing that's done on a  
16 microprocessor.

17 Operating systems and applications  
18 programs can do other forms of checks such as memory  
19 checks. But in general we don't talk about those  
20 built-in tests because we sort of, I guess, assume they  
21 work and are not really crediting them. And some people  
22 credit watchdog timers to be strobed as a form of a  
23 health monitoring.

24 The problem with highly parallel systems is  
25 that unless you figure out a way to route that watchdog

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1 signal through every circuit on that parallel system it  
2 doesn't confirm everything. So a strict reliance on  
3 the watchdog is not -- doesn't give you much and you have  
4 to build in self-testing features to actually confirm  
5 the functionality that's in place. And so there's a  
6 greater reliance on the self-test.

7 For instance, on the CPLD card that we  
8 discussed previously there was a separate self-test  
9 CPLD that queried everything, every function on the main  
10 CPLD. And there will be some need to do that. The  
11 exact scheme to do that at the application level is going  
12 to application specific. And we have not really gotten  
13 into the review of that yet for the core FPGA.

14 Well, what we do know at this point is that  
15 they will be using a state machine. So if you read the  
16 literature on what you do with FPGAs there's a couple  
17 generally-accepted approaches, and these tend to be in  
18 not redundant architectures but they would be in single  
19 architectures. One is a triple modular redundancy: you  
20 implement everything on the FPGA three times and then  
21 you vote the output. That's not the approach that  
22 they're using here.

23 The other option is to do a state machine  
24 and have built-in tests associated with assuring that  
25 you're in the right state.

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1           So different processes are developed.  
2       Different state machines, there's various state  
3       machines implemented on the chip to implement  
4       processes. Some of those processes are independent.  
5       So if you find a fault on that particular state machine  
6       you can reset just that process and not affect the other  
7       processes. Some processes are interconnected and so  
8       you would need to re -- if you found a fault in one of  
9       those state processes you would need to restart all the  
10      associated processes.

11           And then in the worst case, you could  
12      envision a condition where you would have to restart or  
13      reset the whole FPGA itself.

14           Those aspects, that's the general concept  
15      of how this issue is handled in the industry. And if  
16      you read the write-up on FPGAs they're trying to address  
17      single-event upsets, but it could address other types  
18      of problems. That's what we're thinking. We're not  
19      very far along in that review but we are focused on the  
20      built-in tests to assure that the continued operability  
21      of the system.

22           And in terms of severe development  
23      operational environment, basically it will be a  
24      one-for-one correspondence check. So there's nothing  
25      in this system that was not in the design document, and

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1 nothing in the design documentation that's not in the  
2 system.

3 I guess that was a quick blow-through of  
4 that argument. Any questions?

5 CHAIRMAN BROWN: Only one. Your early  
6 slide you said this is microprocessor based -- no, it's  
7 FPGA based. No microprocessor or emulation thereof;  
8 does that mean it's not fuzzy?

9 (Laughter.)

10 MR. CARTE: So one choice would be to  
11 implement a microprocessor. They have explicitly  
12 stated that they are not going to do that, yes.

13 CHAIRMAN BROWN: Yes, okay. So this is a  
14 non-fuzzy application --

15 MR. CARTE: Trying not to use that.

16 CHAIRMAN BROWN: -- with all of its other  
17 r--

18 MR. CARTE: Trying not to use that word  
19 anymore.

20 CHAIRMAN BROWN: All right.

21 MR. HECHT: Can I ask a question?

22 CHAIRMAN BROWN: Depends on how long the  
23 question's going to take. You've got 37 microseconds.

24 MR. HECHT: Okay. This is a fairly complex  
25 design when you come down to state, the solid state

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1 machines itself if you've got things like shift  
2 registers and memories and lots of other things. Yet  
3 they're talking about what do you do about that with  
4 respect to how you assess the completeness of the  
5 verification, particularly when they do their testing.  
6 I mean they can't test for all the states internal to  
7 this ASEP -- not the ASEP, the FPGAs.

8 MR. CARTE: Right. I think their approach  
9 is basically they do what everybody in the industry does  
10 for FPGAs, they do simulation in design life cycle. And  
11 in fact on top of the standard industry is a random  
12 analysis technique used for FPGA. They slapped on top  
13 the whole D&D process. So that's a completely  
14 independent process that goes through and assesses it  
15 after the design team is done.

16 So they're doing more than is typical but  
17 they're doing everything that is typical, typically  
18 done. And, yes, we haven't gotten any details but  
19 that's my level of understanding and that's what we'll  
20 be looking into.

21 MR. HECHT: Okay.

22 CHAIRMAN BROWN: Okay, first object here is  
23 to check whether anybody in the local public arena here  
24 would like to make an observation or a comment? You  
25 have 39 microseconds.

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1 MEMBER BLEY: And he gets cycle three-plus.

2 MR. HIRMANPOUR: So staff mentioned that --

3 CHAIRMAN BROWN: Just identify yourself  
4 again.

5 MR. HIRMANPOUR: This is Bob Hirmanpour with  
6 Southern Company. Staff mentioned I have less reliance  
7 on the watchdog timer for FPG application with the  
8 technology time frames of the design change. I have a  
9 question, as far as the staff position and the  
10 requirement for having the watchdog timer and is it  
11 acceptable to have no watchdog timer for FPGA is the  
12 diagnostic and other handling routines are robust  
13 enough? Thank you.

14 MR. CARTE: Well, that is an evaluation that  
15 will be made by the staff on a case by case basis. You  
16 have to demonstrate predictability and reliability --  
17 repeatability and reliability. If you can do that  
18 there is currently no explicit regulatory requirement  
19 for a watchdog timer. There are requirements for  
20 predictability and repeatability.

21 MR. HIRMANPOUR: Thank you.

22 CHAIRMAN BROWN: Hearing no more from the  
23 public is there anyone on the phone line? Can you say  
24 hello? Just me know that the phone line is on if you're  
25 out there by saying something. I'll give you another

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1 millisecond.

2 MR. BROWN: The bridge is open.

3 CHAIRMAN BROWN: Thank you. That's Theron.

4 All right, hearing nothing we'll close the  
5 bridge line. We'll go around the table to see if  
6 there's any comments from the members.

7 Joy?

8 MEMBER REMPE: I just want to thank everyone  
9 for their presentations and time. It's a learning  
10 experience.

11 CHAIRMAN BROWN: Ron?

12 MEMBER BALLINGER: No. Thank you for the  
13 presentations.

14 CHAIRMAN BROWN: John?

15 MEMBER STETKAR: No. And, again, thanks.  
16 This was part of the morning people who sort of  
17 precipitated this. And I really appreciate the effort  
18 that you folks put into this. I think it was you crammed  
19 a lot of information into three-and-a-half hours.

20 MR. THORP: Thanks, John.

21 MEMBER SCHULTZ: We really do appreciate it.

22 MR. THORP: We were meeting your objectives  
23 for --

24 MEMBER SCHULTZ: Yes. Oh, yes, yes.

25 MR. THORP: -- for this effort.

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1 CHAIRMAN BROWN: Dennis?

2 MEMBER BLEY: No additional comments. But  
3 thanks, it was informative.

4 CHAIRMAN BROWN: Steve?

5 MEMBER SCHULTZ: I agree with John. A very  
6 complex issue to describe in a short period of time.  
7 And at first I was concerned that you took so much in  
8 such a time span of pieces to put together here. But  
9 the puzzle fit together very nicely and you demonstrated  
10 what you've done in the past and how you're doing things  
11 today. It did come together very, very well. And  
12 appreciate all the work that was put into the  
13 development of the presentations. And they were well  
14 delivered.

15 Thank you.

16 CHAIRMAN BROWN: Myron, do you have any  
17 other observations?

18 MR. HECHT: No. Just in general I was glad  
19 to see that there's a recognition that when you put in  
20 an FPGA you don't get rid of the problems that you  
21 normally associate with the sequential execution  
22 software. That was recognized.

23 And the other thing is that I'm glad to see  
24 that there is recognition of the fact that there are some  
25 differences in the development process between FPGAs

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1 and software which are being recognized. And I would  
2 imagine that the staff is capable and competent to  
3 handle that.

4 MR. THORP: Thank you, Myron.

5 CHAIRMAN BROWN: I had I'm not sure whether  
6 it's two or three comments. I will start with one of  
7 them.

8 First of all I thought --

9 MR. THORP: We're keeping count.

10 CHAIRMAN BROWN: Keeping count. Okay.  
11 That's terrible.

12 I appreciated all the paperwork you all,  
13 documentation you all got to us. It was, I thought the  
14 SERs that you all had completed or at least partially  
15 completed provided a lot of assessment of the topical  
16 reports and brought out some points that weren't  
17 necessarily obvious in the topical reports in terms of  
18 how things were stitched together.

19 The other -- so I thought that was well  
20 done. And I thought the presentations were well done.  
21 I will just echo my compatriots' comments also. It was  
22 very informative, good interchange and dialog on  
23 questions.

24 The other thing was this, to echo John, we  
25 were both, we're both -- all the I&C guys obviously are

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1 very interested in having future discussions or  
2 interchanges for information like this on other,  
3 whether they're topical reports on platforms or other  
4 specific related issues that you guys see are coming to  
5 the fore as being critical or important in terms of the  
6 performance and how we apply the digital systems to the  
7 plants.

8 I mean we don't know everything you are  
9 doing down in the birds nests of your offices. And so  
10 --

11 MR. THORP: We're feathering things.

12 CHAIRMAN BROWN: Yes.

13 MEMBER STETKAR: Well, it's that time of  
14 years.

15 CHAIRMAN BROWN: Exactly. And so I mean if  
16 there's other items like this that you're working on,  
17 please, we'll probably have Christina strobe you all  
18 every now and then to see what else is going on. But  
19 we'd like to have the opportunity to have this type of  
20 an interchange. It's very informative for us to see  
21 where we're going and where the staff is going.

22 Any other related comments from those  
23 comments? Comments of some of the members rather.  
24 Excuse me.

25 (No response.)

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1 CHAIRMAN BROWN: With that I will close the  
2 meeting. Thank you very much.

3 (Whereupon, the above-entitled matter went  
4 off the record at 12:09 p.m.)

5

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# EICB Topical Reports Update to ACRS I&C Subcommittee

John Thorp (NRC/NRR/EICB)

April 24, 2015

# AGENDA

Opening Remarks	Chairman C. Brown, ACRS
Introduction	John Thorp, NRR
Regulatory Context and Approach	Norbert Carte, NRR
Spline 3 Topical Report <ul style="list-style-type: none"> <li>- Background</li> <li>- Description</li> <li>- Key Review Criteria</li> </ul>	Rossnyev Alvarado, NRR
CPLD - Based SSPS Cards Topical Report <ul style="list-style-type: none"> <li>- Background</li> <li>- Description</li> <li>- Key Review Criteria</li> </ul>	Norbert Carte, NRR
Break	
HFC – 6000 Topical Report <ul style="list-style-type: none"> <li>- Background</li> <li>- Description</li> <li>- Key Review Criteria</li> </ul>	Samir Darbali, NRR
NuPAC Topical Report <ul style="list-style-type: none"> <li>- Background</li> <li>- Description</li> <li>- Key Review Criteria</li> </ul>	Norbert Carte, NRR
Conclusion	John Thorp, NRR
Closing Remarks	Chairman C. Brown, ACRS

# Topical Reports Being Presented

- Purpose: Regulatory Efficiency
- Rolls Royce Nuclear Spinline III
- Westinghouse CPLD – Based SSPS Cards
- Doosan HFC-6000
- Lockheed Martin NuPAC

# EICB Staff Presentation of Topical Report Reviews Outline

- A basic explanation of each design, how it works, and where it might be used in the reasonably foreseeable future.
  - A summary of each design from a technical engineering perspective - drawings and oral explanations that describe how each design processes signals, inter-divisional communications, interfaces between safety and non-safety signals.
  - Staff understanding of plans to implement these systems - new plants, retrofits, non-US markets, etc.





# Regulatory Context and Approach

Norbert Carte (NRC/NRR)

April 24, 2015

# Outline

- Use of Topical Reports (TRs)
- Topical Report Scope
- Technical Regulatory Requirements
- Key Review Criteria
- How Criteria are Addressed

# Use of Topical Reports

- Increase in Regulatory Efficiency (elimination of redundant reviews)
- Reduce Burden on Licensees (reduction of redundant preparation)
- Industry Proposes for Licensing Use
  - Deals with a specific safety-related subject
  - Expected for multiple use
  - Complete and detailed information
- Digital I&C-ISG-06 encourages use of platform topical reports

# Topical Report Scope(s)

- Topical Reports in General
  - LIC-500 Rev. 5, Topical Report Process
  - SRP, Technical Review Criteria
- Digital Replacement Card
  - CPLD-Based SSPS Card
- System Specific
  - NUMAC PRNM (Not described today)
    - Power Range Neutron Monitor
    - Oscillation Power Range Monitoring System
- Application Framework
  - HFC-6000
  - SPINLINE 3
  - NuPAC

# Topical Report Scope - Historical

- Digital Replacement Cards
  - AREVA Safety Star (August 1995)
    - Installed in Delta Flux Trip at Oconee, prior to TXS Upgrade
  - ASIC Based Replacement Module (ABRM, February 2001)
    - Replacement for Westinghouse 7300 cabinet modules (50.59s)
- System Specific
  - NUMAC PRNM (November 1997)
    - Power Range Neutron Monitor
    - Oscillation Power Range Monitoring System
    - Various Installations

# Topical Report Scope - Historical

- Application Framework
  - Programmable Logic Device (PLD – e.g., FPGA & CPLD) Based
    - ALS (September 2013)
      - Wolf Creek MSFIS & Diablo Canyon PPS
  - Microprocessor Based (PLC –Programmable Logic Controllers)
    - MELTAC (under review)
      - US-APWR; NRR: Topical Report in acceptance review
    - Triconex (2001 & 2012)
      - Diablo Canyon PPS
    - Common Q (August 2000 – February 2013)
      - AP1000, Palo Verde CPCs, 50.59 (PAMS, Diesel Sequencer, Rod Position Indication)
    - TXS (May 2000)
      - EPR, Oconee RPS/ESPS Upgrade & 50.59
    - Eagle 21 (Early 1990s)
      - Various Westinghouse Plant Protection Systems (PPSs)
      - Predated Topical Report Process
      - Approved by Precedent

# Technical Regulatory Requirements

- 10 CFR 50.55a
  - (a)(1), Quality Standards
    - Now 50.54(jj) and 50.55(i)
  - (h), Incorporates by reference:
    - IEEE 279-1971, Protection System
    - IEEE 603-1991, Safety Systems
- 10 CFR 50 Appendix A
- 10 CFR 50.34(f) – TMI Action Items
- 10 CFR 50.62 – ATWS
- All requirements must be addressed

# Key Review Criteria (General)

- SRP
  - Addresses all regulatory requirements and guidance (at time of issuance)
  - Provides one set of review criteria for each aspect being reviewed
  - Matrix organization
    - By Function (e.g., Section 7.2, Reactor Trip, Section 7.3, Engineered Safety Features, ...)
    - By Topic (e.g., BTP 7-14, Development Process Reviews, BTP 7-21, Real Time performance)



# Key Review Criteria (Specific)

- Design Bases
- Single Failure Criteria
  - Implicitly requires redundancy and independence
- Quality
  - Specifications and standards
- Equipment Qualification
  - Performance (e.g., Response Time)
  - Environment
- Independence
  - Between Redundancies, Design Basis Events, & Other Systems
  - Electrical, Physical, Communication, Protection and Control
- Secure Development and Operational Environment (SDOE)
- Diversity and Defense-in-Depth (D3)

# How Criteria are Addressed

- Topical Reports (TR)
  - Digital Replacement Card
  - Application Framework
  - System Specific
- License Amendment Requests (LAR)
  - Everything not addressed by TR
  - Confirm TR bounds Plant design basis

# Criteria Evaluated in Topical Reports (TR)

	Digital Card	System	Application Framework	LAR
<b>Design Basis &amp; Qualification</b>	<b>Plant Specific:</b> Each TR addresses design basis and qualification requirements that are believed to encompass all future applications.			Ensure application is bounded by TR
<b>Single Failure</b>	FMEA	Reviewed	FMEA	Reviewed
<b>Quality</b>	Each item within the scope of review is reviewed against SRP criteria for quality.			
<b>Independence</b>	Mostly NA	Information	Communication Mechanism	Physical & Information
<b>Performance Requirements</b>	Component	System	Component	Design Basis
<b>SDOE</b>	Control of physical access to equipment is plant specific; however, I&C technical review ensure there is no unwanted, undocumented or unneeded code.			
<b>D3</b>	<b>Plant Specific:</b> However, each application may try to eliminate CCF from consideration by inherent diversity or testing.			

# Acronyms

ALS – Advanced Logic Systems	NUMAC – Nuclear Measurement Analysis and Control
ASIC – Application Specific Integrated Circuit	NuPAC – Nuclear Protection and Control
CPLD – Complex Programmable Logic Device	PAMS – Post Accident Monitoring System
D3 - Diversity and Defense-in-Depth	PLD – Programmable Logic Device
EPR – Evolutionary Power Reactor	PPS – Plant Protection System
FMEA – Failure Modes and Effects Analysis	PRNM – Power Range Nuclear Monitor
FPGA – Field Programmable Gate Array	SDOE – Secure Development and Operational Environment
HFC – HF Controls	SRP – Standard Review Plan, NUREG-0800
ISG – Interim Staff Guidance	TR – Topical Report
LIC – Licensing	TXS - Teleperm XS
MSFIS – Main Steam and Feedwater Isolation System	US-APWR - US Advanced Pressurized Water Reactor
NPP – Nuclear Power Plant	
NRC – Nuclear Regulatory Commission	
NRR – Nuclear Reactor Regulation	



# Rolls-Royce SPINLINE 3 Digital Platform

Rossnyev Alvarado (NRC/NRR/EICB)

April 24, 2015

# Outline

- Background
- Description
- Key Review Criteria
- Application

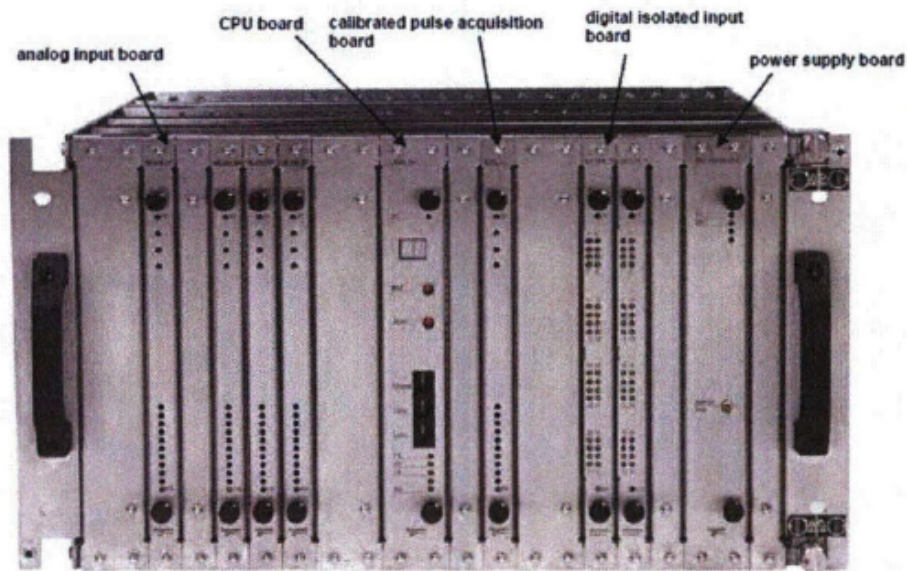
# Background

- The Safety Evaluation of Rolls-Royce SPINLINE 3 Platform was issued in September 2014
- This platform resulted from the evolution of previous Rolls-Royce I&C systems
- This platform was designed, implemented, and qualified in compliance with European Nuclear and Quality Standards (e.g., IEC-880)
- The SPINLINE 3 platform has been qualified and accepted for use in safety related applications for U.S. Nuclear Power Plants

# Description

- Based on microprocessor technology
- A modular digital system that can be configured in different sizes according to the application
- Components: interface boards, daughter or main boards, power supply modules, communication modules, operator interfaces, and a chassis with a backplane board

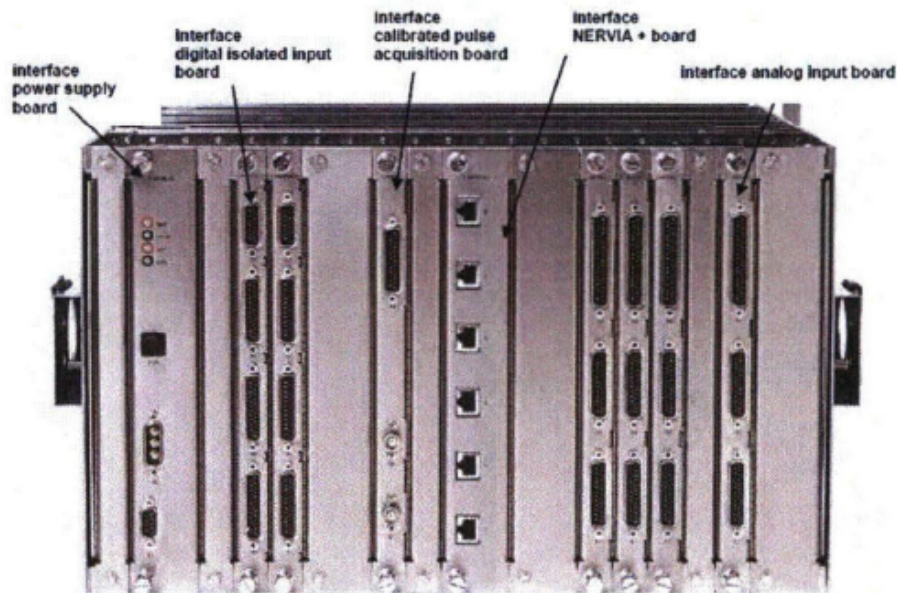




# SPINLINE 3 Chassis

Main or Daughter boards

Front View



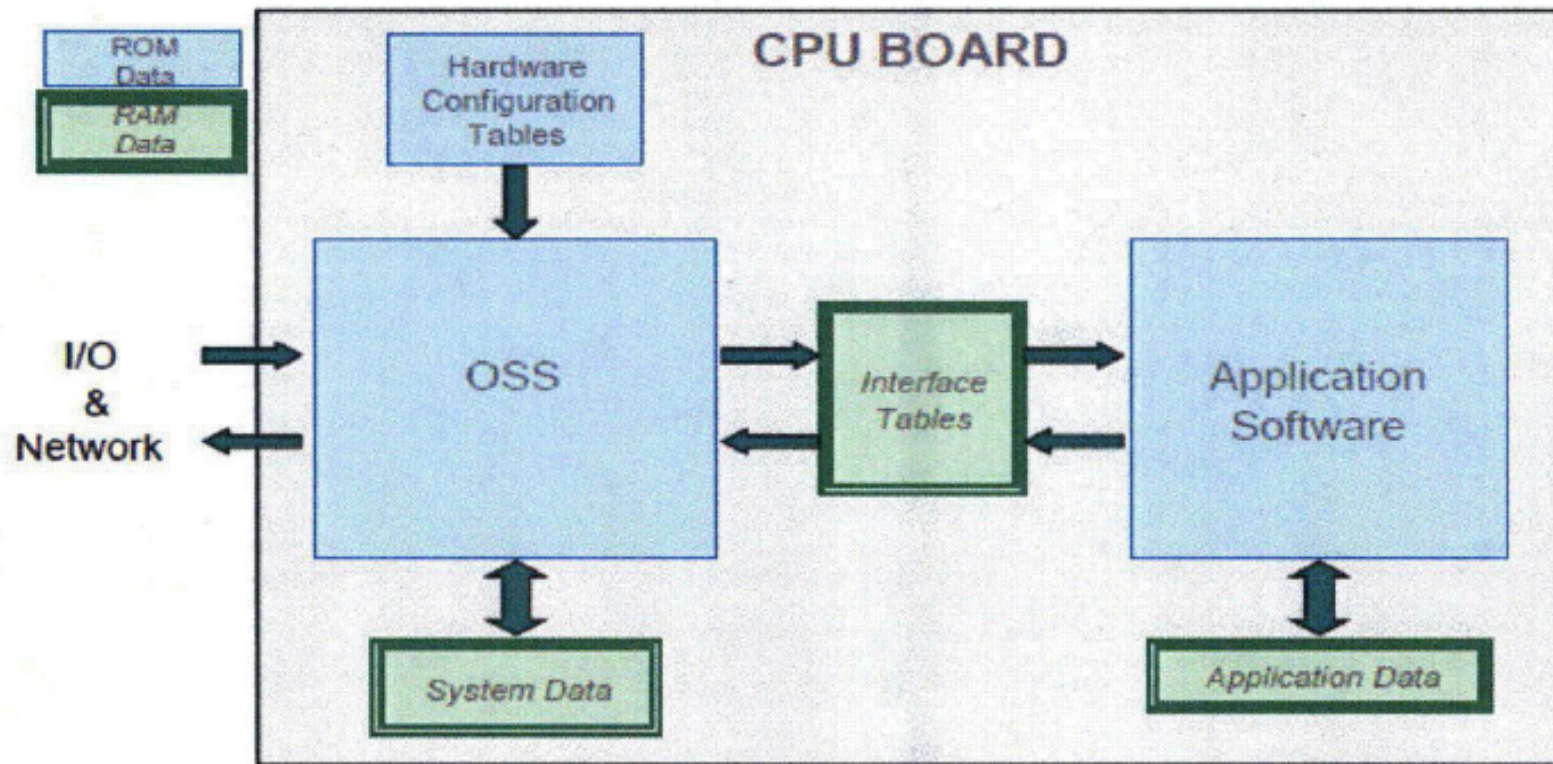
Interface boards

Rear View

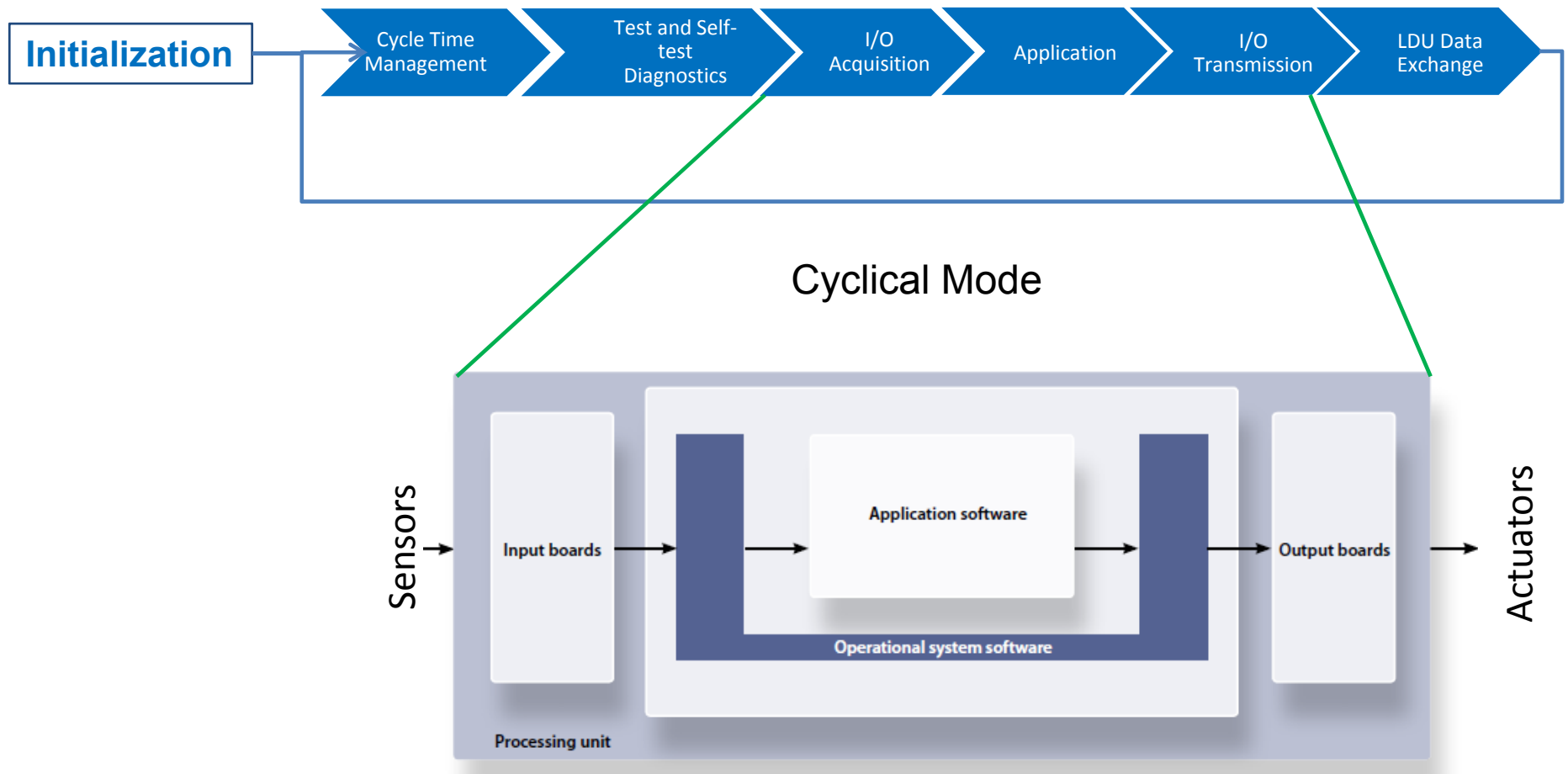
# SPINLINE 3 Components

Component ID	Name	Type
8PT100	RTD board	Conditioning
I.8PT100 Interface board		Interface
16E.ANA ISO	Analog input board	Main
I.16EANA Interface board		Interface
32ETOR TI SR	Digital isolated input board	Main
I.32ETOR TI interface board		Interface
ICTO	Calibrated pulse acquisition board	Main
I.ICTO interface board		Interface
32ACT	Actuator drive board (Discrete output)	Main
I.32ACT interface board		Interface
6SANA ISO	Analog output board	Main
I.6SANA interface board		Interface
UC25 N+	CPU board	Main
NERVIA+ board	NERVIA+ communication board	Main
I.NERVIA+ interface board		Interface
ALIM 48V/5V-24V	Power supply board	Main
I.ALIM 48 interface board		Interface

# Software Architecture and Configuration



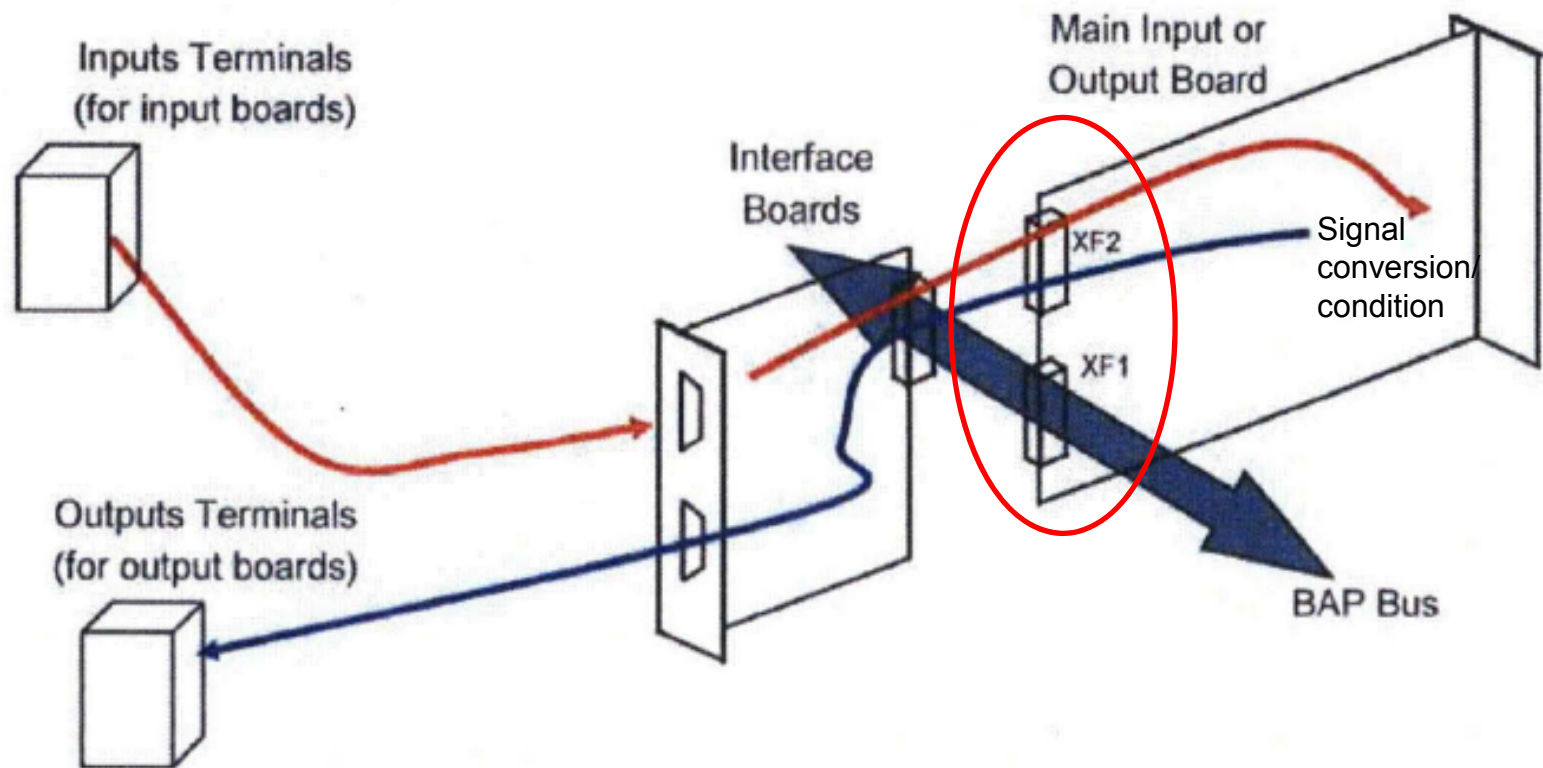
# System Operation



# System Communication

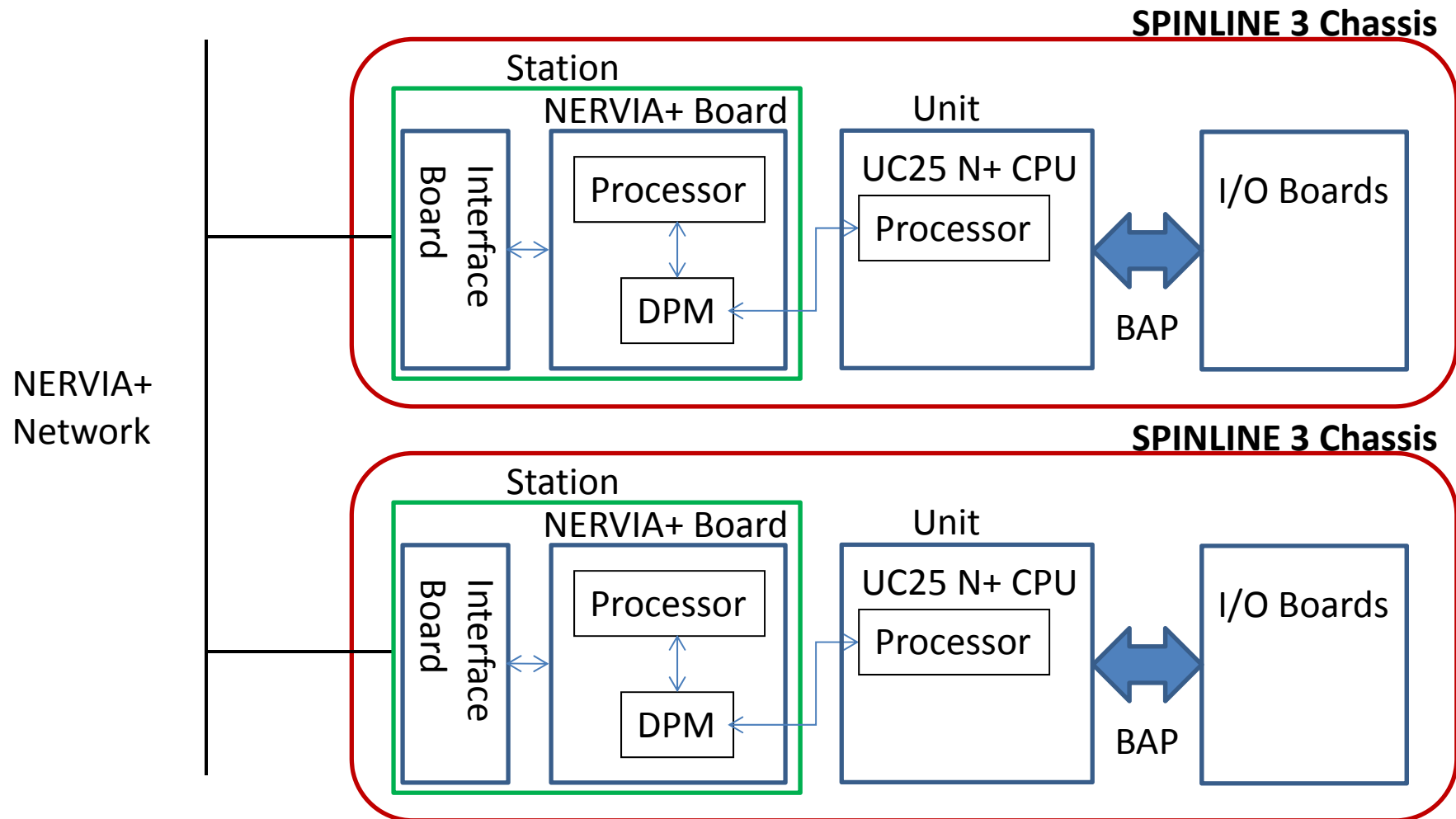
- Backplane (BAP) Bus
- Intra-Divisional Communication (NERVIA+ Network)
- Passive Communications, Hubs, and Converters
- Serial Links

# Backplane Bus Communication





# Intra-Divisional Communication



# Key Review Criteria

- Independence
- Redundancy(Application Specific)
- Diversity (Application Specific)
- Predictability and Repeatability
- Secure Development and Operational Environment

The TR did not address specific applications or establish a definitive system architecture. Therefore, the evaluation against the review criteria was limited to consideration of the means provided within the platform.



# Independence

- The design permits Non-1E connections to the analog and discrete output modules, mechanical output relay interfaces, and the NERVIA network
- SPINLINE 3 platform met the criteria of IEEE Std. 384-1981 and Section 6.3.6 of EPRI TR-107330 for electrical independence
- SPINLINE 3 platform provides digital communication design features that can support independence between an SPINLINE 3 platform-based safety system and other interfacing systems
- Although the system includes features for one-way communication to non-1E components, the TR did not provide enough information to evaluate communication between safety and non-safety components

# Predictability and Repeatability

- Software runs sequentially, deterministically, and periodically
- System's cycle time is fixed and functions are executed in the same order
- The system's cycle time performance is deterministic and defined during the system design
- The Unit's processor is independent of the Station's processor
- Data exchange between the Unit and the Station is via the DPM
- Data exchange between Stations and Units is not synchronized
- The system uses the BAP bus for data exchange with I/O modules
- NERVIA network is a time-based bus protocol
- The actual response time of an SPINLINE 3 platform-based system will be determined by its overall configuration

# Secure Development and Operational Environment

- The SPINLINE 3 OSS and plant-specific application software for a SPINLINE 3-based system are developed in-house by Rolls-Royce (France)
- The manufacturer developed the SPINLINE 3 platform under a secure environment which controls the access to the facility, the facility LAN, the development environment, quality records, and the configuration management system
- The software cannot be modified on-line by operators
- The SPINLINE 3 platform includes design attributes and features that a licensee could apply and credit to demonstrate protection against undesirable behavior of connected systems and the prevention of inadvertent access
- The NRC staff determined a secure development environment had been established for the SPINLINE 3 platform that is consistent with the regulatory positions found in RG 1.152, Revision 3

# Application

- Can be used in protection systems, such as RPS, NIS, Process Instrumentation System, ESFAS, and Diesel Load Sequencing System
- None installed in the US
- Installed in more than 50 PWR in France and VVER nuclear reactors all over the world
  - In 2011 EdF selected SPINLINE 3 to replace the RPS of the 1300MW French nuclear reactors (20 units).
- Used by 8 Neutron Instrumentation Systems in operation in China. Also to be installed as the NIS of 20 reactor units currently under construction.

# Acronyms

BAP – backplane

CPLD – complex programmable logic device

CPU – central processing unit

DPM – dual port memory

EdF - Électricité de France

ESFAS – engineering safety actuation system

EPRI – electric power research institute

FPGA – field programmable gate array

I/O – input/output

NIS – neutron instrumentation system

OSS – operating system software

PWR – Power Water Reactor

RAM – random-access memory

RG – regulatory guide

RPS – reactor protection system

ROM – read-only memory

RTD – resistance temperature detector

SR – safety related

NSR – non-safety related

TR – topical report

VVR – water-water energetic reactor



Westinghouse SSPS Board  
Replacement Licensing Summary Report  
WCAP-17867-P-A Rev. 1

Norbert Carte (NRC/NRR/EICB)

April 24, 2015

# Outline

- Background - SSPS
  - Solid State Protection System (SSPS) History
  - SSPS Cabinets
  - List of Circuit Boards
  - SSPS in Context
- Description – CPLD-Based SSPS Topical Report
  - Timeline: Regulatory Positions for PLDs
  - Summary Description
- Key Review Criteria

# SSPS History

- RTS & ESFAS Voting
  - Relay Voting (First Westinghouse plants)
    - 14 Cabinets
    - 4 hour per train test time
    - Monitoring Information – 1,000 Conductors
    - 750 Relays with 4000 contacts
- January 1971 – Westinghouse SSPS TR
  - Solid State Voting
    - 6 Cabinets (2 Trains – 3 Cabinets each)
      - Input, Logic, Relay
    - 10 minute per train test time
    - Monitoring Information – 42 conductors (Multiplexed)
- March 1974 – SSPS TR Approved



# SSPS Cabinets

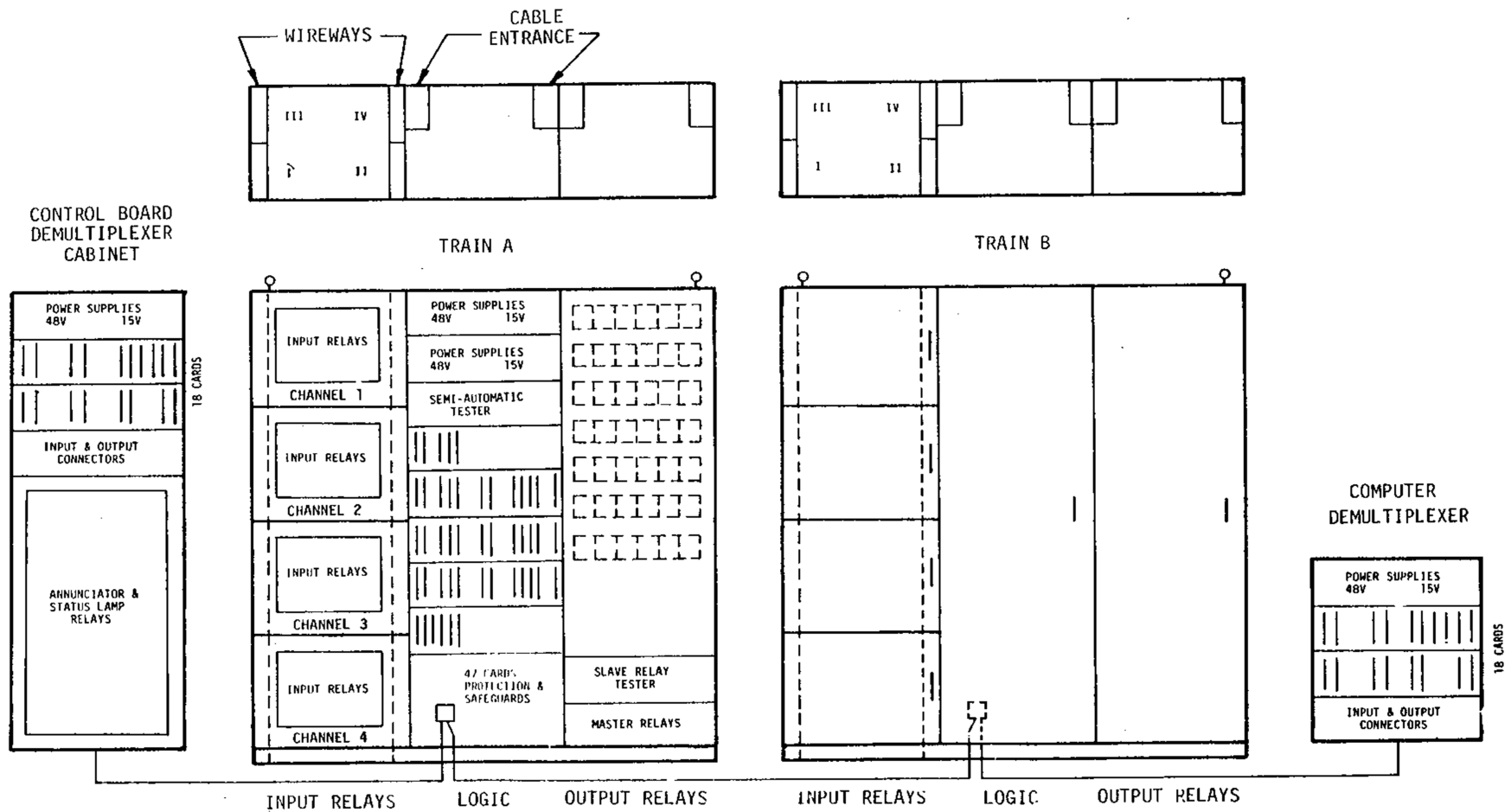


Figure 2. Solid State Protection System Equipment Layout

# List of Circuit Boards

ULB – Universal Logic Board (voting)

SGD – Safeguard Driver (drives ESF relays)

UVD – Undervoltage Driver (powers trip breakers)

SAT – Semi-Automatic Tester (surveillance testing)

CCB – Clock Counter Board (test & status indication)

DEC – Decoded (decodes clock counter for status indication)

MEM – Memory (non-safety status indication)

ISO – Isolation (electrical isolation)

# SSPS in Context

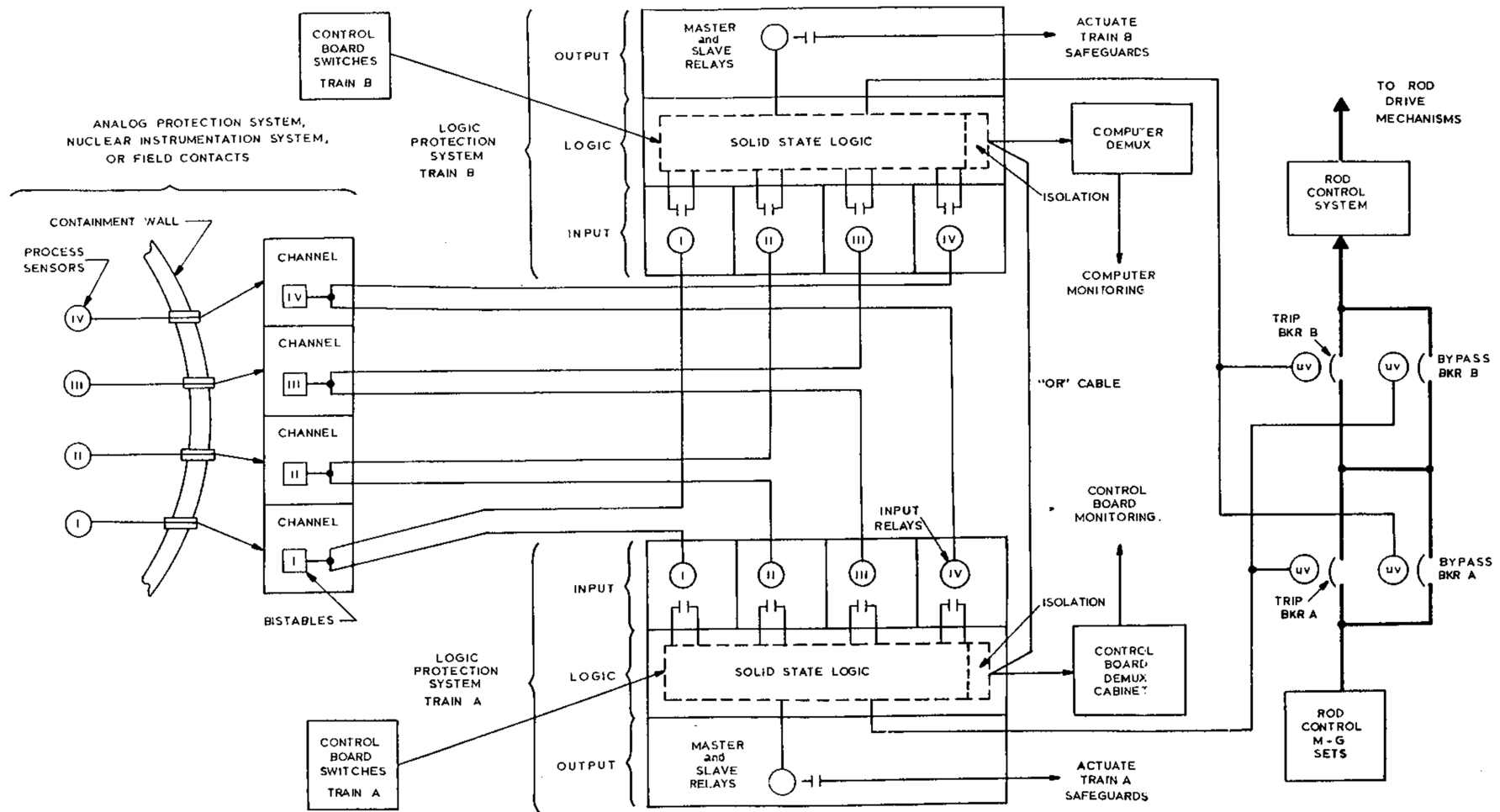
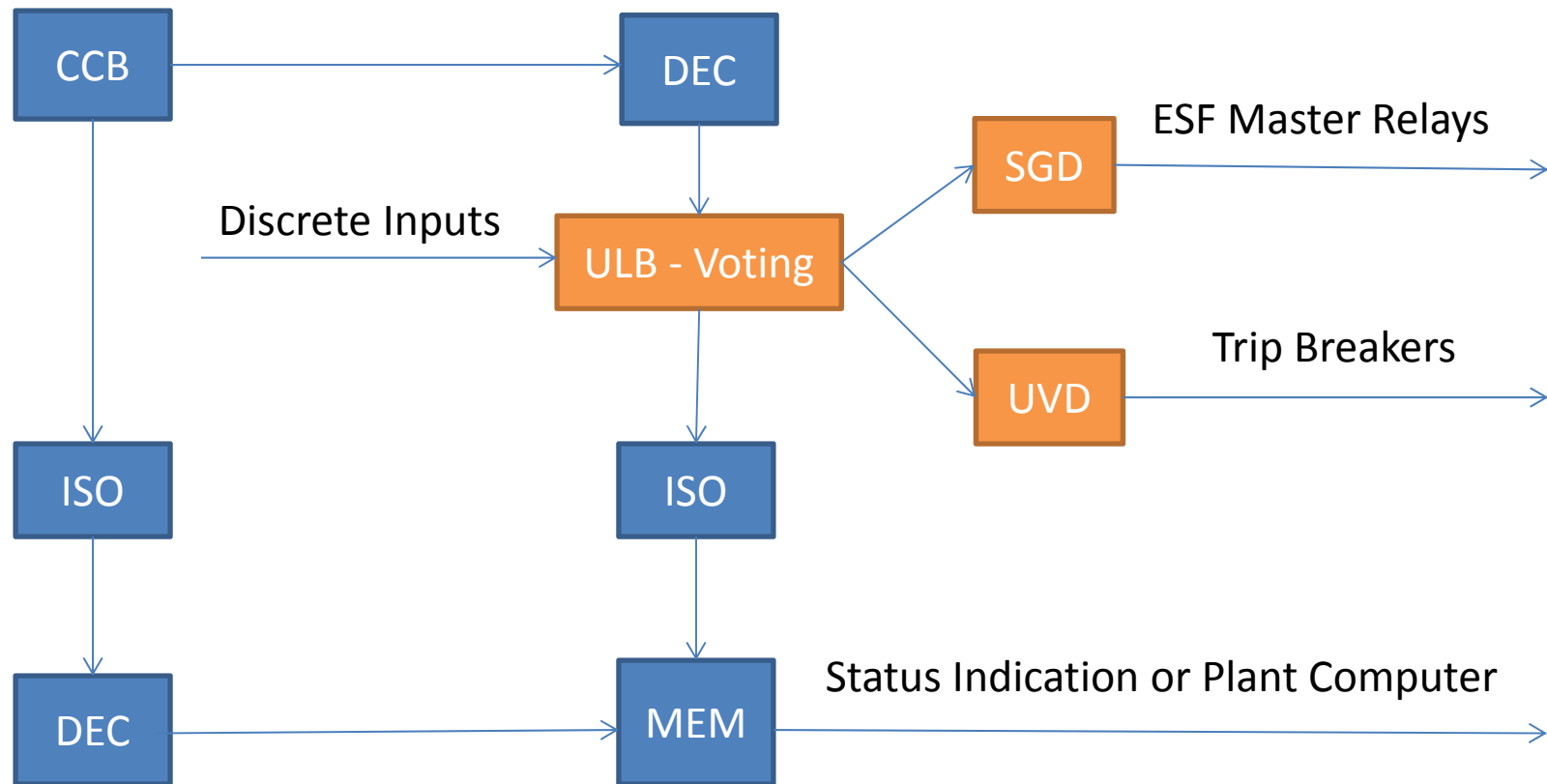
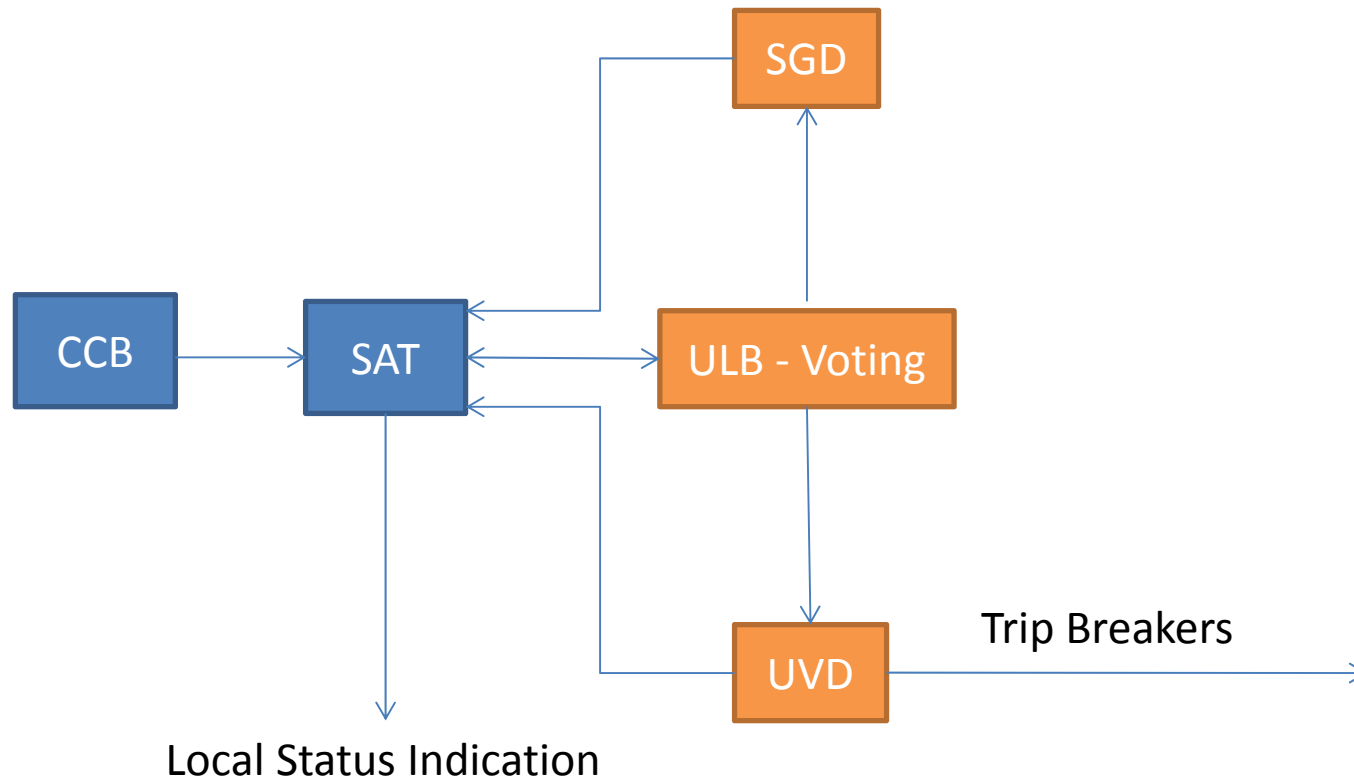


Figure 1. Solid State Logic Protection System Block Diagram

# SSPS Cards Used When Operating



# SSPS Cards Used When Testing



# Timeline: Regulatory Positions for PLDs

- February 2001 – ABRM TR Approved
- April 2002 – CPLD-Based SSPS Card TR Funded
- November 2006 – Industry Met with Commission
- March 2007 → March 2009 – Wolf Creek MFSIS Review
- September 2007 – ISG-04 Rev. 0 Issued
- July 2010 → September 2013 – ALS Topical Report under Review
- February 2013 – CDBI Inspection at Harris
  - Four meeting regarding condition
  - Decided topical report was most efficient approach
- August 2013 – Violation issued to Harris
- February 2014 – CPLD-Based SSPS Card TR docketed

# Summary Description

- Digital Replacement Cards
  - Old Cards used MHTL Logic Chips (No longer available)
  - New Cards perform identical functions
- 8 New Cards
  - 7 Installed in Existing SSPS Racks (ULB, SGD, UVD, SAT, CCB, DEC, & ISO)
  - 1 Installed in Non-safety demultiplexer cabinets (MEM)
  - 3 have CPLDs and they process safety signals
    - Universal Logic Board (ULB)
    - Safeguards Driver Board (SGD)
    - Under Voltage Driver Board (UVD)

# Key Review Criteria

- Design Basis
- Single Failure
- Quality
- Equipment Qualification
  - Performance
    - CPLD based
    - No Interrupts
    - Aliveness checks - LEDs
- Independence
- Secure Development and Operational Environment (SDOE)
- Diversity and Defense-in-Depth



# Questions?

# Backup Slides

# PLDs vs. Microprocessors

- Microprocessors
  - Share resources
  - Watchdog Pulse process is last in big loop
- Programmable Logic Devices (PLDs)
  - Implement microprocessor
    - Watchdog may be appropriate
  - Highly parallel
    - Watchdog does not provide much assurance

# ULB – Universal Logic Board

- Three Discrete Voter Logic Circuits
  - One 4-input: two out of four
  - Two 3-input: two out of three
- Six Test Points
  - Output of each voter (3)
  - Address inputs to multiplex circuits (3)
- Enhancements
  - Card edge LEDs
  - Redundant components to address single point vulnerabilities
  - Self-test CPLD

# SGD – Safeguards Driver Board

- 8 drivers to actuate ESF master relays
  - Include Reset input
- Enhancements
  - Card edge LEDs
  - Redundant components to address single point vulnerabilities
  - Self-test CPLD

# UVD – Undervoltage Driver Board

- “Ors” up to 22 inputs (ULB voted outputs)
- Single Driver, maintain undervoltage coil of reactor trip breakers
- Enhancements
  - Card edge LEDs
  - Redundant components to address single point vulnerabilities
  - Self-test CPLD
  - Short Circuit protection

# CCB – Clock Counter Board

- Inputs to SAT board
- Inputs to multiplexing for status indication
- Enhancements
  - Improved enable signal
  - Card edge LEDs
  - Redundant components to address single point vulnerabilities

# SAT – Semi-Automatic Tester

- Monitors board health
  - Cabinet self-health
  - Test switch position
  - Card status condition
- For Surveillance testing of ULBs
  - Inputs from Clock Counter board
  - Generate test sequence
  - Evaluate test results
- Enhancements
  - Card edge LEDs
  - Redundant components to address single point vulnerabilities



# DEC – Decoder Board

- Decodes clock counter bits to address signals
- Enhancements
  - Manual test feature
  - Card edge LEDs
  - Redundant components to address single point vulnerabilities

# MEM – non-safety Memory

- Receives multiplexed data from ULB
- Outputs data to:
  - Control Board & Plant Computer
- Enhancements
  - Card edge LEDs
  - Redundant components to address single point vulnerabilities

# ISO – Isolation Board

- Electrical Isolation
  - Between Redundancies
    - Required to ensure coordination of plant computer and main control board information
  - Between SSPS & Demultiplexer Cabinets
    - Between ULBs and MEMs
- No CPLDs
- Enhancements
  - Redundant components
  - Redundant error indication
  - Status indications
  - Test points

# Acronyms

ABRM – ASIC Based Replacement Module	ULB – Universal Logic Board
ASIC – Application Specific Integrated Circuit	SGD – Safeguard Driver
CPLD – Complex Programmable Logic Device	UVD – Undervoltage Driver
FPGA – Field Programmable Gate Array	SAT – Semi-Automatic Tester
ISG – Interim Staff Guidance	CCB – Clock Counter Board
NPP – Nuclear Power Plant	DEC – Decoded
NRC – Nuclear Regulatory Commission	MEM – Memory
NRR – Nuclear Reactor Regulation	ISO - Isolation
NuPAC – Nuclear Protection and Control	
PAMS – Post Accident Monitoring System	
PLD – Programmable Logic Device	
PPS – Plant Protection System	
SRP – Standard Review Plan, NUREG-0800	
TR – Topical Report	



# HFC-6000

## Safety System Platform

Samir Darbali (NRC/NRR/EICB)

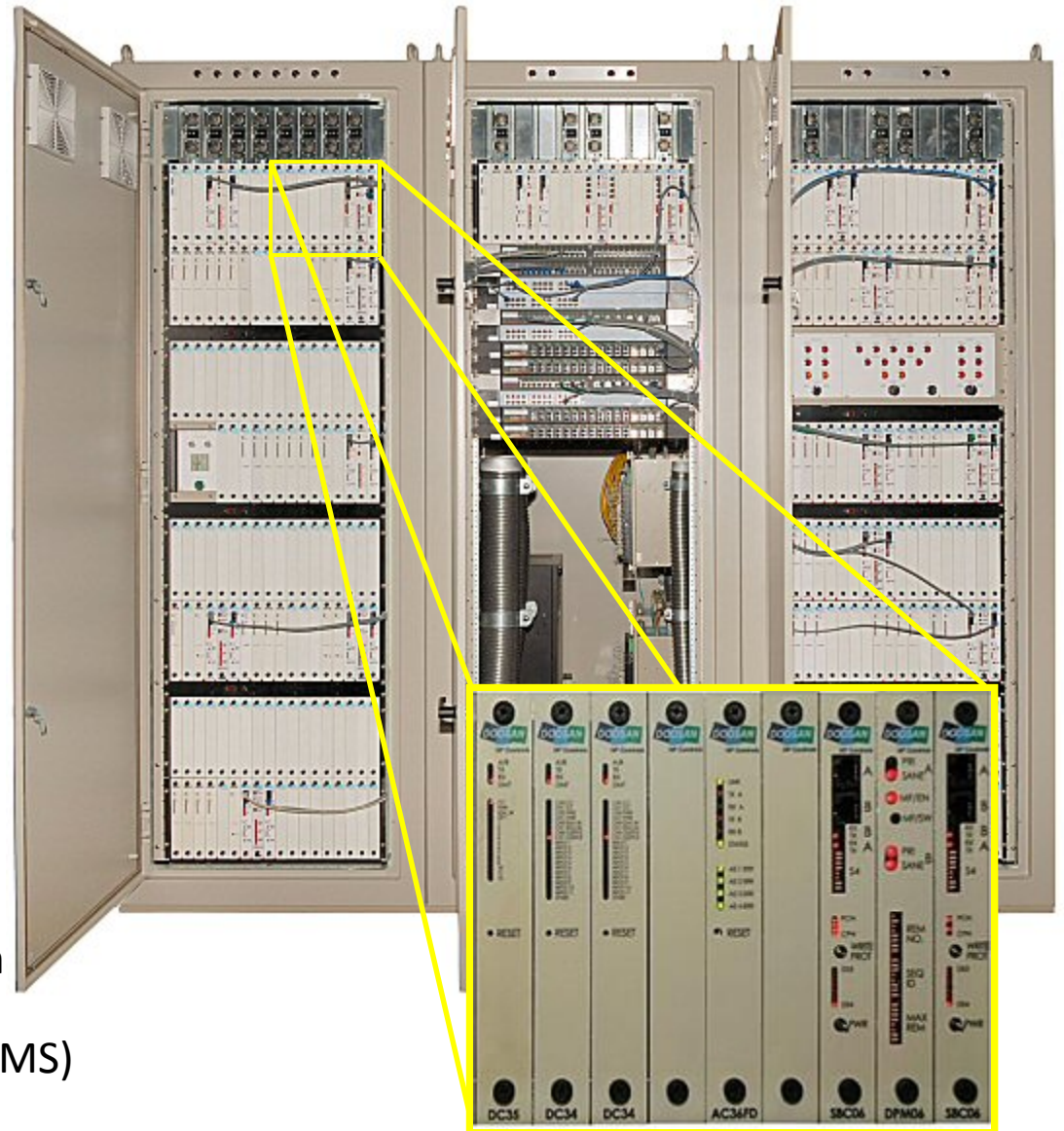
April 24, 2015

# Outline

- Background
- Description
- Key Regulatory Criteria
- Amendments to the HFC-6000 Topical Report

# HFC-6000 Background

- HFC-6000 is a modular, rack mounted platform that is housed in cabinets
  - Developed by HF Controls (HFC) Corporation, owned by Doosan Heavy Industries & Construction Company
  - Based on product lines developed by Forney Engineering Company dating back to the 1980s
- Applications could include:
  - reactor protection system (RPS)
  - engineered safety features actuation system (ESFAS) functions
  - post accident monitoring system (PAMS)



# HFC-6000 Background

- Topical Report (TR) submitted for review in March, 2008
- Technical Review contracted to Oak Ridge National Lab
  - NRC Technical Monitoring of contract performed by NRR/DE/EICB
- Safety Evaluation (SE) issued in April, 2011
  - SE included six Generic Open Items related to Equipment Qualification Testing
- Operational history:
  - HFC-6000 platform-based systems currently installed in 24 South Korean NPP Units
  - Not installed in any US NPPs
  - No license amendment requests for installation in US NPPs



# HFC-6000 Platform – Topical Report Scope

- Application Framework
- Redundant (Microprocessor-based) Controllers
  - Operating System Software
- Dual Ported Memory (DPM)
- Input / Output Modules (Analog & Digital)
- Redundant Power Supplies
- Equipment included in the TR:

<b>HFC-SBC06</b> (Controller Module)	<b>HFC-DI16I</b> (Digital Input Module)
<b>HFC-DPM06</b> (Dual-Ported Memory)	<b>HFC-DO8J</b> (Relay Digital Output Module)
<b>HML 601-5</b> (24 V Power Supply)	<b>HFC-DC33</b> (Digital Control Module for MOVs)
<b>HML 601-8</b> (48 V Power Supply)	<b>HFC-DC34</b> (Digital Control Module for EOBs)
<b>HFC-BPC01-19</b> (Controller Backplane)	<b>HFC-AI8M</b> (RTD Input Module)
<b>HFC-BPE01-19</b> (Expansion Backplane)	<b>HFC-AI16F</b> (Analog Input Module)
<b>HFC-AI4K</b> (Pulse Input Module)	<b>HFC-AO8F</b> (Analog Output Module)
<b>HFC-ILR06</b> (I/O Link Fiber-Optics Repeater/Terminator)	

MOV - Motor Operated Valve

EOB - Electrically operated breaker

RTD - Resistance temperature detector

# Out of Scope of the Topical Report

- External Communications
  - Between HFC-6000 Channels
  - Between HFC-6000 platform and other systems
- Human-Machine Interface
- Displays
- Any Application-Specific Software
- Multi-Channel Operation (i.e., Voting Mechanism)

# Safety System Architecture Example Based on the HFC-6000 Platform

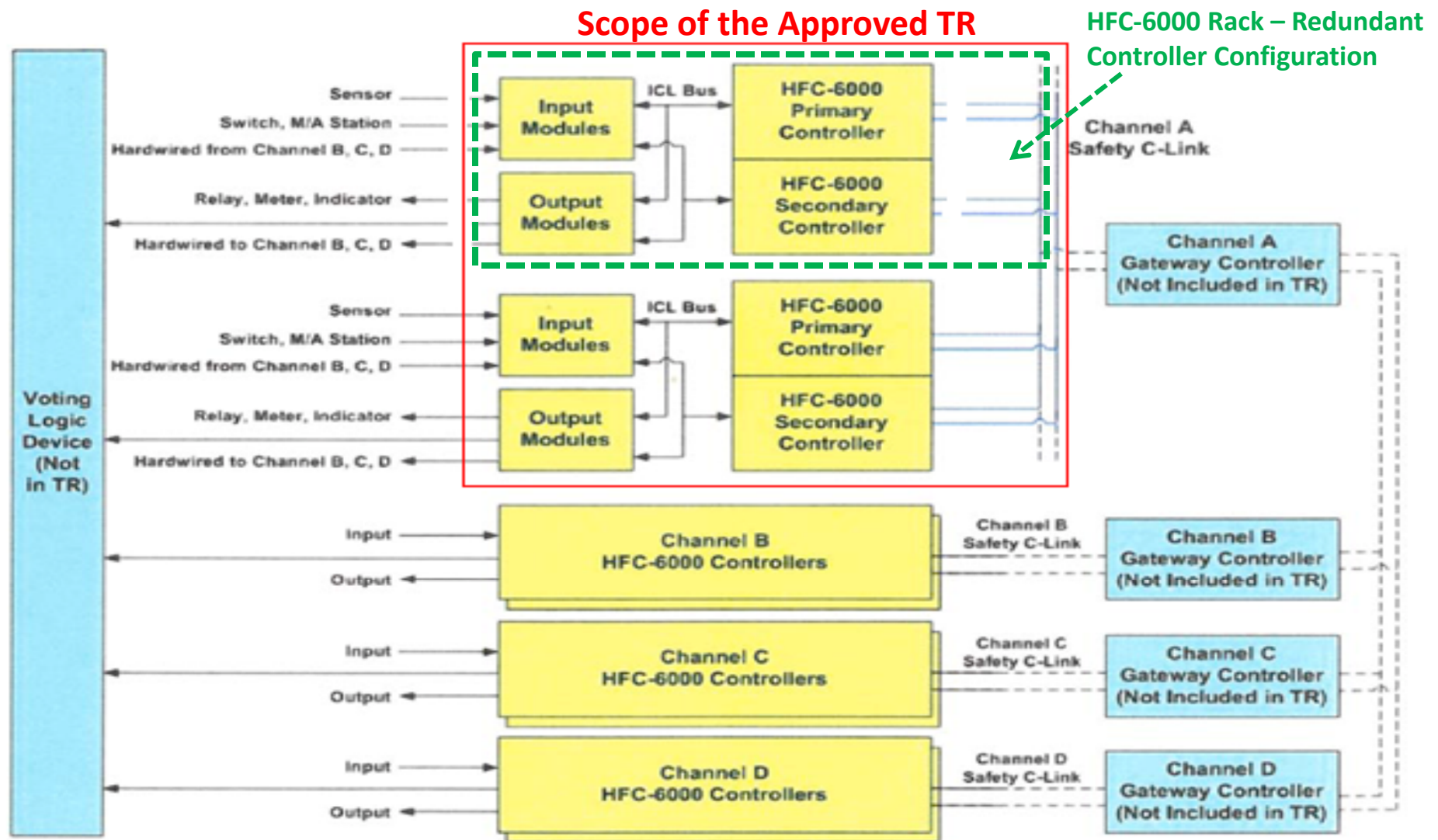
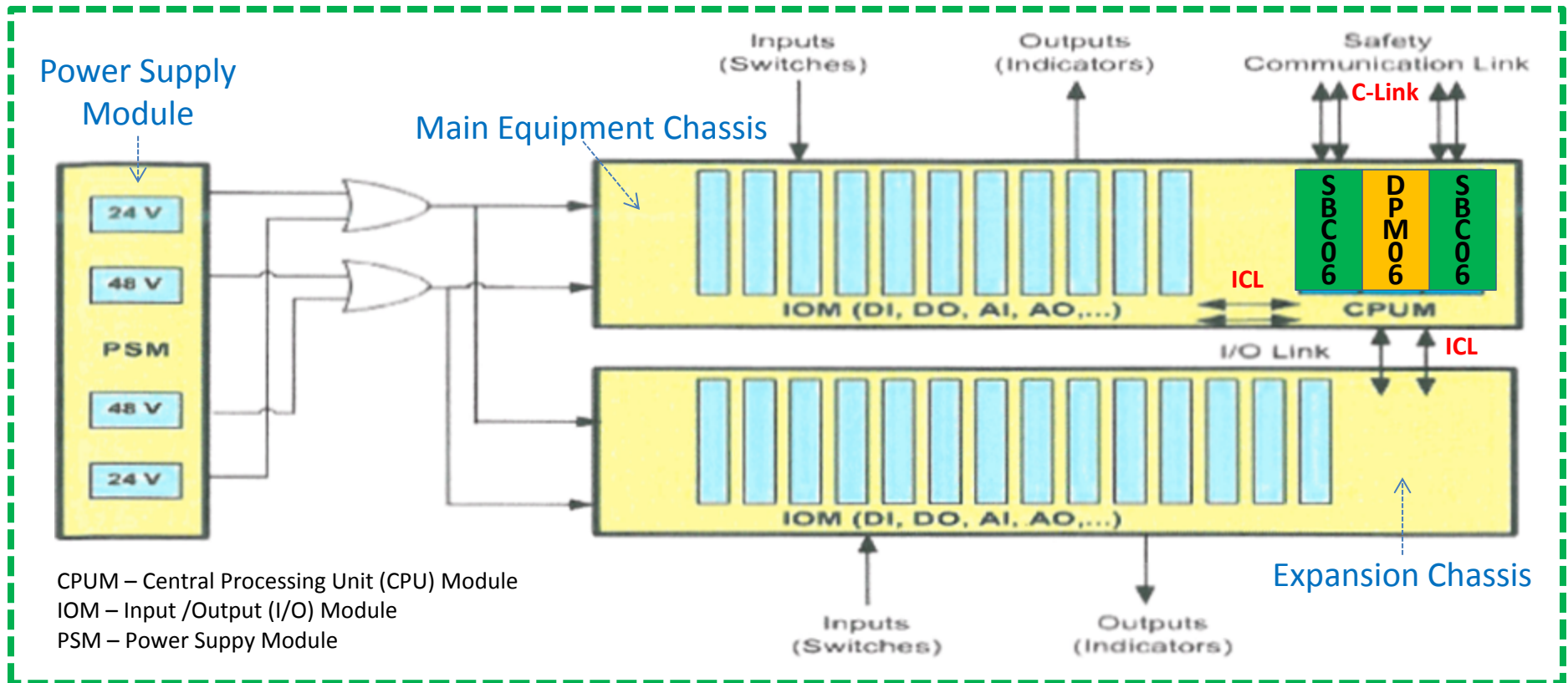


Figure 1 of HFC-6000 SE (ML110831017)

# Hardware Arrangement for the HFC-6000 Platform

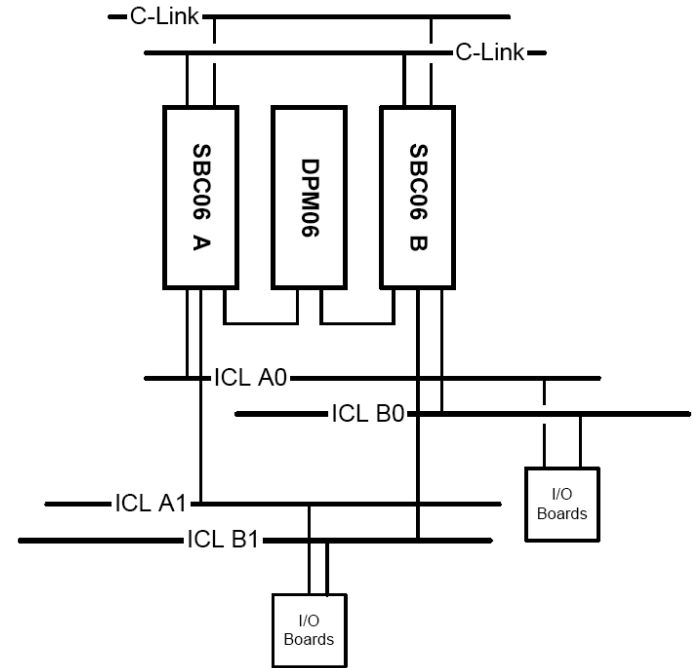


- CPUM and IOMs (up to 11) are housed in the main equipment chassis
- Additional IOMs (up to 14) implemented in an expansion chassis
- PSMs in a separate power rack that provides redundant 24 VDC and 48 VDC power via separate backplane traces in each equipment chassis

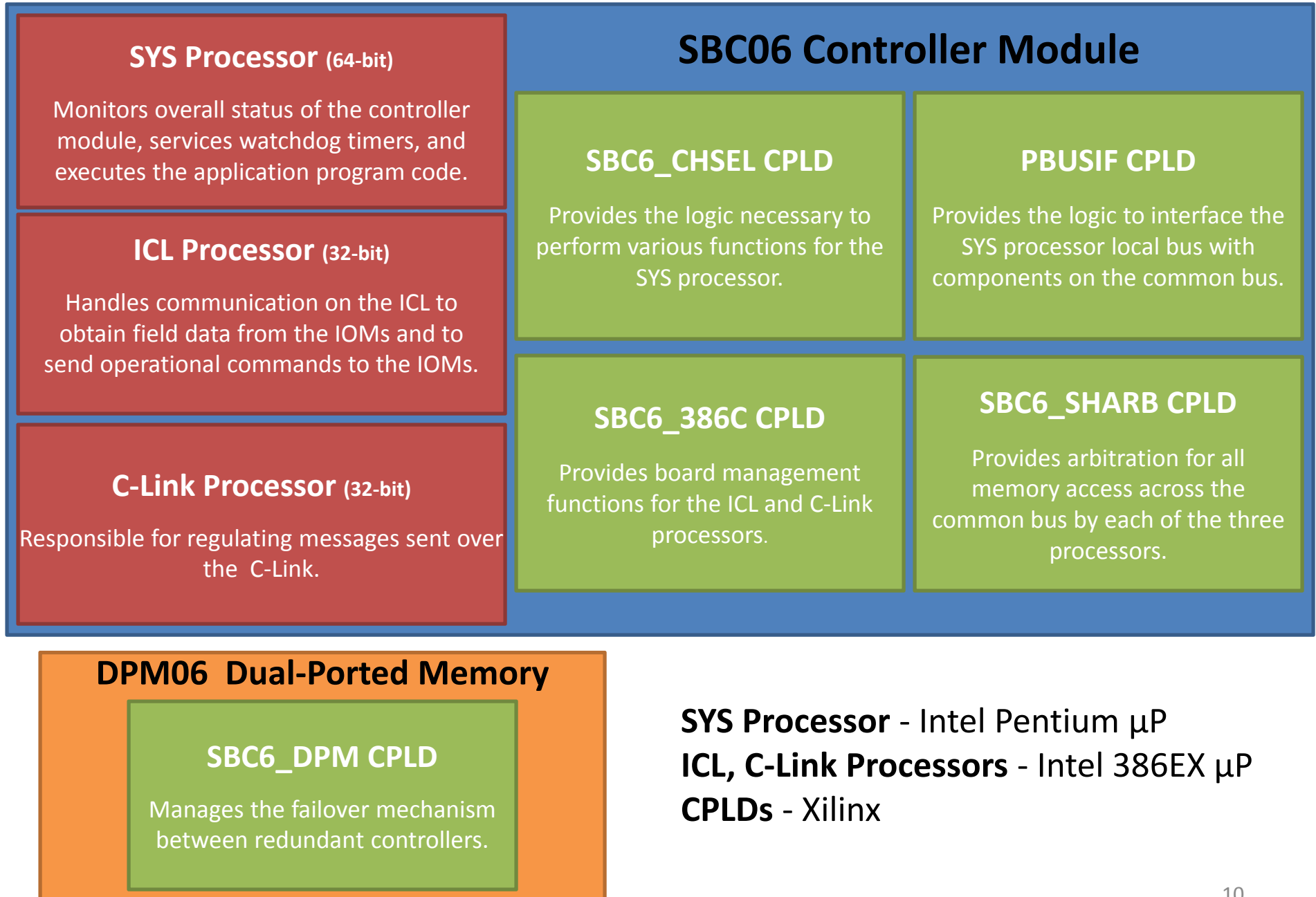
# Communications

The HFC-6000 platform provides two communication interfaces:

- **Intra-Channel Communication link (C-Link)** - Transfers information among safety controllers (SBC06) within a channel to provide status information and operational data. The C-Link is a redundant Ethernet-based network employing a proprietary token-passing protocol to implement deterministic communications.
- **Backplane interconnections/ Intercommunication link (ICL)** - Supports transmission of data between the CPUM and IOMs to allow periodic polling to update I/O data. The ICL bus implements a proprietary deterministic protocol based on a poll/response approach to communication.



# SBC06 and DPM06 Modules





# SBC06 and DPM06 Module Architectures

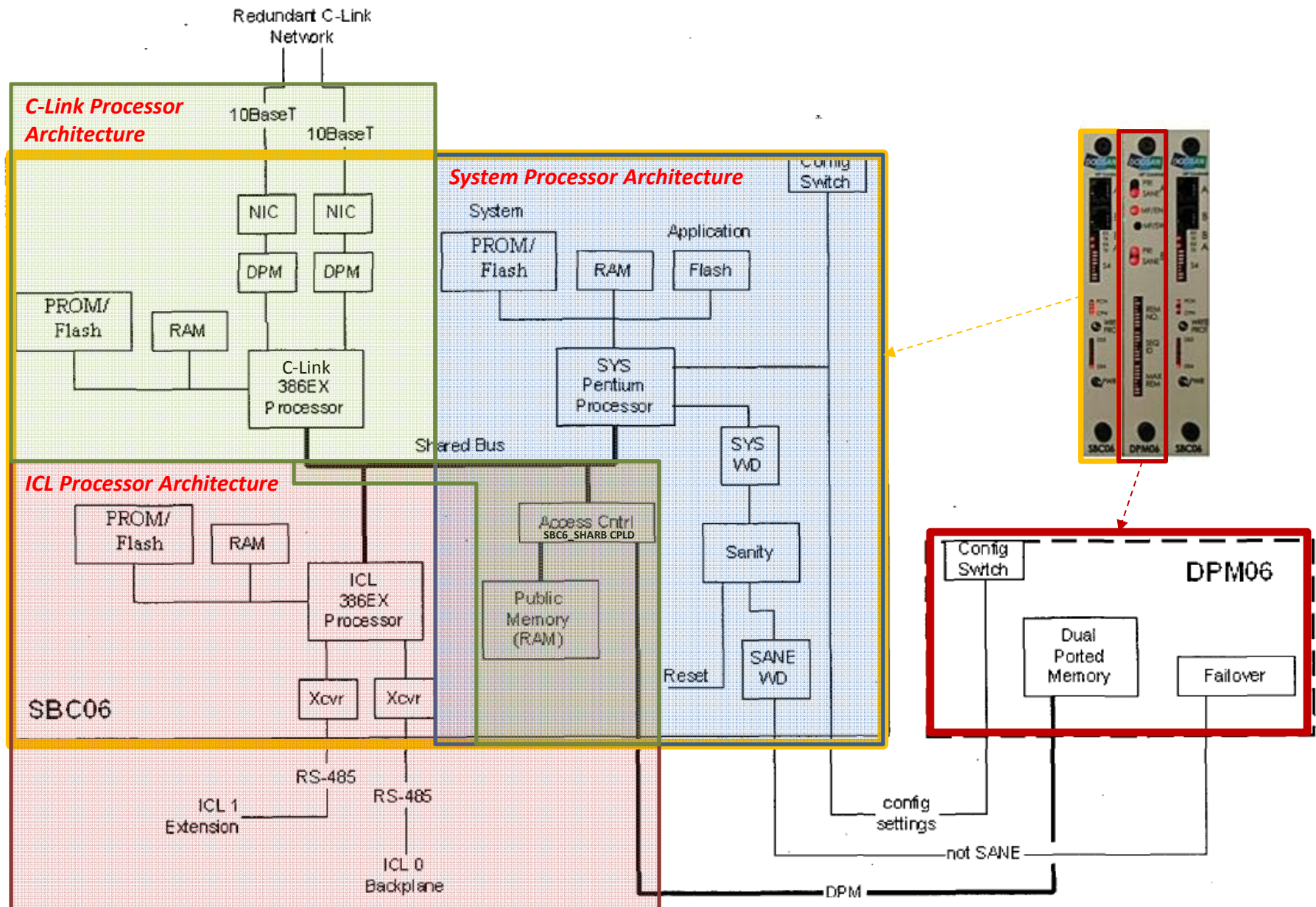
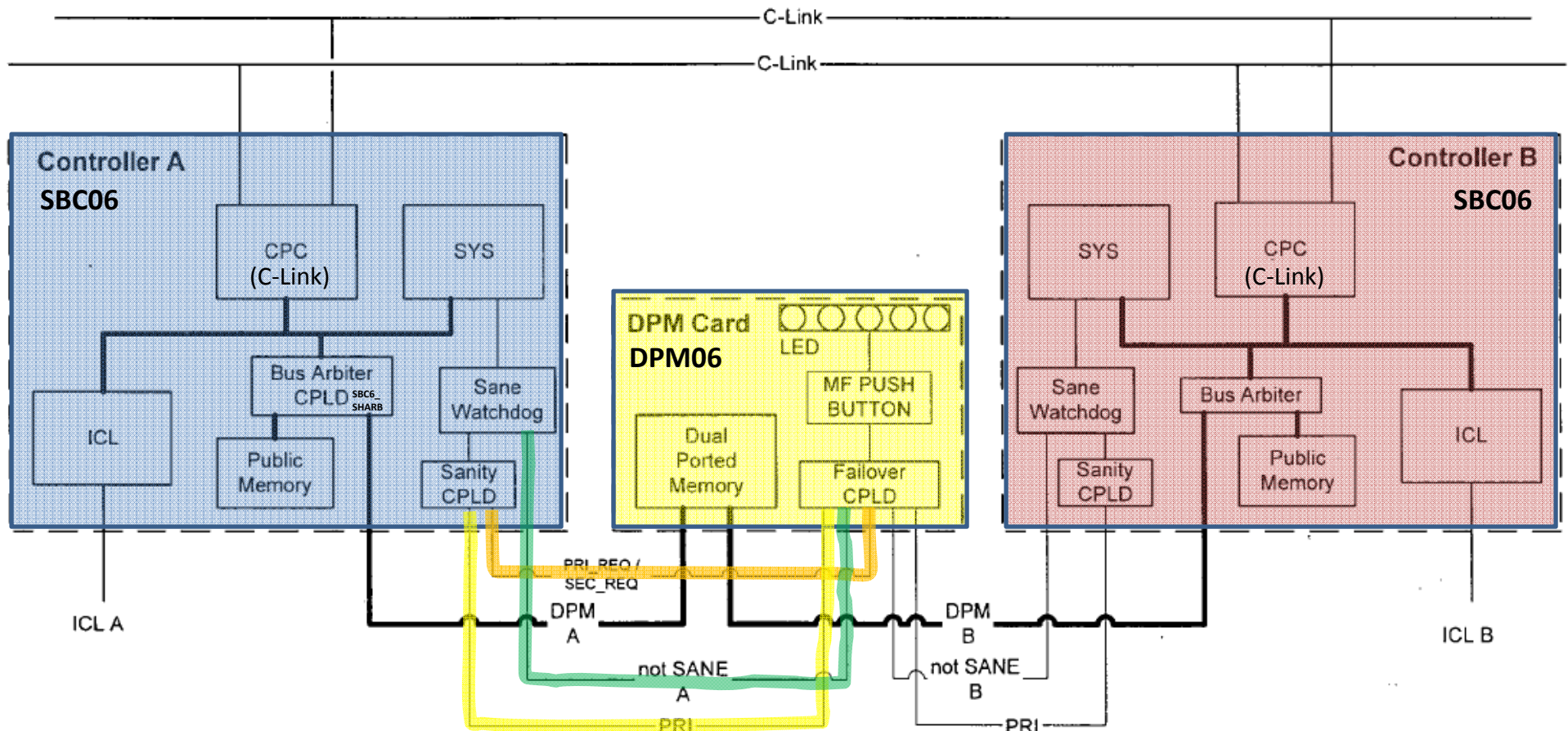


Figure 5 of SBC06-DPM06 Design Specification (ML091480158)

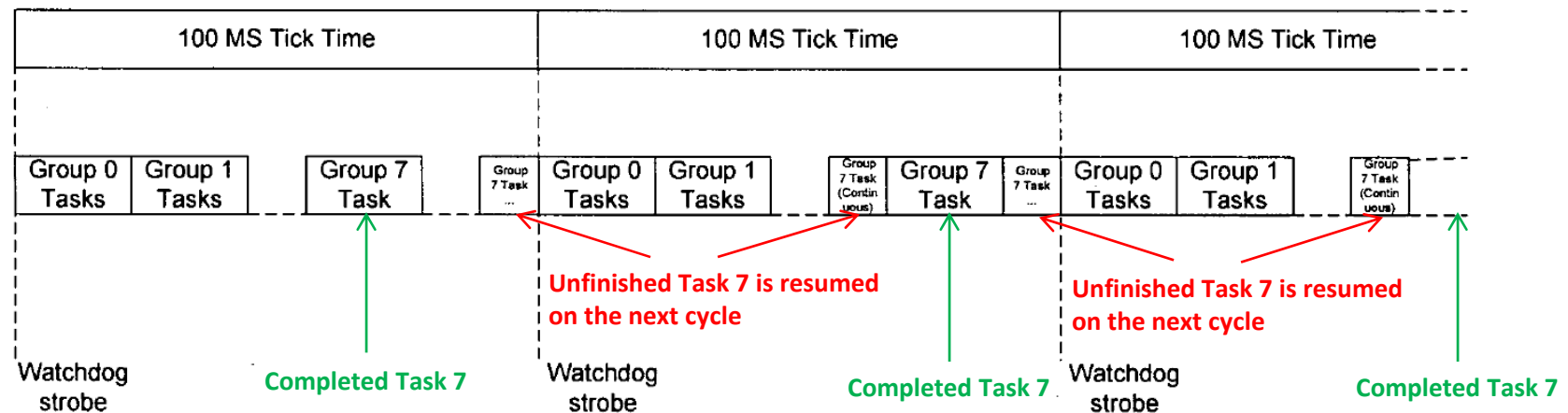
# Redundancy and Failover



- Logic to determine controller operation mode: Primary or Secondary
- Controller failure detection mechanism
- Failover mechanism on failure of primary controller
- Mechanism to ensure a smooth transition of control during failover
- Manual maintenance failover



# Execution Sequence for Tasks in the SYS Processor



- Operating cycle of the main (SYS) processor is 100 ms
- Task groups 0-6 are diagnostic tasks (nominally 10 ms)
- Task 7 is the application program
  - A check is performed to ensure that Task 7 is fully executed at least once each cycle
  - If not, a system alarm flag is set for fault identification and handling
  - Task 7 may be executed more than once, in a continuous loop, until the end of the cycle
  - An unfinished application task is resumed on the next cycle

# Predictability and Repeatability

- Deterministic behavior is supported by design measures such as:
  - sequential execution of tasks
  - continuous loop execution of the application function
  - regular schedule for time-based routines
  - diagnostics that confirm the execution of the safety function
  - deterministic communications with preconfigured communications architectures (i.e., predefined nodes and addressing)
- The SYS processor, which serves as the safety processor, is buffered from communications transactions through the use of interposing communications processors (i.e., the ICL and C-Link subordinate processors).

# Secure Development and Operational Environment (SDOE)

- The system software for the HFC-6000 platform is burned into PROMs that cannot be altered in the field.
- Any firmware change requires physical replacement of the PROMs.
- Application software for a module can be installed via PROM replacement or download to dedicated Flash memory. Either of these modification processes for application software are intended to occur while the module is out of service (i.e., out of the cabinet).
- A write protect switch on the faceplate of the HFC-SBC06 controller module allows for preventing modification (i.e., overwrite) of the application executable in Flash memory during online, in-service operation.

# Amendments to the HFC-6000 TR

- After NRC approval of the HFC-6000 TR, HFC submitted two amendments to the approved TR for:
  - The closure of the six generic Equipment Qualification open items
    - Final Safety Evaluation issued in April, 2015 (ML15064A002).
  - The inclusion of additional modules that can be used with the HFC-6000 platform
    - For example, in a newer version of the SBC06 controller module, the four CPLDs are replaced with one FPGA.
    - EICB staff is currently performing the acceptance review for this amendment.



# Nuclear Protection and Control (NuPAC)

Norbert Carte (NRC/NRR/EICB)

April 24, 2015

# Outline

- Background
- Description
- Key Regulatory Criteria

## Background

June 2011	Topical Report (TR) Docketed
May 2012	NRC Accepted TR for Review
May 2013	NRC Sent RAI
Feb-Sep 2014	Review Suspended
Sept 2014	Palo Verde Intent to use
April 2015	First Audit
Sept 2015	Second Audit
June 2016	Evaluation to be Completed

# Description

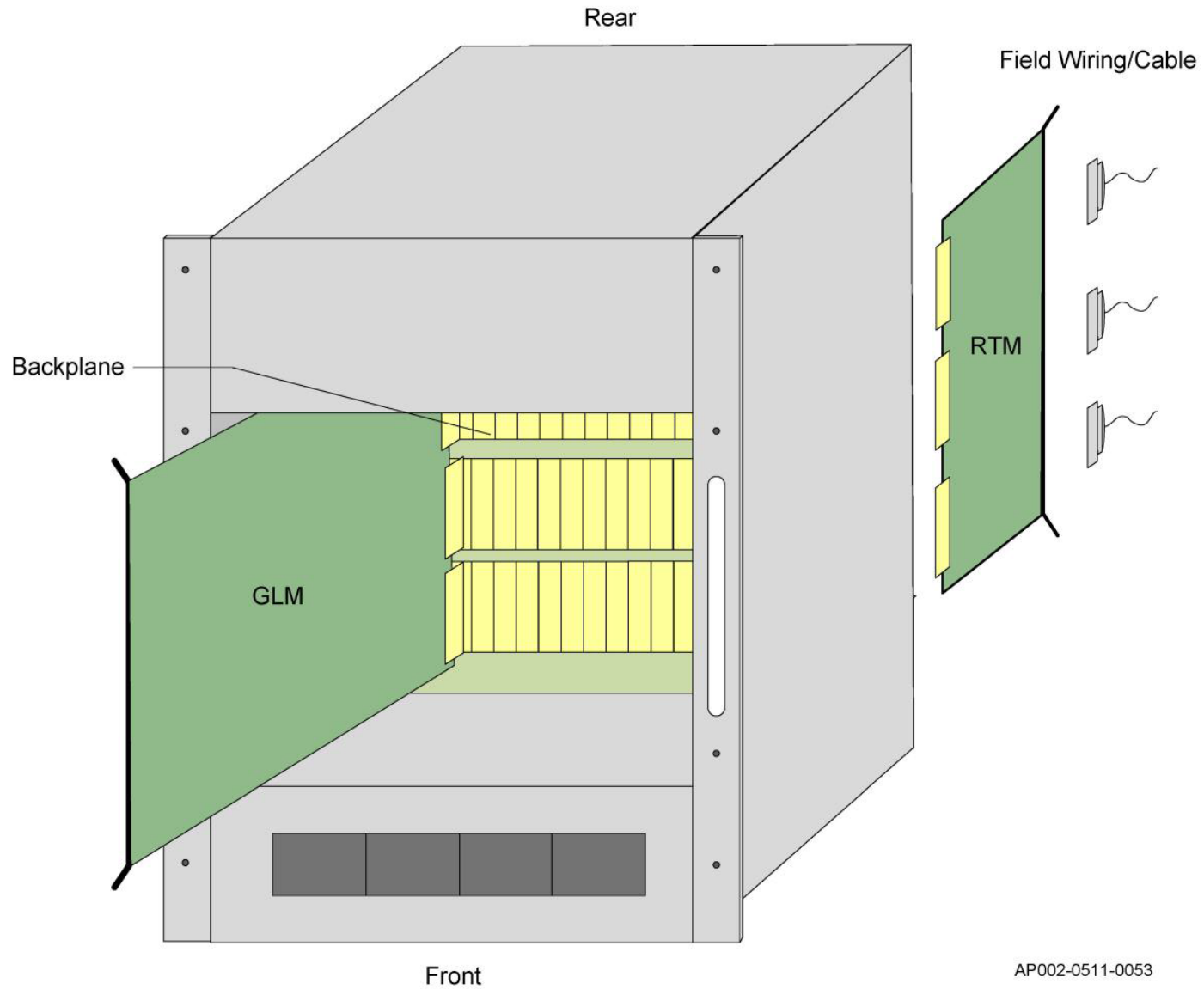
- Application Framework
  - FPGA-based (no microprocessor or emulation thereof)
  - No system specific design
- Digital Communication Mechanism
- Does not Address Diversity and Defense-in-Depth
- Does not Address Electrical Isolation
- Does not Include Power Supplies



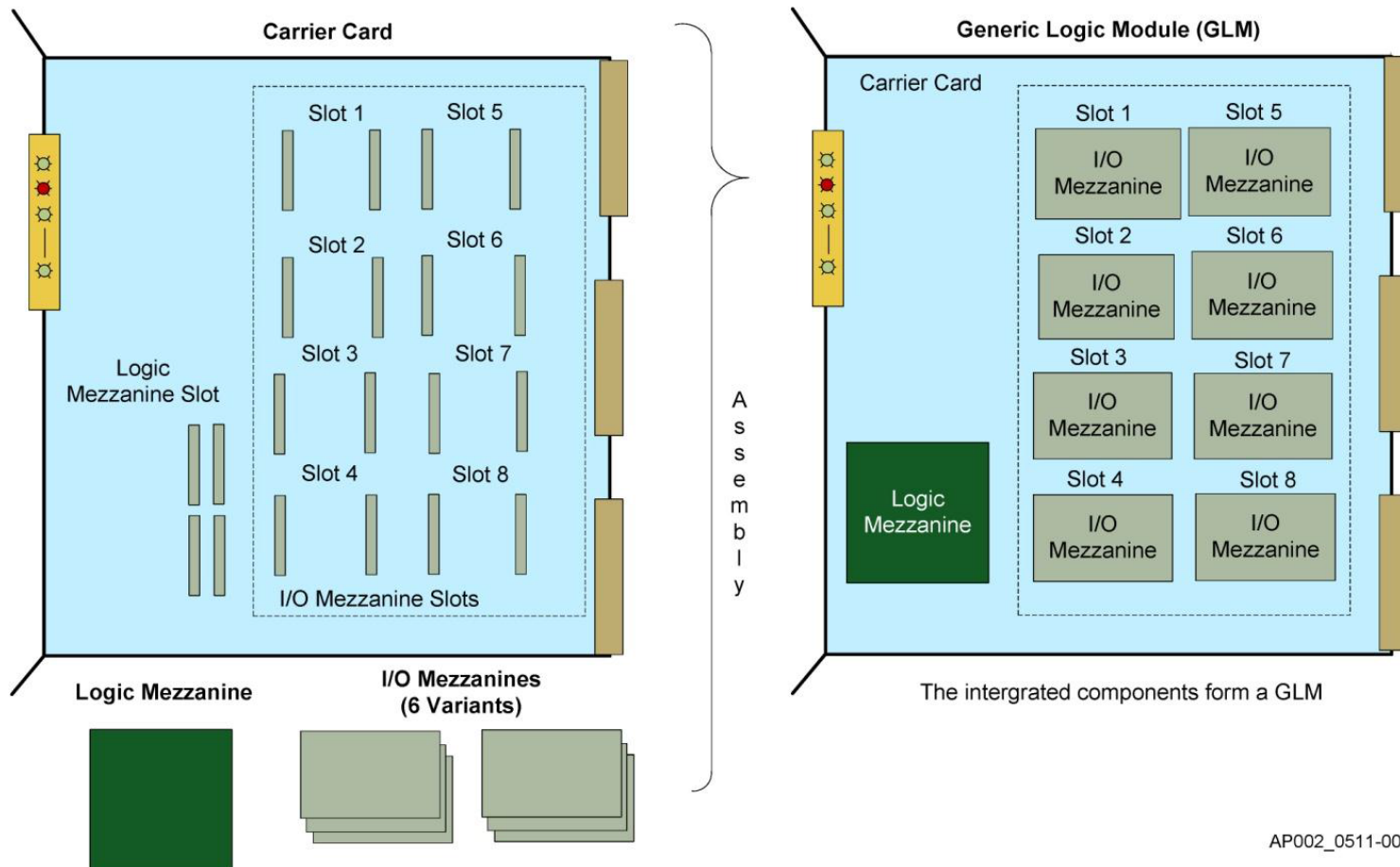
# Description

- Chassis & Backplane
- Generic Logic Module - Carrier Card (Supports mezzanine cards)
  - FPGA-based Logic mezzanine
    - Parallel Processing
    - No Interrupts
  - I/O Mezzanines
    - Serial Communication RS-422
    - Analog Input and Analog Output
    - Discrete/Pulse Input
    - Temperature Input
    - Solid State Relay Output
- Rear Transition Module

# Description

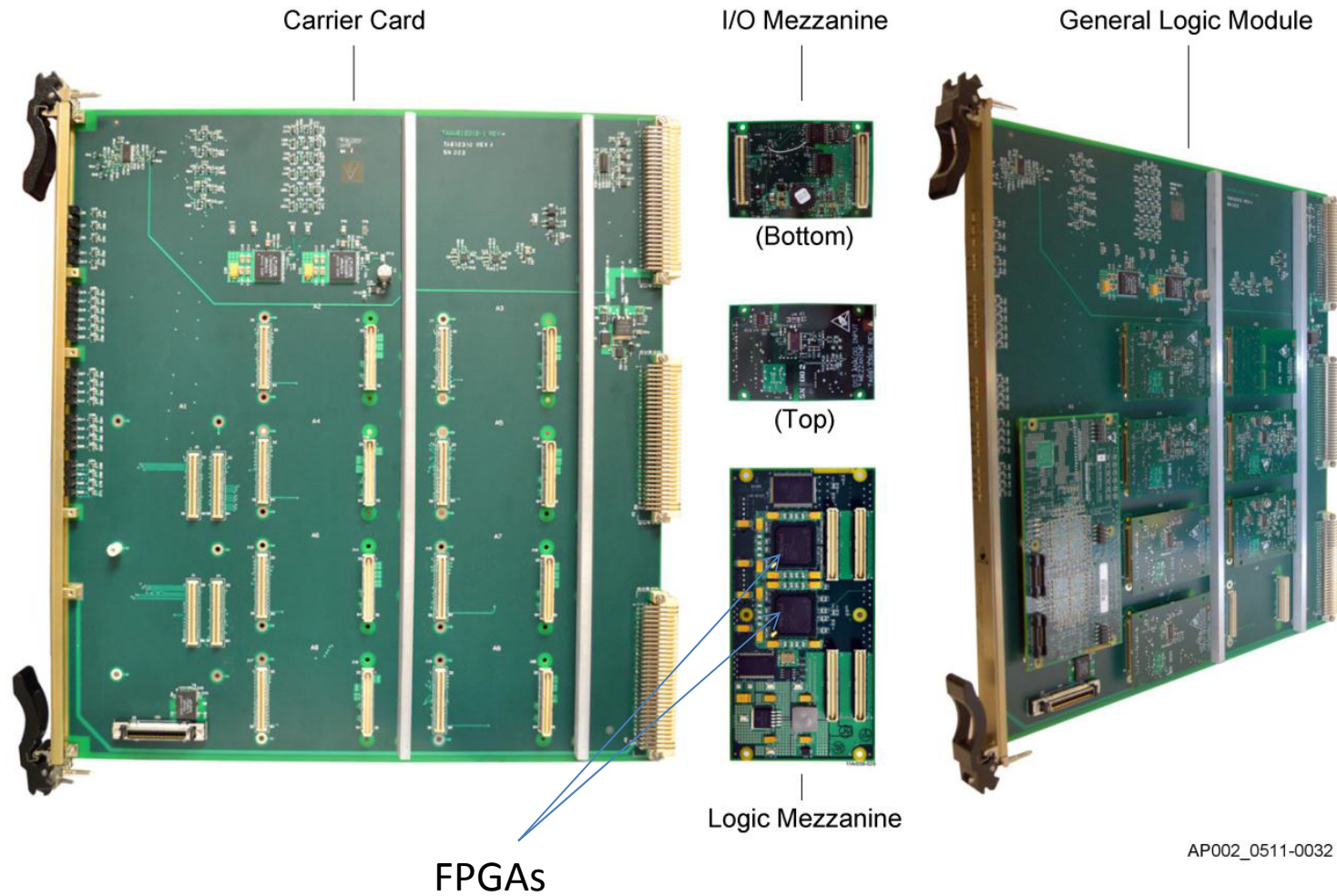


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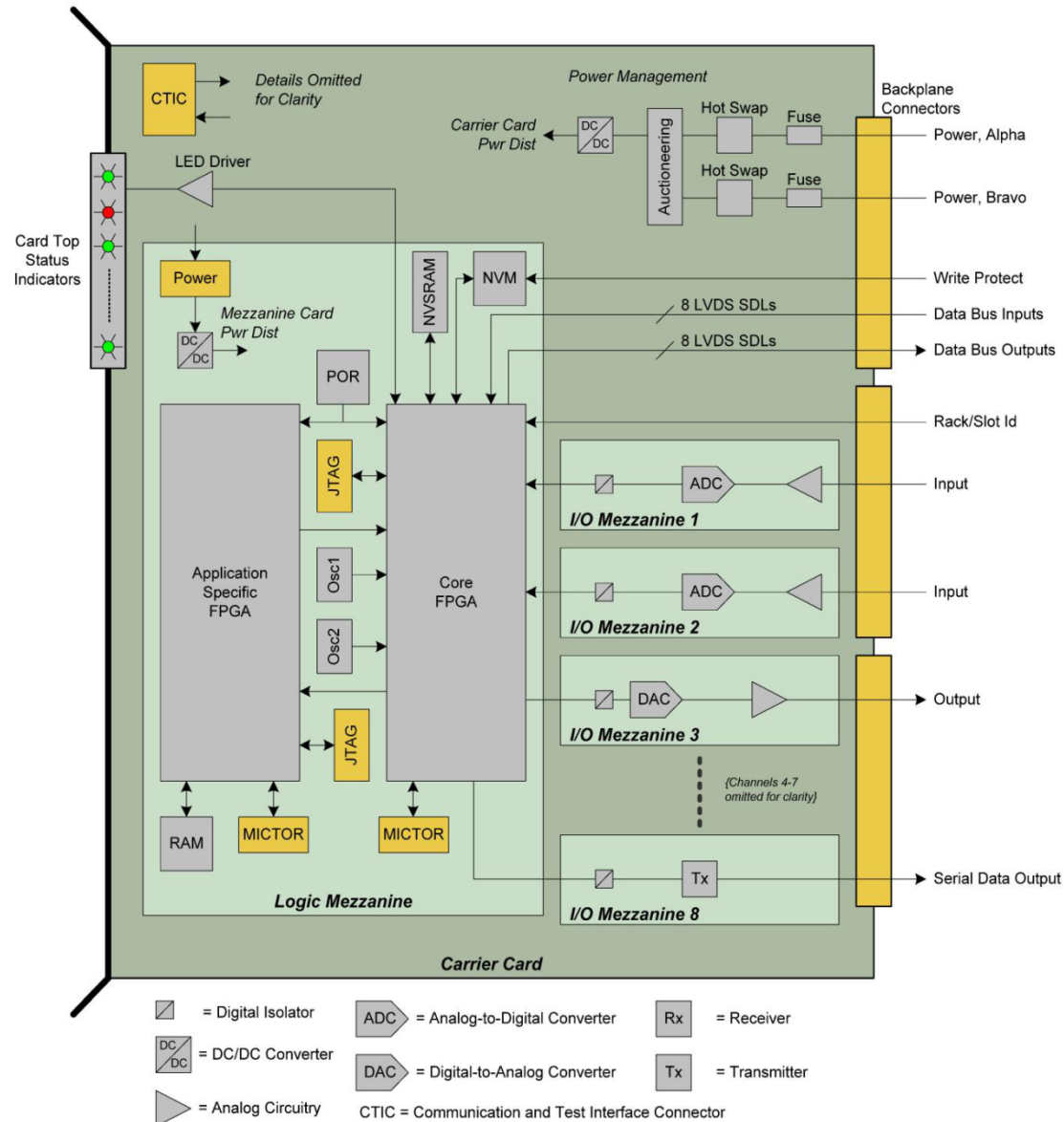


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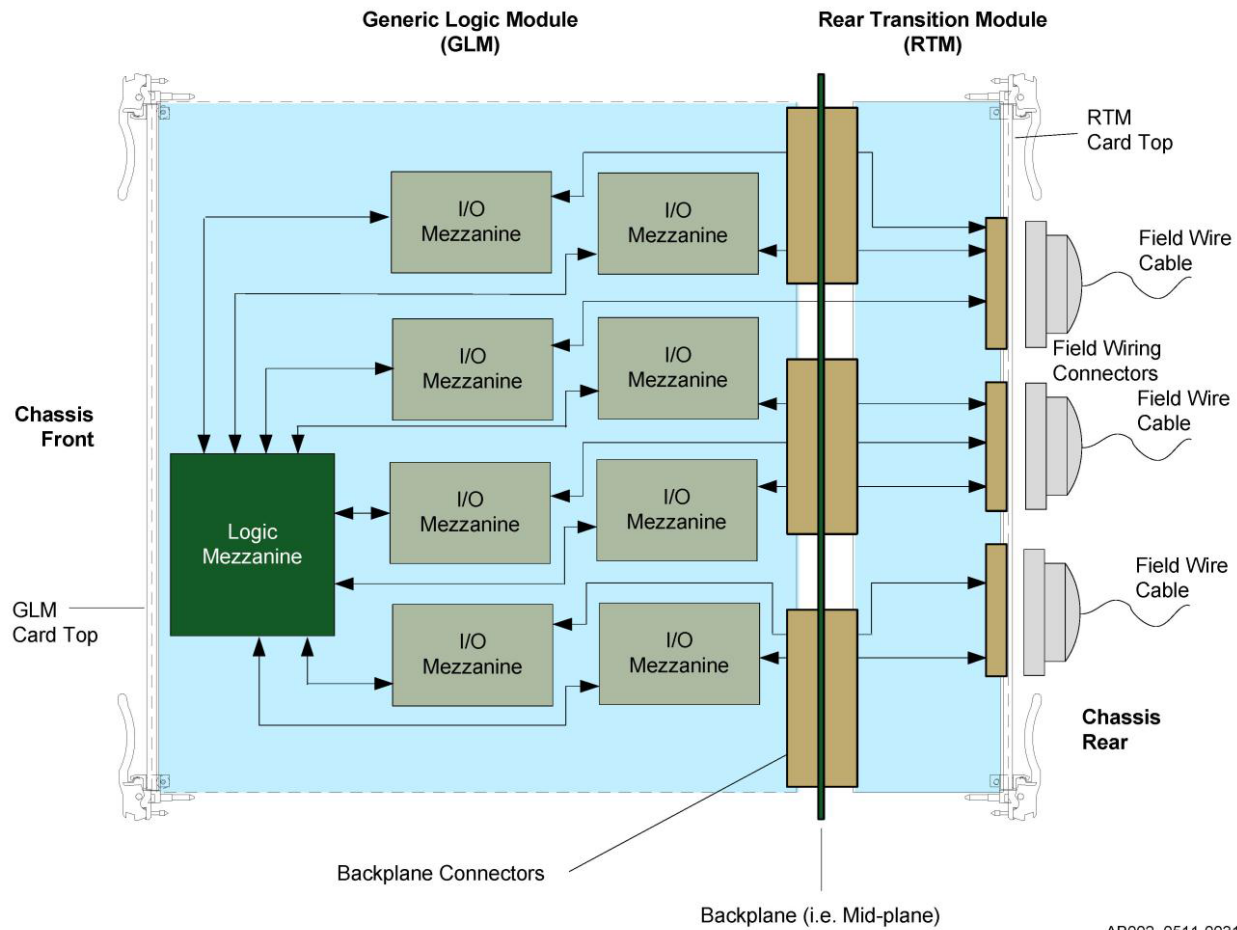
# Description



# Description



# Description



AP002\_0511-0031

# Key Regulatory Criteria

- Independence
  - ~~— Electrical~~
  - ~~— Information~~
  - ~~— Segregation (physical independence)~~
  - Communication Mechanism
    - Serial Communication Card (RS-422) & Core FPGA
    - Byte level
- ~~• Redundancy~~
- Predictability and Repeatability
  - Communication heartbeat
  - Invalid state machine detection
  - Analog output control loss (WD)
- Secure Development and Operational Environment (SDOE)
- ~~• Diversity and Defense in Depth (D3)~~

# Questions?



# Backup Slides

# Embedded Microprocessor System Determinism

- Microprocessor / Interrupt Based Paradigm
- Common processing provides all functions
  - Serial Execution
  - All function share limited resources
- Independent watchdogs can mitigate risk
  - Function stalls results in watchdog action
  - Potential to interrupt functions

# NuPAC Platform FPGA

## Determinism

- Latency Requirements
  - Declared for each FPGA functional requirement
  - Resource Allocation
    - Dedicated to function if necessary
    - Shared among functions if necessary
    - Allocation performed to guarantee max required latencies
- Dedicated Resources
  - Custom Finite State Machines (FSM)
  - Fixed / Tightly Controlled State Sequences & Latencies
  - Massively Parallel Function Execution
    - Provides very low latency
- Resource Sharing
  - Equal and repetitive access to all functions
  - Deterministic sharing of resources achieved through fixed sequence dedicated access

# Verification of Deterministic Performance

- Covers each and all required functions
- Constrained Randomized Stimulus
  - Includes randomized injected errors
  - All functions execute simultaneously
  - Verifies required latencies
- Randomized and Repeatable

# Acronyms

ASIC – Application Specific Integrated Circuit  
CPLD – Complex Programmable Logic Device  
D3 - Diversity and Defense-in-Depth  
FMEA – Failure Modes and Effects Analysis  
FPGA – Field Programmable Gate Array  
ISG – Interim Staff Guidance  
LIC – Licensing  
NPP – Nuclear Power Plant  
NRC – Nuclear Regulatory Commission  
NRR – Nuclear Reactor Regulation  
NuPAC – Nuclear Protection and Control  
PLD – Programmable Logic Device  
SDOE – Secure Development and Operational Environment  
SRP – Standard Review Plan, NUREG-0800  
TR – Topical Report