Group __A__

FOIA/PA NO: __2013-0240__

RECORDS BEING RELEASED IN PART

The following types of information are being withheld:

Ex. 1: ☐ Records properly classified pursuant to Executive Order 13526
Ex. 2: ☐ Records regarding personnel rules and/or human capital administration
Ex. 3: ☐ Information about the design, manufacture, or utilization of nuclear weapons
☐ Information about the protection or security of reactors and nuclear materials
☐ Contractor proposals not incorporated into a final contract with the NRC
☐ Other ____________________
Ex. 4: ☐ Proprietary information provided by a submitter to the NRC
☐ Other ____________________
Ex. 5: ☒ Draft documents or other pre-decisional deliberative documents (D.P. Privilege)
☐ Records prepared by counsel in anticipation of litigation (A.W.P. Privilege)
☐ Privileged communications between counsel and a client (A.C. Privilege)
☐ Other ____________________
Ex. 6: ☐ Agency employee PII, including SSN, contact information, birthdates, etc.
☐ Third party PII, including names, phone numbers, or other personal information
Ex. 7(A): ☐ Copies of ongoing investigation case files, exhibits, notes, ROI's, etc.
☐ Records that reference or are related to a separate ongoing investigation(s)
Ex. 7(C): ☐ Special Agent or other law enforcement PII
☐ PII of third parties referenced in records compiled for law enforcement purposes
Ex. 7(D): ☐ Witnesses' and Allegers' PII in law enforcement records
☐ Confidential Informant or law enforcement information provided by other entity
Ex. 7(E): ☐ Law Enforcement Technique/Procedure used for criminal investigations
☐ Technique or procedure used for security or prevention of criminal activity
Ex. 7(F): ☒ Information that could aid a terrorist or compromise security

Other/Comments: ____________________

Powell, Eric

From: Wagner, Katie
Sent: Tuesday, May 15, 2012 7:56 PM
To: Barto, Andrew; Sullivan, Randy; Schrader, Eric; Jones, Steve; Mitman, Jeffrey; Bowman, Eric; Witt, Kevin; Tegeler, Bret; Powell, Eric
Cc: Gibson, Kathy; Scott, Michael; Poole, Brooke; Lewis, Robert; Ruland, William; Giitter, Joseph; McGinty, Tim; Ader, Charles; Bergman, Thomas; Skeen, David; Evans, Michele; Clifford, James; Lee, Richard; Coyne, Kevin; Hogan, Rosemary; Santiago, Patricia; Wood, Kent; Hansell, Samuel; Ennis, Rick; Esmaili, Hossein; Helton, Donald; Murphy, Andrew; Nosek, Andrew; Pires, Jose
Subject: RE: ACTION: Spent Fuel Pool Scoping Study (SFPSS) Working Draft for Working Group Review by EOB on Tue., May 22nd

BATA FSME

All – Please note that the results of the consequence analysis are preliminary because they are calculated with a 10-mile evacuation model. While a 10-mile evacuation model is applicable to some smaller releases, it is not realistic for some of the larger releases. Updated results with the new evacuation models are expected in the coming weeks. – Thanks, Katie

RES FSME

From: Wagner, Katie
Sent: Tuesday, May 15, 2012 7:42 PM
To: Barto, Andrew; Sullivan, Randy; Schrader, Eric; Jones, Steve; Mitman, Jeffrey; Bowman, Eric; Witt, Kevin; Tegeler, Bret; Powell, Eric
Cc: Gibson, Kathy; Scott, Michael; Poole, Brooke; Lewis, Robert; Ruland, William; Giitter, Joseph; McGinty, Tim; Ader, Charles; Bergman, Thomas; Skeen, David; Evans, Michele; Clifford, James; Lee, Richard; Coyne, Kevin; Hogan, Rosemary; Santiago, Patricia; Wood, Kent; Hansell, Samuel; Ennis, Rick; Esmaili, Hossein; Helton, Donald; Murphy, Andrew; Nosek, Andrew; Pires, Jose
Subject: ACTION: Spent Fuel Pool Scoping Study (SFPSS) Working Draft for Working Group Review by EOB on Tue., May 22nd

~~Attachment contains OUO – Sensitive Internal Information~~

All,

Attached is a working draft for review and comment by Other-Office Working Group members by end-of-business on Tuesday, May 22nd. We understand that this is a large document and the review time is relatively short, we appreciate your input to help meet our deadlines. A few notes about this document:

- This is a working draft which has not been formally reviewed by the SFPSS Team or technical writing editors yet due to the tight schedule involved. The formatting of the document has not been finalized at this time. Equations which did not show up in the main .pdf document are attached in a MS Word file.
- The current plan is that the SFPSS report will be sent by memo from Brian Sheron, RES to Eric Leeds, NRR at the end of June for their consideration as part of the NTTF Tier 3 issue regarding transfer of spent fuel from pools to casks.
- RES and NRR are still determining the path and schedule to obtain public comment on the report and providing it to the Commission.
- Division Directors have been cc'ed on this email at the request of RES Division Management.

Please let me know if you have any questions or comments.

Thanks,

Katie Wagner
General Engineer
U.S. Nuclear Regulatory Commission
(301) 251.7917
Katie.Wagner@nrc.gov

A6-1

Powell, Eric

From: Weerakkody, Sunil
Sent: Wednesday, May 23, 2012 11:45 AM
To: Powell, Eric
Subject: RE: ACTION: Spent Fuel Pool Scoping Study (SFPSS) Working Draft for Working Group Review by EOB on Tue., May 22nd

NRR

Nice work! Thanks for copying. I browsed through some of the comments.

Sunil

NRO ok to release

From: Powell, Eric
Sent: Tuesday, May 22, 2012 4:43 PM
To: Wagner, Katie
Cc: Ader, Charles; Mrowca, Lynn; Weerakkody, Sunil
Subject: RE: ACTION: Spent Fuel Pool Scoping Study (SFPSS) Working Draft for Working Group Review by EOB on Tue., May 22nd

Katie,

In the attached document you will find my comments.

Thanks,
Eric

From: Wagner, Katie
Sent: Tuesday, May 15, 2012 7:42 PM
To: Barto, Andrew; Sullivan, Randy; Schrader, Eric; Jones, Steve; Mitman, Jeffrey; Bowman, Eric; Witt, Kevin; Tegeler, Bret; Powell, Eric
Cc: Gibson, Kathy; Scott, Michael; Poole, Brooke; Lewis, Robert; Ruland, William; Glitter, Joseph; McGinty, Tim; Ader, Charles; Bergman, Thomas; Skeen, David; Evans, Michele; Clifford, James; Lee, Richard; Coyne, Kevin; Hogan, Rosemary; Santiago, Patricia; Wood, Kent; Hansell, Samuel; Ennis, Rick; Esmaili, Hossein; Helton, Donald; Murphy, Andrew; Nosek, Andrew; Pires, Jose
Subject: ACTION: Spent Fuel Pool Scoping Study (SFPSS) Working Draft for Working Group Review by EOB on Tue., May 22nd

RES FSME

~~**Attachment contains OUO - Sensitive Internal Information**~~

All,

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- This is a working draft which has not been formally reviewed by the SFPSS Team or technical writing editors yet due to the tight schedule involved. The formatting of the document has not been finalized at this time. Equations which did not show up in the main .pdf document are attached in a MS Word file.
- The current plan is that the SFPSS report will be sent by memo from Brian Sheron, RES to Eric Leeds, NRR at the end of June for their consideration as part of the NTTF Tier 3 issue regarding transfer of spent fuel from pools to casks.
- RES and NRR are still determining the path and schedule to obtain public comment on the report and providing it to the Commission.
- Division Directors have been cc'ed on this email at the request of RES Division Management.

Please let me know if you have any questions or comments

Thanks,

Katie Wagner
General Engineer
U.S. Nuclear Regulatory Commission
(301) 251.7917
Katie.Wagner@nrc.gov

Summary of Comments on SFPSS Report - ELP Comments.pdf

Page: 4

Author: ELP1 Subject: Sticky Note Date: 5/22/2012 2:05:18 PM
Mitigative strategies are what we have required

Author: ELP1 Subject: Highlight Date: 5/22/2012 2:05:07 PM

Author: ELP1 Subject: Highlight Date: 5/22/2012 2:05:05 PM

Author: ELP1 Subject: Sticky Note Date: 5/22/2012 2:08:38 PM
drain down event has occurred

Author: ELP1 Subject: Highlight Date: 5/22/2012 2:05:00 PM

A6-2

Page: 5

Author: ELP1 Subject: Sticky Note Date: 5/22/2012 2:21:03 PM

Is this really appropriate given the events at Fukushima? More of a philosophical question, but I would say that it is not appropriate given how such an event would affect multiple units on a site.

Author: ELP1 Subject: Highlight Date: 5/22/2012 2:17:10 PM

Page: 6

Author: ELP1 Subject: Highlight Date: 5/22/2012 2:23:39 PM

Author: ELP1 Subject: Sticky Note Date: 5/22/2012 2:25:11 PM
See highlighted section below (#8)

Author: ELP1 Subject: Sticky Note Date: 5/22/2012 2:26:04 PM
Has there been discussion about some kind of requirement in this area? Just a thought.

Author: ELP1 Subject: Highlight Date: 5/22/2012 2:23:48 PM

Author: ELP1 Subject: Highlight Date: 5/22/2012 2:23:45 PM

Author: ELP1 Subject: Sticky Note Date: 5/22/2012 2:29:46 PM
I think you mean "safely"

Author: ELP1 Subject: Sticky Note Date: 5/22/2012 2:32:31 PM
This doesn't seem to be consistent with numbers 5 & 8 above. On second thought, I guess saying that something could be safer in a low-density configuration, isn't the same as saying high density configurations are not safe. I will continue reading to understand this point better, but I wanted to put a note here anyways.

Author: ELP1 Subject: Highlight Date: 5/22/2012 2:29:25 PM

Author: ELP1 Subject: Highlight Date: 5/22/2012 2:29:24 PM

Author: ELP1 Subject: Highlight Date: 5/22/2012 2:27:52 PM

Page: 17

T Author: El PI Subject: Highlight Date: 5/22/2012 2:40:36 PM

Page: 19

Author: ELP1 Subject: Sticky Note Date: 5/22/2012 2:55:53 PM
same comment as above in the executive summary

Author: ELP1 Subject: Highlight Date: 5/22/2012 2:55:05 PM

Author: ELP1 Subject: Highlight Date: 5/22/2012 2:55:23 PM

Author: ELP1 Subject: Highlight Date: 5/22/2012 3:05:02 PM

Author: ELP1 Subject: Sticky Note Date: 5/22/2012 3:09:55 PM

While this is true, 50.54(hh)(2) looks at losses of large areas from any number of threats. Why not use language similar? Is it the sabotage aspect?

Page: 22

Author: ELP1 Subject: Sticky Note Date: 5/22/2012 3:11:41 PM

Why? With the NTT Task Force recommendation of making the 50.54(hh)(2) equipment more robust and required (or whatever language they use), why not look at sabotage events in a general manner. Instead of saying aircraft crashes, we could say losses of large areas of the plant due to any number of threats. I think it would be more flexible and comprehensive this way.

Author: ELP1 Subject: Highlight Date: 5/22/2012 3:07:22 PM

Author: ELP1 Subject: Highlight Date: 5/22/2012 3:12:31 PM

Page: 81

Author: ELP1 Subject: Sticky Note Date: 5/22/2012 4:11:24 PM

Based on the guidance in NEI 06-12, the site will have sufficient fuel for the pumping source to operate for 12 hours without off-site support. This means that the 50.54(hh)(2) equipment relied upon to mitigate an event is only required to be able to operate for that amount of time. This is a potential issue, because if the study is assuming off-site support doesn't arrive until 24 hours after the event (and implemented sometime after) then for at least 12 hours the plant will not be able to provide makeup or spray to the SFP.

Author: ELP1 Subject: Highlight Date: 5/22/2012 4:02:40 PM

Page: 82

Author: ELP1 Subject: Sticky Note Date: 5/22/2012 3:50:13 PM
Revision J was issued in September 2009

Author: ELP1 Subject: Highlight Date: 5/22/2012 3:49:45 PM

Author: ELP1 Subject: Highlight Date: 5/22/2012 3:51:38 PM

Page: 84

Author: ELP1 Subject: Highlight Date: 5/22/2012 3:54:11 PM

Page: 88

Author: ELP1 Subject: Sticky Note Date: 5/22/2012 4:19:21 PM

This assumption may not be accurate, given the language that is currently in NEI 06-12 (plants only have enough fuel on-site for 12 hours of operation for their portable pumps).

Author: ELP1 Subject: Highlight Date: 5/22/2012 4:17:09 PM

Page: 182

Author: ELP1 Subject: Sticky Note Date: 5/22/2012 4:33:05 PM

This appears to address my earlier comment. However, I would like to note that looking at only a single unit event, given a threat which affects more than a single unit, is a dated approach and inconsistent with the lessons that have been learned since the accident at Fukushima.

Author: ELP1 Subject: Highlight Date: 5/22/2012 4:25:41 PM

Author: ELP1 Subject: Highlight Date: 5/22/2012 4:25:23 PM

RES/NRR

SFP HRA Study

September 14, 2012

Y. James Chang, RES/DRA
Jeffrey Mitman, NRR/DRA
Antonios Zoulis, NRR/DRA
Christopher Cahill, Region I
Elizabath Keighley, Region I

A6-3

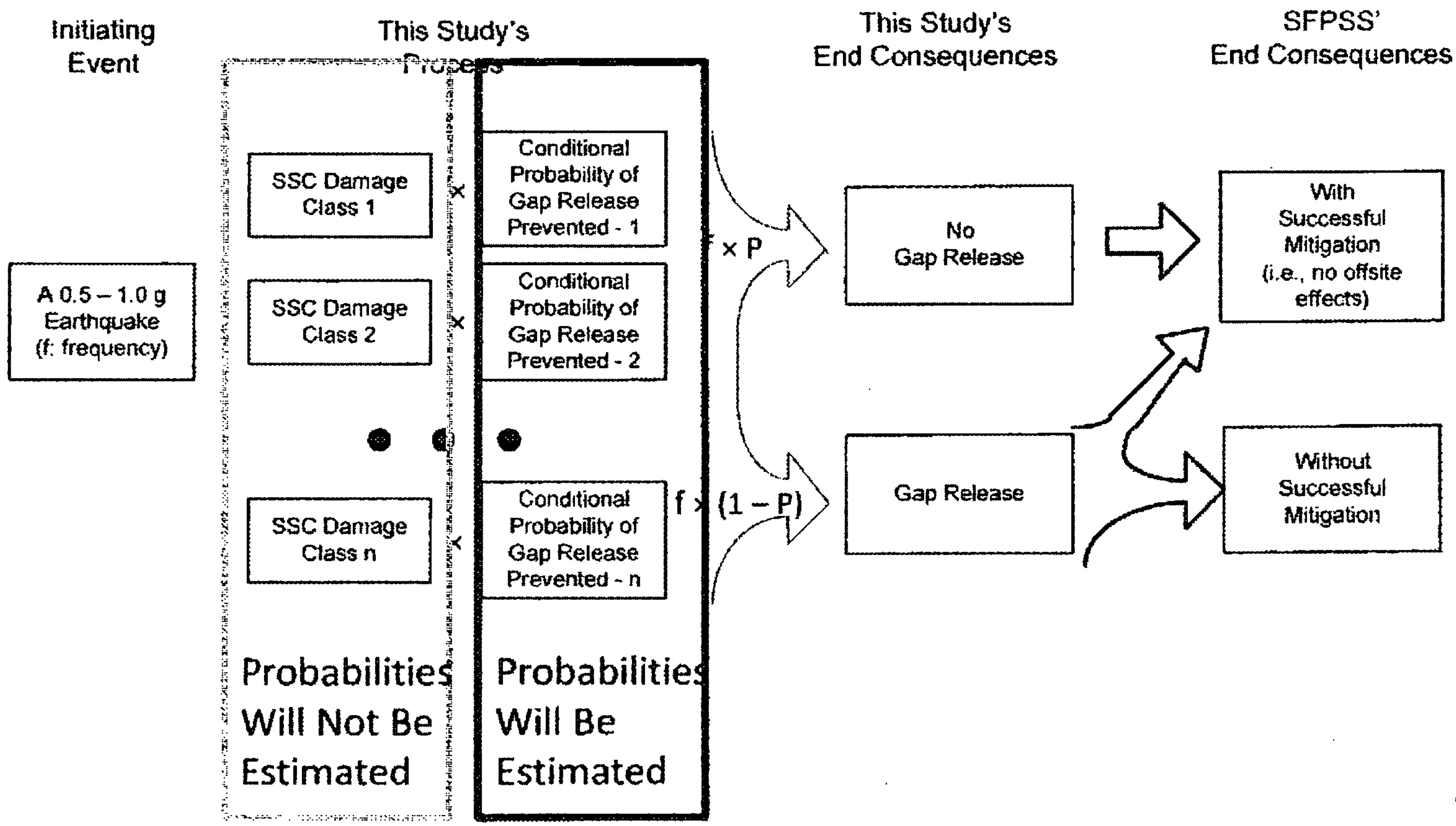
Purposes

- Brief the approach and preliminary results of the SFP HRA task
- Obtain comments

About This Study

- A 0.7 G earthquake affects the Peach Bottom station
  - Two reactors and two SFPs at the PB station site
  - A ~ 1 in 60,000 years earthquake
- Assess the likelihood of successful mitigation on earthquake induced SFP problem
  - In this study, success is defined as gap release is prevented
  - Focus on SFP safety; not reactor
  - Recognizing the earthquake can be a common cause failure mechanism causing multiple failures on various structure, system, and components
- An appendix to the SFPSS report
  - By 9/30/2012

Study Framework



SFP Damage States

- No leak
  - More than 9 days boiling to the fuel rack top
- Small leak
  - Maximum leakage rate: ~ 250 gpm
- Moderate leak
  - Maximum leakage rate: ~1900 gpm

SFPSS Classification

Table 16: OCP Definition for a "Typical" Peach Bottom Operating Cycle

OCP #	OCP Description	Time (days)	% of operating cycle	Pool-reactor configuration	Spent fuel config. for high-density loading	Total decay power	Peak assembly power
1	Defueling of the reactor (~ 1/3 core)	2 – 8	0.9%	Refueling	Contiguous OR 1x4	Existing[2] + (27% of offloaded assemblies) @ 4 days[1]	Highest powered offloaded assembly @ 4 days[1]
2	Reactor T&M / inspection and refueling	8 – 25	2.4%	Refueling	Contiguous OR 1x4	Existing[2] + (offloaded assemblies) @ 13 days[1]	Highest powered offloaded assembly @ 13 days[1]
3	Highest decay power portion of non-outage period	25 – 60	5%	Unconnected	1x4	Existing[2] + (offloaded assemblies) @ 37 days[1]	Highest powered offloaded assembly @ 37 days[1]
4	Next highest decay power portion of non-outage period	60 – 240	25.7 %	Unconnected	1x4	Existing[2] + (offloaded assemblies) @ 107 days[1]	Highest powered offloaded assembly @ 107 days[1]
5	Remainder of operating cycle	240 – 700; 0 – 2	66%	Unconnected	1x4	Existing[2] + (offloaded assemblies) @ 383 days[1]	Highest powered offloaded assembly @ 383 days[1]

[1] These times are based on mean decay heat load (as opposed to mean time) during the

SFPSS' Conclusions

Four classes of scenarios do not result in a release from the fuel (before simulation truncated)

- Boiloff scenarios with no SFP leaks
- Mitigated scenarios for small leaks
- Unmitigated scenarios in late phases (OCP 4&5)
- Mitigated post outage scenarios (OCP 3, 4, and 5)

Mitigation Time Used in The SFPSS

Sum of the following

- SFP level decreases 5 feet (including sloshed water)

	Small Leak	Moderate Leak
OCP 1&2	~ 7.5 hr	~ 65 min
OCP 3,4&5	~3.0 hr	~ 15 min

- 30 minutes in diagnosis
- 2 hours in mitigation deployment

A Big Picture

(Given a 0.7 G Earthquake; Based on SFPSS)

	No Leak (90%)	Small Leak (5%)		Moderate Leak (5%)	
		Mitigated	Unmitigated	Mitigated	Unmitigated
OCP1 (0.9%)			(0.05%)		(0.05%)
OCP2 (2.4%)			(0.12%)		(0.12%)
OCP3 (5%)			(0.25%)		(0.25%)
OCP4 (25.7%)		(99.2%)			
OCP5 (66%)					

Within The 0.8%

(Based on SFPSS Data)

	Small Leak		Moderate Leak	
	Mitigated	Unmitigated	Mitigated	Unmitigated
OCP1		FUT: 39.7 hr GRT: 54.2 hr[1] H_2D: No	MT: ~3.5 hr Inject water[2] No Zr fire	FUT: 5.9 hr GRT: 8.7 hr H_2D: No
OCP2		FUT: 42.6 hr GRT: 59.2 hr H_2D: 64.8 hr (HD) H_2D: No (LD)	Same as above	FUT: 5.9 hr GRT: 10.5 hr H_2D: No
OCP3		FUT: 38.7 hr GRT: 40.6 hr H_2D: 47.3 hr (HD) H_2D: No (LD)		FUT: 2.5 hr GRT: 16.9 hr H_2D: No

MT: Mitigation Time
FUT: Fuel Uncovery Time
GRT: Gap Release Time
H_2D: Hydrogen Deflagration
HD: High Density Fuel Load
LD: Low Density Fuel Load

[1]Use the lower value of high and low density loading
[2]Likely be green if spray is used

Summary of Success Criteria

	Small Leak	Moderate Leak
OCP 1 & 2	< 40 hr Inject or Spray	< 5.9 hr Spray
OCP 3	< 18 hr Inject or Spray	< 2.5 hr Spray

*Assumptions:

1. After the fuel uncover, the refueling floor radiation is too high for workers to work
2. The established equipment (i.e., HPCI or (RCIC and RHR)) can be used for injection (but not spray) if available.

Study Assumption and Approach

- Success mitigation relies on
  - Detecting the SFP is leaking
  - Apply correct mitigative actions in time (inject/spray)
- Use gap release as success criteria
- Focus on Unit 3 (SFP and Reactor)
  - Unit 3 reactor affects the work environment of Unit 3 SFP refueling floor
  - Treat complications outside of the Unit 3 separately

Detecting SFP Leakage

Considered Means/Cues	Comments
SFP Trouble Alarm in MCR	Actuated when LOOP or SFP slush
Earthquake plant walkdown procedure Step 10	Possible cues: -Visual look at the pool level -Local level indicator (LI-2695) -See leakage from SFP bottom -Tell Tail drain -Level indicator of skimmer surge tank -Refuel instrument (if in OCP 1&2)
Routine shift tour	Same as above
High radiation in SFP area	May sent operator to do on site check
Operator sees water while monitoring ECCS equipment in the RB.	SFP water flows down from the stairwell
Security tour the plant	Report unusual water accumulation and water flow at stairwell

Injecting/Spraying Water Into SFP

Considered Means	Comments
Condensate transfer system	Need AC to run the condensate transfer pump
Deminalization water	Not credited
RHR from suppression pool	Only work for COP 1&2; need AC to run
High pressure service water (HPSW)	-Safety graded, seismic qualified; 9000 gpm; -Procedurized (AO 32 3-2/3) -HPSW → RHR → SFP -Need AC to run
Fire water	- Need AC to run fire pump - Not credited for surviving in a 0.7 G earthquake
B5b pumps	-Do not need AC nor DC to operate -Draft water from the Conowingo pond -Inject/spray nozzle in place at SFP floor and TB roof
Offsite Resources (e.g., fire engines)	-Not with this study's scope

Two B5b Pumps

- Goodwin fire pump
  - 650 gpm

(b)(7)(F)

- Goodwin Model 130
  - 1300 gpm

(b)(7)(F)

Notes:

- Max small leak: ~ 250 gpm
- Max moderate leak: ~1900 gpm
- An Inject nozzle capacity: 500 gpm
- A spray nozzle capacity: 250 gpm

Instructions for Using B5b Pumps

- Hook on fire main for water source (PSG 4.1)
- If fire main not available then use
  - Conowingo pond
  - 2 CSTs and dike
  - RWST and dike
  - Torus storage tank
  - Emergency cooling tower basin
    - 3.5 million gallons; safety graded
    - No apparent way to get water from the basin

Key Factors Affecting Unit 3 SFP Mitigation

- Unit 3 power availability
  - LOOP
  - SBO
  - SBO without DC
- Unit 3 reactor and containment status
- Issues outside of Unit 3, e.g.,
  - B5b equipment availability
  - Unit 2 status
  - Conowingo dam status
  - Structure damage and fire at specific locations

Preliminary Results

(OCP 1 & 2; Not Consider Issues Outside of Unit 3)

Break Size	Power	Imminent CD?	Available Time	Detect	Act	Overall Assessment
Small Leak	LOOP		40 hr or before CD			
	SBO	< 3.5 hr*				
	SBO	No				
	SBO w/o DC	< 3.5 hr*				
	SBO w/o DC	No				
Moderate Leak	LOOP		5.9 hr or before CD			
	SBO	Before 3.5 hr*				
	SBO	No				
	SBO w/o DC	Before 3.5 hr*				
	SBO w/o DC	No				

*1 hr to sent EO to plant walkdown + 30 min detect leak + 2 hr deploy mitigation
Assume an EO is available for the task

Preliminary Results

(OCP 3; Not Consider Issues Outside of Unit 3)

Break Size	Power	CD/CMT	Available Time	Detect	Act	Overall Assessment
Small Leak	LOOP		40 hr or before CD	[redacted]	[redacted]	[redacted]
	SBO	CD < 3.5 hr/OK				
		CD < 3.5 hr/Fail			[redacted]	[redacted]
		No CD		[redacted]	[redacted]	[redacted]
	SBO w/o DC	CD< 3.5 hr/OK				
		CD < 3.5 hr/Fail			[redacted]	[redacted]
		No		[redacted]	[redacted]	[redacted]
Moderate Leak	LOOP		5.9 hr or before CD	[redacted]	[redacted]	
	SBO	CD < 3.5 hr/OK		[redacted]		
		CD < 3.5 hr/Fail		[redacted]	[redacted]	[redacted]
		No CD		[redacted]	[redacted]	
	SBO w/o DC	CD< 3.5 hr/OK		[redacted]		
		CD < 3.5 hr/Fail		[redacted]	[redacted]	[redacted]
		No				

Steps Forward

- Estimate the Basic Human Error Probabilities
  - Based on Unit 3 status
  - Bin the HEPs into several groups
- Add complications external to Unit 3 to adjust the Basic HEPs
  - Divide into two classes
    - Make mitigation infeasible
    - Make mitigation more difficult
  - Provide examples but not exhaustive list

From:	Ader, Charles
To:	Flanders, Scott; Shuaibi, Mohammed
Cc:	Mrowca, Lynn; Schaperow, Jason; Hawkins, Kimberly
Subject:	FW: Interim DRAFT Spent Fuel Pool Scoping Study sent to ACRS today
Date:	Tuesday, April 23, 2013 5:41:08 PM
Attachments:	Kathy Halvey Gibson.vcf SFPSS_DivDir_CompiledCommentskonaster.docx SFPSS_Doc (April ACRS).pdf — Previously provided
Importance:	High

Kim previously provided you the RES response to our comments. In a discussion with Kathy Gibson yesterday, she ask if there were any concerns that we are aware of that would prevent NRO concurrence on this report. She expects the report to come to NRO by the end of the month for office concurrence and is looking for early indication of major issues.

If I missed someone that provided comments previously, please forward this e-mail.

NRO-OK

-----Original Message-----
From: Hawkins, Kimberly
Sent: Friday, April 12, 2013 12:42 PM
To: Flanders, Scott; Shuaibi, Mohammed
Subject: FW: Interim DRAFT Spent Fuel Pool Scoping Study sent to ACRS today
Importance: High

Not sure if you saw this... Responses to our comments on the study... some were addressed and resulted in revisions to the study; for others, RES provided its response.

-----Original Message-----
From: Holahan, Gary
Sent: Friday, April 12, 2013 9:47 AM
To: Hawkins, Kimberly
Subject: FW: Interim DRAFT Spent Fuel Pool Scoping Study sent to ACRS today
Importance: High

From: Tracy, Glenn
Sent: Thursday, April 11, 2013 5:37 PM
To: Holahan, Gary
Subject: FW: Interim DRAFT Spent Fuel Pool Scoping Study sent to ACRS today

From: Sheron, Brian
Sent: Thursday, April 11, 2013 4:51 PM
To: Johnson, Michael; Weber, Michael; Leeds, Eric; Wiggins, Jim; Tracy, Glenn; Haney, Catherine; Satorius, Mark; Skeen, David
Subject: FW: Interim DRAFT Spent Fuel Pool Scoping Study sent to ACRS today
Importance: High

FYI.

From: Gibson, Kathy
Sent: Thursday, April 11, 2013 4:40 PM
To: McGinty, Tim; Ader, Charles; Lombard, Mark; Skeen, David; Correia, Richard; Case, Michael; Thaggard, Mark; Miller, Chris
Cc: McIntyre, David; Burnell, Scott; Richards, Stuart; Lee, Richard; Algama, Don; Blount, Tom; Reis, Terrence; Shear, Gary; Sheron, Brian; West, Steven
Subject: Interim DRAFT Spent Fuel Pool Scoping Study sent to ACRS today
Importance: High

Prior to RES

E/5

A6-4

Gentlemen,
The interim draft SFPSS report was due to the ACRS today at noon and we met that deadline. We are scheduled for an all-day briefing of the ACRS subcommittee on Materials, Metallurgy and Reactor Fuels on the study on May 8. I encourage you and your staff to attend all or part of the briefing as you have time and interest. We will send out an agenda and slide package in advance of the meeting.

I am providing for your information two documents: (1) A list of the division director level comments that you provided in response to my request on 3/22/13 and our responses, and (2) a copy of the version of the report that was sent today to ACRS.

I believe we were able to address your comments in this version of the report. We were not able to incorporate them all directly, but we describe why the study is the way it is and added significant clarifications to add the context that you were seeking.

The study team will now go back to addressing the comments received from your staff and BCs that we were not able to get to before the ACRS deadline. Therefore, revisions to the report will continue.

This email will be forwarded by Don Algama to your staff and BCs that have been involved in the project.

It was just decided by senior management this week that the study report will be released for a 30-day public comment period from about June 10 – July 10 (ACRS full committee meeting). We are evaluating how to accommodate this development within our schedule to have the report finalized by September. As I indicated previously, the offices will have at least one more opportunity to review and concur on the report.

I appreciate your quick review and thoughtful comments on the prior version of the report. I also appreciate all the hard work and effort the team has put into responding to your comments, including late nights and some very animated conversations.
I trust that you will find this version an improvement.

ADAMs links:

View ADAMS P8 Properties
ML13101A168<https://adamsxt.nrc.gov/WorkplaceXT/integrationWebBasedCommand?_commandId=3010&objectStoreName=Main.__.Library&id=current&vsId=%7b07CA2DD4-F1D3-4BD8-874F-978C0047FB66%7d&objectType=document>
Open ADAMS P8 Package (Issuance of the DRAFT "Consequence Study of a Beyond-Design-Basis Earthquake Affecting the Spent Fuel Pool for a U.S. Mark I Boiling Water Reactor" for ACRS Review)<https://adamsxt.nrc.gov/WorkplaceXT/getContent?objectStoreName=Main.__.Library&id=current&vsId=%7b07CA2DD4-F1D3-4BD8-874F-978C0047FB66%7d&objectType=document>

[cid:image002.jpg@01CE36CE.5AF56E80]

NRR

Comments to be addressed for ACRS SC report:

NRR

1. From a DSS perspective, we believe the report needs to be revised to clearly indicate why the study was done, why we chose the seismic response that we did, and how this compares to what would be expected at our 104 nuclear plants (or at least put in perspective that this is representative of a small subset of U.S. reactor designs). I really liked Rich's characterization in that the message is that we evaluated at the design basis and got no release. We doubled it and got no release, we tripled it and got no release so we went to four times the design basis and finally got a release for a very small number of unmitigated scenarios.

   Response: The report was revised to incorporate the following points that address this comment:
   - The study was done to confirm the results of past studies using state-of-the-art tools, as well as Fukushima insights, in a publicly available study.
   - The study will inform the Tier 3 activity by providing an updated technical basis for any regulatory action and input for the regulatory analysis.
   - The study used design, operational, and location data for a reference site for which we already had information available, a BWR Mark I with an elevated SFP. The report also considered a 1x4 pattern (required after some time after offloading) as well as sensitivity analysis for more favorable loading (1x8) and less favorable loading (checkerboard and uniform) and sensitivities for other key parameters that will provide insights for analysis of other plants.
   - The report was revised to make clearer that a low likelihood beyond design basis seismic event with and without mitigation was chosen to gain risk insights that could not be gained using a less severe seismic initiator. NRC analyzes low likelihood beyond design basis seismic events with and without mitigation to gain insights on the safety margin provided by NRC's regulatory framework.
   - The study concludes that the SFP is robust and not expected to leak, successful mitigation prevents most releases, no early fatalities are expected and individual LCF is low because effective protective actions limits individual exposure. (Note that high and low density *mitigated* moderate leak scenarios in the first week (OCP 1) resulted in releases, all other scenarios that resulted in releases were unmitigated and within the first few months (OCP 1, 2, 3) after shutdown.)

2. DSS also challenges why we are evaluating land contamination since no previous study directly discussed this issue. Considering that the Commission is currently reviewing whether to change its long-standing policy on addressing land contamination, it may be premature to evaluate this particular aspect in the report at this time.

   Response: The study included land contamination to provide inputs to a regulatory analysis. A paragraph has been added to the introduction to describe the study's relationship to the Tier 3 activities and how the study will be used in the current regulatory process. Other analyses did evaluate land contamination, including some directly (e.g., NUREG/CR-6451, NUREG-4982). Land contamination is already part of NRC's current regulatory framework including being used as input in SAMA/SAMDA analyses and is an input to regulatory/backfit analyses as part of the cost benefit analysis. Chapter 7 was revised to distinguish the safety-related individual health effects

Response: This scope of this study does not include making recommendations for further study. NRR will determine whether further analyses are needed to make any regulatory determinations within NRC's current regulatory framework. A paragraph has been added to the introduction to describe the study's relationship to the Tier 3 activities and how the study will be used in the regulatory process. The following statement has been added to the introduction and results sections of the report:

> Other aspects of SFP risk that have not been informed by this or past studies, may be addressed by future studies, such as the site Level 3 probabilistic risk assessment (PRA), as documented in SECY-11-0089, "Options for Proceeding with Future Level 3 Probabilistic Risk Assessment Activities," dated July 7, 2011, and the associated staff requirements memorandum; or will be addressed through other inputs to the regulatory decision-making process, as needed.

7. Appendix B-why is the first table included on Page B-3? It does not include any data regarding dry cask storage.

   Response: Appendix B addresses part of the SRM (dated July 16, 2012) to compare the results of the SFPSS with past studies and consider consequences associated with loading, transfer, and long-term storage. Appendix B provides a comparison of SFPSS results to previous spent fuel pool studies and updated analyses from NUREG-1864 Dry Storage Pilot PRA. Staff will revise the introduction to Appendix B to make this clear.

NRO

8. The report needs to describe how its results could be useful in making regulatory decisions on matters including the Japan lessons-learned Tier 3 recommendation on assessment of the transfer of spent fuel to dry-cask storage and recent Commission direction on economic consequences. In responding to this comment, a fuller characterization of the purpose and usefulness of the report should be added, including an explanation of how the study's point-estimate approach is appropriate in the context described above.

   Response: NRR will determine whether further analyses are needed to make any regulatory determinations within NRC's current regulatory framework. A paragraph has been added to describe the study's relationship to the Tier 3 activities and how the study will be used in the regulatory process. Using representative point-estimates with sensitivities for important parameters is appropriate in research studies to be able to gain insights and data for regulatory decision-making in a reasonable period of time.

   NRO - OK To closure

   The study used design, operational, and location data for a reference site for which we already had information available, a BWR Mark I with an elevated SFP. The report also considered a 1x4 pattern (required after some time after offloading) as well as sensitivity analysis for more favorable loading (1x8) and less favorable loading (checkerboard and uniform) and sensitivities for other key parameters that will provide insights for analysis of other plants.

9. The report needs to describe the relationship between the study results and our current approach to approving nuclear power plant sites and designs. In addition to describing this approach, a column could be added to the assumptions in Chapter 2 to provide context relative to the current regulatory approach for licensing nuclear power plants and

plants' licensing bases. Accordingly, the conclusions could also be reframed to highlight the robustness of our regulatory framework for the safe operation of nuclear power plants, e.g., that mitigation strategies provide a significant reduction in release rates.

Response: NRR will use the study in making related Tier 3 regulatory determinations within NRC's current regulatory framework. A paragraph has been added to describe the study's relationship to the Tier 3 activities and how the study will be used in the regulatory process. The study's conclusions include that successful mitigation generally prevented releases. (Note that there were mitigated scenarios that resulted in releases.)

10. The Staff Requirements Memorandum (SRM) on SECY-08-0029 directed the State-of-the-Art Reactor Consequence Analyses (SOARCA) to use individual cancer fatality risk as its latent cancer health-effects metric. The study should follow the same approach by using this metric and not reporting the total number of cancer deaths. For example, Chapter 7, Table 29 reports total latent cancer fatalities per year. Also, Chapter 11, conclusion 11 states "For scenarios with large releases, significant numbers of latent cancer fatalities are predicted when using a dose-response model based on the linear-no threshold hypothesis; however, this would be a small fraction compared to cancer fatalities from all causes."

    Response: Given the uncertainty of low doses on health effects, LCFs is being removed as a quantitative metric. For clarification, SECY-08-0029 and the related SRM did not "direct" SOARCA to exclude the reporting of LCFs or other potential societal health effects. Rather, the Commission agreed to the staff's recommendation that SOARCA should report individual LCF risk. The basis for reporting individual LCF risk can be found in the Qualitative Safety Goals (QSGs). However, the QSGs also provide the basis for reporting societal health impacts, as they are an important measure of the safety of nuclear power in general. Therefore while LCFs are not quantified in the report, they are still discussed in broad terms. Societal dose as a surrogate provides a reasonable measure for societal health effects and is not subject to the uncertainty of low dose health effects. Societal dose is also an input to cost benefit analyses for backfit/regulatory analyses and SAMA/SAMDA analyses. Chapter 7 was revised to distinguish the safety-related health effects measures other measures that are inputs to the cost-benefit analysis for the regulatory analysis.

11. A memorandum to the Commission dated April 3, 2007 (OUO-SII), stated that the staff would not report land contamination/economic consequences in SOARCA because of modeling and policy issues. SRM-COMPBL-08-0002/COMGBJ-08-0003 directed the staff to develop an improved economic consequence model for the MELCOR Accident Consequence Code System (MACCS). This SRM also stated that the resulting model may be applied to the SOARCA results if so directed by the Commission. The study should follow the same approach by not reporting land contamination.

    Response: Land contamination and economic consequences results from MACCS2 models are routinely used as inputs in NRC's current regulatory framework in backfit/regulatory analyses and, in SAMA/SAMDA analyses, and have been reported in previous research studies (e.g. NUREG/CR-6451, NUREG/CR-4982). Regarding the use of MACCS2 for SAMA analyses, the ASLB has ruled that the models are adequate for the regulatory purpose (Accession No. ML11200A224).

A paragraph has been added to the introduction to describe the study's relationship to the Tier 3 activities and how the study will be used in the regulatory process. Chapter 7 was revised to distinguish the safety-related individual health effects measures from other measures that are inputs to the cost-benefit analysis for the regulatory analysis. NRR will use these measures within NRC's current regulatory framework.

Regarding the memorandum to the Commission dated April 3, 2007, current staff updated its position on MACCS models in Enclosure 9 of SECY-12-0110 stating:

> It is not obvious to current MACCS2 experts at both the NRC and Sandia National Laboratories (SNL) that rehabilitation and clean up, land contamination area, or economic models and results are excessively conservative. Economic results and some land contamination area results are controlled by user inputs and could be biased to be either conservative or nonconservative, depending on the input values selected by the user. A MACCS2 user's guide and code manual is available for reference when deciding various parameter inputs. Other land contamination areas produced by MACCS2 are influenced chiefly by the Gaussian plume and deposition modeling. Based on the 2004 benchmarking study, these values do not appear to have either a conservative or nonconservative bias.

The new economic model is not relevant to this study. It has not been completed and is not available for use at this time. Enclosure 9 of SECY-12-0110 also provides details on this project.

12. Table 3 (the last entry on page 19) includes this sentence: "Vertical spectral accelerations as high as horizontal accelerations are justified on the bases that nearby earthquakes control the ground motions spectra for this event and that the frequencies of interest for the study are frequencies near or above 10 Hz." Provide the basis for the assumption that nearby earthquakes control the estimated ground motions at the reference site.

    Response: The revised report now reads:

    > A few studies (e.g., McGuire, Silva, and Costantino, 2001; ASCE, 1999) indicate that for rock sites and frequencies near and above 10 Hz, and especially nearby seismic sources, vertical spectral accelerations may be as high as or exceed horizontal spectral accelerations. For this study, the frequencies of interest are, for the most part, frequencies near or above 10 Hz. Therefore, the assumption of equal vertical and horizontal spectral accelerations was deemed to be a reasonable starting assumption. This assumption is also supported by seismic hazard de-aggregation with the USGS (2008) model (http://earthquake.usgs.gov/hazards/apps/#deaggint) which indicates that for the seismic bin of interest (high PGA, low likelihood events) the contributors to risk would be moderate magnitude earthquakes at nearby distances.

13. Table 3 (the first entry on page 20) includes this paragraph:

The current seismic assessment uses a model and code generated by the US Geological Survey (USGS, 2008). The USGS 2008 information is being further developed and updated by a group of stakeholders, including the NRC, in a collaborative study which includes (a) the seismic source zone characterization, and (b) the ground motion attenuation models. In addition, the NRC is developing independent methods and computer codes, which will be publicly available when completed, to combine (a) and (b). Although part (a) of this updating effort has been completed in early 2012, part (b) and the computer code development are still ongoing. Therefore, this study used the earlier USGS information instead of the ongoing update program.

a. It seems that the intent of this paragraph is to reference the recently published Central and Eastern United States Seismic Source Characterization (CEUS SSC) model. Instead of saying: "The USGS 2008 information is being further developed and updated by a group of stakeholders, including the NRC, in a collaborative study," the paragraph should reference the CEUS SSC model and note that it is a new seismic source model cosponsored by EPRI, DOE, and NRC. Also, clarify that CEUS SSC is independent of the USGS 2008 model.

b. Change "ground motion attenuation models" to "ground motion prediction equations (GMPEs)" and make the distinction that the GMPE update effort was not part of the CEUS SSC model and it is an industry effort, which is still in progress.

c. Add a sentence to justify the use of the USGS 2008 model for the purposes of this scoping study, since the USGS hazard model is not endorsed by the NRC in licensing new reactors (currently the CEUS SSC model is the NRC approved starting model).

d. Add a disclaimer stating that the use of the USGS hazard is not consistent with the hazard defined in the licensing basis for new reactors.

e. This comment also applies to Section 3.1 (page 29, 2nd paragraph).

Response: The revised report will read (note that for a scoping study of this type we try, to the extent possible, to avoid references to application reviews or licensing-related activities)

> A group of stakeholders, which includes the NRC, is developing a new probabilistic seismic hazard model in a collaborative study which comprises two parts: (1) the seismic source zone characterization and (2) the ground motion attenuation models. In addition, the NRC is developing independent methods and computer codes, which will be publicly available when completed, to combine parts (1) and (2) above. Although part (1) of this updating effort has been completed (NRC, 2012b), it was not completed at the start of this scoping study. In addition, part (2) and the computer code development are still ongoing. Therefore, this study used the existing USGS (2008) model instead of the model in the ongoing program

14. Table 3 (the first entry on page 22) includes this paragraph:

In general, for an aftershock to cause subsequent additional damage to a structure, it would have to occur much closer to the site than the main event and with characteristics, for example frequency content, that would make the structure especially vulnerable to it. The earthquake ground motion considered in the SFP scoping study is a probabilistic quantity that aggregates motions from events with various magnitudes and distances to the site. For this site, this probabilistic ground motion already tends to be controlled by relatively close events in the larger magnitude range for the credible seismic sources. . This main shock cracks the SFP studied but its structure is still stable after the earthquake and it cracks in a manner that allows for additional loading cycles at this level. Under these conditions, earthquake ground motions greater than those for the main shock would be needed to further damage the SFP. This is unlikely given that the ground motion considered is already controlled by close events with magnitudes near the credible upper magnitudes for the site.

It would be better to just state that current probabilistic seismic hazard analysis (PSHA) models do not consider aftershocks and that is why they were not considered in this study. Otherwise the statements in the above paragraph would lead to the following comments that should be clarified:

a. There is no discussion on the controlling earthquakes and the associated annual exceedance frequencies to support the statement that "[f]or this site, this probabilistic ground motion already tends to be controlled by relatively close events in the larger magnitude range for the credible seismic sources."

b. Aftershocks can be numerous and substantial (especially if the study is considering very low probability events).

c. Aftershocks could in fact be closer to the site than the main shock, and that could be significant since the report stated previously that the estimated ground motions at the reference site are controlled by nearby events.

Response: We verified that the contributing earthquakes are nearby events and the report has been modified to read:

> In general, for an aftershock to cause subsequent additional damage to a structure, it would have to occur significantly closer to the site than the main event as well as spectral accelerations at frequencies that would make the structure vulnerable to the ground motion. For this site, and for events associated with PGAs and spectral accelerations of interest for risk assessment (high PGA, low likelihood events), the main contributors to the ground motion hazard for this site are expected to be moderate magnitude nearby earthquakes (http://earthquake.usgs.gov/hazards/apps/#deaggint). The main event would crack the SFP studied but its structure would be stable after the earthquake and would crack in a manner that is expected to resist additional loading cycles at this level. Under these conditions, earthquake ground motions with damage potential greater than that for the main event would be needed to further damage the SFP. This is thought to be unlikely given that the contributors to the ground motion hazard are already nearby events.

15. Section 3.1 (page 29, 3rd paragraph) mentions the hazard estimates for a rock site. The report should discuss the implications for soil sites, as well as the implications of sites with different controlling earthquakes. Clarify how SFP characteristics vary between different operating plants and what are the implications of this variation.

    Response: The study focuses on, to the extent possible, a site-specific hazard estimate to avoid assumptions that are not realistic. The site chosen is a rock site. Consideration of the items raised would be out of the scope of the work. See also the response to Comment #1.

16. Section 3.1 (page 29, paragraphs 4 to 6) includes bullets that compare the USGS 2008 hazard estimates for the reference site with the LLNL and EPRI results. The report should clarify the purpose of these comparisons.

    Response: The report has been revised to read:

    > These comparisons are provided to compare the model used in this scoping study to well-known and extensively documented information sources (LLNL model and EPRI model) that were used in past SFP risk studies.

17. Section 3.1 (page 31, Figures 4 and 5) should indicate in the figure captions that these are hard rock hazard curves.

    Response: The captions have been modified to address the comment.

18. Section 3.2 (page 33, last paragraph) includes this statement: "In addition to the PGA, ground motions at a site are also characterized by their frequency content expressed in terms of response spectra. Based on the USGS 2008 model, a uniform hazard site Ground Motion Response Spectrum (GMRS) (NRC, 2007b) was derived for the GI-199 study and used in this study." It is incorrect to combine the term uniform hazard response spectra with the term GMRS. In addition, Footnote 5 states that "the term GMRS has a specific meaning in the context of Regulatory Guide (RG) 1.208 (NRC, 2007b). In this report, the term GMRS is used more generally." The report should describe how the response spectrum for the selected site was developed. If it is not consistent with the definition of the GMRS in RG 1.208, then use a different name. Clarify whether the response spectrum for the reference site shown in Figure 7 is a uniform hazard response spectrum. In addition, do a global search for "GMRS" because it is used throughout the report.

    Response: The footnote has been deleted. After further examination, it was confirmed that the GMRS in the report is based on the guidance in Regulatory Guide 1.208 used in conjunction with USGS (2008) model. This is clearly noted in the report and repeated often. Use of a different hazard model and maybe a more detailed analysis might produce a somewhat different GMRS. We do not think that the footnote is needed because the assumptions are clearly indicated. Also, as per the response to the comment related to the use of the USGS (2008) model (comment 13) we prefer not to make references to licensing review aspects in a study of this type.

    Nevertheless, when referring to the GMRS, the text in the report will be modified to replace "site GMRS" with "reference GMRS." Also, the text at the end of Section 3.2 and after Table 5 will be modified to read:

In addition to the PGA, ground motions at a site are also characterized by their frequency content expressed in terms of response spectra. Based on the guidance in Regulatory Guide 1.208 (NRC, 2007b) used in conjunction with the USGS 2008 model, mean uniform hazard response spectra were derived to then estimate a reference ground motion response spectra (GMRS) for the GI 199 study. This reference GMRS was subsequently scaled as indicated in Section 3.3 below to obtain the input free-field ground motion response spectra used in this study.

The text at the beginning of Section 3.3 also will be modified to read:

The free-field reference GMRS for horizontal earthquake shaking for this site is based on the response spectrum and PGA used in conjunction with research assessments for GI-199, which utilized the USGS 2008 model. This reference GMRS has a zero-period spectral acceleration (PGA) of about 0.34 g.

19. In Section 3.3 (page 34, 1st and 2nd paragraphs), change "Peach Bottom" to "reference site" and do a global search for further changes because "Peach Bottom" appears in multiple places.

Response: The report will be searched for that and the change made as appropriate, which include the occasions noted in this comment. Note that the report identifies the plant on which the reference plant is based

20. The second paragraph on page 35 includes this statement:

Vertical spectral accelerations and the vertical PGA are taken to be the same as the horizontal spectral accelerations and PGA. This is assumed on the bases that nearby earthquakes would control the ground shaking spectra for this event and that the frequencies of interest for this study are frequencies above 5 Hz (ASCE, 1999) (McGuire, Silva and Costantino, 2001).

The report should describe how controlling earthquakes were determined.

Response: The report has been revised to read.

A few studies (e.g., McGuire, Silva, and Costantino, 2001; ASCE, 1999) indicate that for rock sites and frequencies near and above 10 Hz, and especially nearby seismic sources, vertical spectral accelerations may be as high as or exceed horizontal spectral accelerations. For this study, the frequencies of interest are, for the most part, frequencies near or above 10 Hz. Therefore, the assumption of equal vertical and horizontal spectral accelerations was deemed to be a reasonable starting assumption. This assumption is also supported by seismic hazard de-aggregation with the USGS (2008) model (http://earthquake.usgs.gov/hazards/apps/#deaggint) which indicates that for the seismic bin of interest (high PGA, low likelihood events) the contributors to risk would be moderate magnitude earthquakes at nearby distances.

21. Section 3.3 (page 35, 2nd paragraph) describes other "ground motion response spectra of interest for this study." Clarify which response spectra were used in the structural

analysis described later in the report.

Response: The report has been revised to clarify this. In addition information from Section 4 will be brought to Section 3.3. The end of section 3.2 will include the following:

> These spectra are of interest for comparison purposes. The spectra in the NUREG-1150 study are also of interest because in-structure response spectra calculated for those ground motions were scaled (see Section 4), in approximation, to estimate in-structure response spectra for the input free-field ground motion used in this study.

22. Chapter 11, conclusion 5, footnote 43 gives the timeframe during which the fuel cannot be cooled by air. The Information Security Branch of NSIR should be consulted to confirm that this information is not security-related sensitive unclassified non-safeguards information, because the study is intended to be made publicly available.

    Response: The RES staff views the information as non-sensitive because it stems from the plant's response to a large seismic event (something an adversary cannot generate). Staff will confirm with NSIR and revise the report if necessary.

23. Chapter 11, conclusion 6 seems to imply that the additional spent fuel pool instrumentation required by Order EA-12-051 is not effective for mitigating spent fuel pool accidents. Text should be added to this conclusion to explain its technical basis.

    Response: The report indicates that the required instrumentation is important to provide reliable indication to ensure that plant personnel can prioritize emergency actions. Further indication can affect which mitigation strategy is deployed as discussed in Chapter 2 of the report. Consideration of EA-12-051 was outside the scope of the study because it was not implemented by industry or verified by NRC at the time the plant was analyzed.

24. Chapter 11, conclusion 7 seems to imply that the additional mitigation capabilities required by Order EA-12-049 were not credited in the study. The additional mitigation capabilities required by Order EA-12-049 should be credited to improve the study's realism.

    Response: Consideration of EA-12-049 was outside the scope of the study because it was not implemented by industry or verified by NRC at the time the plant was analyzed.

25. Chapter 11, conclusion 16 states the study demonstrates that past spent fuel pool risk estimates from large seismic events are similar to this study for most consequence metrics. Text should be added to this conclusion to explain its technical basis

    Response: Agreed and revised the conclusion to reference consequence comparison in Appendix B.

NSIR

26. Intro and Background Comments provided are repeated from the BC level review. Pg.8, Section 1.5, the report identifies that the majority of the risk from a seismic event is due to the inability of the operator to inject water into the pool for an extended period of time

(e.g., days). However, this is based upon a research assumption and not a direct result of the seismic event. As such, a general comment that the research assumption of inability of mitigation efforts to commence for 48 hours is not based upon current Emergency Preparedness program capabilities which would assume that mitigation efforts commence significantly sooner rendering offsite release consequences moot. This acknowledgement of EP capabilities needs to be clearly stated early in the document and continuously throughout. If licensees presented onsite and offsite coordinated emergency response plans with the response assumptions used in this report, a reasonable assurance finding would definitely be in question.

Response: The assumptions in the study and the results of the study do not call into question a finding of reasonable assurance. Mitigation times for the study were chosen based on those assumed in SOARCA and informed by Fukushima. Section 5.3 has been revised to include a more detailed description of emergency measures in place in case of severe accidents. This section has also been revised to make clear that the truncation and assumed mitigation times were chosen by the team for purposes of the study. The report also makes clear that the initiating event chosen for analysis is well beyond design basis so a SFP failure resulting in offsite consequences is unlikely. The report also discusses the offsite response and challenges to implementing this response.

The report was clarified to explain that NRC analyzes low likelihood beyond design basis seismic events with and without mitigation to gain insights on the safety margin provided by NRC's regulatory framework. The HRA combined with reporting both mitigated and unmitigated results provides informative data to determine possible regulatory enhancements for consideration. The study corroborates the results of past studies. The study concludes that SFPs are robust and not expected to leak as a result of a seismic event, successful mitigation prevents most releases, no early fatalities are expected and individual LCF is low because effective protective actions limits individual exposure.

27. Major Assumptions Comments provided are repeated from the BC level review - Dispositioning of comment was not complete and needs to be completed as a Division Director comment. Major assumptions should include the fact that mitigation time is not indicative of the current EP environment.

    Response: See comment #26. Section 5.3 has been updated to include a more detailed description of emergency measures in place in case of severe accidents. This section has also been revised to make clear that the truncation and assumed mitigation times were chosen by the team for purposes of the study.

28. Pg 60 Comments provided are repeated from the BC level review. Under "Liner Strains and Small Leakage Rates", 1st paragraph, "Maximum effective membrane liner strains from strain concentrations at the floor-walls junction are on the order of 0.037 (3.7 percent)."
    2nd paragraph, "On the basis of the reported failure criteria, this study assumed a somewhat conservative estimate for the liner failure strain from the point of view of leakage rate in order to characterize the leakage rate for a damage state with small leakage flow rate. Specifically, a liner strain at failure of 0.10 (10 percent) was assumed .." This comment was previously sent and the resolution was, "The study calculated the strains caused by the earthquake (demands). The reviewer is citing a sentence that refers to strain capacity." BC comment: clarity needs to be provided in

report as to the differences in the types of strains and the reasons/justification for the assumption which appears to be extremely conservative with respect to the design.

Response: To clarify the items raised in the comment, Section 4.4.1 is re-organized so that the part on Damage States and Relative Likelihoods will be at the beginning of section 4.4.1 (it was the last of three parts in this section). This is done to promptly inform the reader that the study treats both the induced strain (demand) and the limiting failure strains (capacity) as random variables. Although, median induced strains are less than median limiting failure strains, the uncertainty assessment shows that there is a small likelihood that the liner would tear.

The text in the second and third paragraphs of the part Liner Strains and Small Leakage Rates will be modified to read:

> An approach and failure criteria for steel liners used in reinforced concrete containments is used here to assess tearing of the SFP liner (Cherry, 2001 and 1996). Failure criteria for liners without corrosion damage reported by Cherry (1996) are used in this study to estimate limiting failure strains for the stainless steel SFP liner. The approach estimates the crack width by multiplying the liner strain at failure by the width of the finite element with the maximum induced effective strain, which is approximately equal to 3.7 mm (0.15 in.) as indicated above.
>
> Since both the induced strains (demands) and failure strains (capacity) are treated as random variables, the strain at which the liner would tear, that is the condition at which the induced strain exceeds the limiting failure strain, is also random. An approach for a point estimate of that strain would be to calculate the most likely failure strain, which would be a strain greater than the estimated median induced strain (demand) of 0.37 but likely less than the median limiting failure strain (capacity) of about 0.10. Such an approach would involve a more detailed uncertainty analysis and probabilistic modeling than that used in this study, which does not seem justified given the approximations used as well as the uncertainties involved in the assessment of the flow rates through tears in the liner. This study assumed a failure strain of 0.10 (10 percent) for the liner strain at failure which is approximately equal to the assumed median failure strain.

29. Pg 61 Comments provided are repeated from the BC level review. Under "Liner Strains and Small Leakage Rates". "Given the estimated width, length and depth for each localized liner tear and their number, it is still necessary to estimate the leakage rate through these tears. Estimation of this flow rate uses the following assumptions (1) the flow rate can be estimated using an equation similar to that used for flow through the concrete cracks and (2) the friction factor for that equation can be calculated on the basis of test results for leakage rates through cracks in pipes. These assumptions are not validated at this time. Therefore, considerable uncertainty exists for the resulting leakage rate estimate." This comment was previously provided and the response given was: "The assumptions referred to by the reviewer relate to the leakage rate given the estimated cracks in the liner. The initiation of cracks was calculated separately based on the strain demands and capacities." BC Comment: Response does not address comment as to why non-validated leakage rates were assumed. If the leakage rate has considerable uncertainty, the variability in the leakage rate should be stated and the assumed leakage rate needs to be justified as to why it was chosen given the

considerable uncertainty. More clarity needs to be provided on the basis for the assumed leakage rate.

Response: the paragraph is modified to read:

> Given the estimated width, length and depth for each localized liner tear and their number, it is still necessary to estimate the leakage rate through these tears. Estimation of this flow rate uses the following assumptions (1) the flow rate can be estimated using an equation similar to that used for flow through the concrete cracks and (2) the friction factor for that equation can be calculated on the basis of test results for leakage rates through cracks in pipes. These assumptions are not validated at this time. Therefore, considerable uncertainty exists for the resulting leakage rate estimate. The following paragraph addresses the process used to estimate the flow rate through these liner tears as well as sources of uncertainty for this estimation. These uncertainties may result in flow rate estimates that can vary by more than 100 %. It is noted that this damage state (small leakage rate) already is a result of binning the uncertain liner tearing into two discrete tearing conditions to cover a range of uncertainty for liner damage and associated flow rates. Assigning equal likelihood to the two highly distinct damage states acknowledges these uncertainties.

30. Pg 64 Comments provided are repeated from the BC level review. "Damage to the Reactor Building and Other Relevant SSCs" The response to the previously provided comment did not address why the HRA assumed containment failure when the SFPSS did not. The two studies should reflect the same assumptions such that mitigation efforts can be aligned between the studies. As it is, the two studies have significantly different mitigation efforts for different reasons. How can a determination be made as to how the two studies support one another with these differences? This is a fundamental question that needs to be answered/clarified within the report.

    Response: The containment in HRA is the primary containment that if failed in a reactor core damage event would make the refueling floor inaccessible for plant staff to inject or spray water into the SFP.

    The SFPSS assesses offsite consequences. It provides two bounding conditions: 10CFR50.54(hh)(2) mitigation is assumed to be successfully deployed or this mitigation is assumed to not be successfully deployed. The HRA estimates the probability of having successful mitigation for various plant damage states. These two pieces of information (i.e., consequence and probability) complement each other to inform SFP risk. The HRA provides scenario-specific likelihoods for each plant damage state (considering the state of the reactor, offsite power, etc.) The HRA combined with reporting both mitigated and unmitigated results provides informative data to gain insights on the safety margin provided by NRC's regulatory framework as well as possible regulatory enhancements for consideration.

31. Chapter 7 Comments provided are repeated from the BC level review. 1st paragraph, Doses are calculated at a great distance, e.g., 500 miles. Any health effects for small doses at such distance are speculative. As such, there is no value added to the report for this highly speculative result when considering its regulatory purposes. If not removed, then it is recommended that such health effects not be summed but rather segmented into appropriate categories and considered separately.

Response: Given the uncertainty of low doses on health effects, LCFs is being removed as a quantitative metric. See reply to comment #10 for more information. Land interdiction, displaced persons, and societal dose are reported to inform regulatory analysis under NRC's current regulatory framework. The consideration of distances beyond 50 miles is consistent with most previous research studies (See also the response to comment #43).

Individual LCF risk has been separated into appropriate categories and reported as a range based on dose truncation levels, the same as what was done in SOARCA. This SOARCA technique is preferred because it provides a range of results (that can be compared to the qualitative health objectives, for instance).

32. Pg 27 Comments provided are repeated from the BC level review. The original comment (below) as previously submitted with the disposition/response is provided. The "reviewer response" provides additional BC comment on the issue to be considered / dispositioned.

    There is some confusion as to the statement that dose truncation has been implemented. The comment was not referencing the calculation of consequences with differing truncation models as has been done, but rather the summing of small doses to large numbers of people and reporting accumulated health effects while using he LNT model. At the least, the NCRP technique should be used. IT would be preferable to use the techniques of SOARCA and not report speculative dose and health effects beyond the area of regulatory interest to NRC, i.e., 50 miles. Additionally, the reporting of summed health effects, i.e., LCF is not as useful a metric as individual risk of LCF for risk communication purposes. LCF is often misinterpreted as absolute deaths, rather than an estimate of potential consequences given a conservative treatment.

    Response: Given the uncertainty of low doses on health effects, LCFs is being removed as a quantitative metric. See reply to comment #10 for more information. Land interdiction, displaced persons, and societal dose are reported to inform regulatory analysis under NRC's current regulatory framework. The consideration of distances beyond 50 miles is consistent with most previous research studies (See also the response to comment #43).

    Individual LCF risk has been separated into appropriate categories and reported as a range based on dose truncation levels, the same as what was done in SOARCA. This SOARCA technique is preferred because it provides a range of results (that can be compared to the qualitative health objectives, for instance).

33. Pg 150 Comments provided are repeated from the BC level review. Add an item 3 for why the latent cancer fatality risk is low because: 3. of the emergency preparedness response mitigation efforts.

    Response: Section 7.2 has since been rewritten to make this point. In addition, the study concludes that SFPs are robust and not expected to leak as a result of a seismic event, successful mitigation prevents most releases, no early fatalities are expected and individual LCF is low because effective protective actions limits individual exposure.

34. Major assumption I don't agree with the assumption that offsite assistance will not arrive for 24 hours and that mitigative efforts with such equipment (e.g., fire truck) does not begin for 48 hours after the initiating event

    Response: See response to comment #26. In Section 5.3, "At 24hrs" has been changed to "within 24hrs". Section 5.3 has been updated to include a more detailed description of emergency measures in place in case of severe accidents.

35. Chap 8 The HRA improved the study analysis but was unable to judge the effectiveness of offsite resources such as a fire truck. This limitation should be noted as a conservative limitation of the study.

    Response: A table was added to provide an explicit list of scope and assumptions of the HRA study. Further, new text is being explored to clarify.

36. Conclusion 13 The frequencies noted appear to lack consideration of the HRA success probabilities that would, I believe, reduce the frequencies reported.

    Response: The reliability of mitigation is not included as stated in Table 3 in Section 2. The conclusion will be expanded to include mitigation results. The HRA provides scenario-specific likelihoods for each plant damage state (considering the state of the reactor, offsite power, etc.) The HRA combined with reporting both mitigated and unmitigated results provides informative data to gain insights on the safety margin provided by NRC's regulatory framework as well as possible regulatory enhancements for consideration.

37. Section 8.1.2 the dose rate estimate is in error. The peak dose rate at the SFP rail is used whereas the spray would be located some distance back in a lower dose rate region. Additionally, the licensee has shielding on the floor to facilitate placement of the spray.

    Response: Based on the oscillation monitors (or SFP spray nozzles) setup locations as indicated in the procedure TSG-4.1, the authors confirm that the dose rates stated in the report are correct. In addition, NRC staff walked down this strategy at PB in May 2012 with a Region 1 SRA as part of the B.5.b component of the triennial fire inspection with 2 of the individuals (Equipment Operators) assigned to carry out the strategy. At no time did they identify shielding that they anticipated using during deployment of the strategy. Additionally, the plant did not raise this as a result of their fact check of the HRA. Perhaps it is something that has been put in place since May 2012, but if so, it's newer than the snapshot of the plant that we set out to analyze. If the shielding can be confirmed and would have an impact on the results, a qualitative statement to that fact can be added to the report.

38. Section 8.1.2 the timing used in the HRA to denote when mitigation cannot be accomplished due to dose rate or steam environment, misjudges the ability of the ERO to perform the relatively simple task of attaching a fire hose to a spray in a challenging environment. For some analyses, one hour of additional time to mitigate would allow success.

    Response: The high steam (or high temperature) becoming a limiting factor only occurs in small leak scenarios where the available time for response is greater than 13 hours.

Adding one or a few extra hours to the available time has little effects to HRA results. This is because in these situations time is not the dominant factor affecting human performance. Time is more important in moderate leak scenarios in which available time is 6 hours and 2.5 hours for refueling and non-refueling scenarios respectively. The radiation level is the limiting factor in these situations. Based on the SFP spray nozzles setup location indicated in TSG-4.1 the radiation level at the locations at that time is greater than 30 rem/hr. The time is firm in this criterion.

To set up the spray nozzles on the refueling floor in a moderate leak scenario where the leakage rate is greater than nozzle injection rate, based on procedure instruction the plant staff would first connect two fire hoses to two spray nozzles and inject water into the SFP, observing the change of the SFP water level (in this case the SFP water level continues lowering), attach a spray head to the spray nozzles each to change from injection mode to spray mode, ensuring the water spray into the SFP, and place a lead bag on top of the spray nozzle each to damp vibration for stable SFP spray. Completing these tasks requires some time. The 30 rem/hr is a reasonable threshold for the activities.

Furthermore the study assumptions are consistent with Appendix EE of EPRI TR-1025295 (2012) which is the technical basis for Severe Accident Management that the industry is relying on to update their Accident Management Programs.

39. Section 7.1.4 Please replace the second paragraph with the following: The staff modeled offsite response organization (ORO) decision making based upon the accident sequences, timing, radiological release, knowledge of response activities and the availability of emergency response technical support. Since actions beyond the EPZ would be taken ad hoc, there is no procedural guidance or exercise performance documentation upon which to base assumptions. However, state and local OROs have shown long standing capability and understanding of response to hypothetical radiological accidents. The accidents modeled in the SFPSS are slow to develop relative to the accident scenarios used in evaluated exercises. Additionally, there would be national level assistance to help civil authorities with protective action decision making. While alternative timing could be assumed the staff used a best estimate approach to modeling ORO decision making for protective actions beyond the EPZ.

    Response: Text has been added as requested.

40. Section 7.2 This section describes the use of dose truncation models in a manner that suggests they are a method to lower consequences rather than an alternative model. Dose truncation model use should be put in context as alternative and potentially valid health effects model

    Response: Dose truncation models provide two benefits, an alternative (and potentially valid) health effects model as well as a tool to better understand the contributions to LNT risk. Section 7.2 has since been reorganized and now is written to better represent the dose truncation models as potentially valid health effect models.

41. Fig 96 the title is confusing; is it meant to be "% of all individuals that are displaced"?

    Response: Section 7.2 has since been rewritten and the figure no longer exists.

42. General. My primary concern with this document is the fact that we are reporting significant results from a highly conservative and very low probability scenario that could be misinterpreted by the public. Accordingly, I believe that a section should be added to the document that discusses the results in the context of safety and adequate protection; i.e., do we still believe that there is adequate protection with the continued use of wet-storage and is there enough of a safety enhancement from a cost-benefit perspective to warrant moving more to the use of dry storage.

    Response: As stated in Section 1 of the report the U.S. Nuclear Regulatory Commission (NRC) has maintained that SFPs provide adequate protection of the public health and safety in either low-density or high-density storage configurations. This report does not call into question this finding. The study also does not make any determinations regarding whether there is enough of a safety enhancement from a cost-benefit perspective to warrant moving more to the use of dry storage. That is the role of NRR and the regulatory analysis. A paragraph has been added to explain the study's applicability to the Tier 3 activity and the NRC's current regulatory framework. The study corroborates the results of past studies. This study concludes that SFPs are robust and not expected to leak as a result of a seismic event, successful mitigation prevents most releases, no early fatalities are expected and individual LCF is low because effective protective actions limits individual exposure.

43. General The use of our models at great distance (i.e.. up to 500 miles) becomes speculative and indicates a level of fidelity that likely exceeds their veracity. There are uncertainties in source term, dispersion modeling, and weather at distance and deposition at distance. The results are reported with excessive confidence. It would be more appropriate to provide estimates out to a distance that the analysis tools could more confidently calculate (e.g., 50 miles) and estimate qualitatively the potential impacts further away. A statement that the relocation could potentially extend to 500 miles in the worst case, would be more appropriate than reporting the results as the agency best estimate.

    Response: Though MACCS2 has been benchmarked against other Atmospheric Transport and Dispersion models up to 100 miles with favorable results, the authors acknowledge that uncertainty exists In light of this, we have added the statement:

    > The accuracy of atmospheric transport and deposition models tend to decrease with distance, and therefore the results should be viewed with caution.

    In addition, the figures showing land contamination and displaced individuals at specific distances have been replaced with tables that more generally report these consequences at 0-50, 0-100, and 0-500 miles, which is largely consistent with most past research studies.

44. Section 7.3.2 DD Comment: I am providing this comment to give the answer to the "disposition" question. Please reconsider original comment with this additional information:

    after reading this I cannot determine whether contaminated food is included in consequence data or not... it should not be, no one is going to eat contaminated food in the US after this accident.

The basis for stating that no contaminated food will be consumed simply comes from the knowledge of public and civil authority reaction to actual and hypothetical radiological incidents. In repeated exercises public officials have decided to condemn a regional crop rather than parse contamination levels. Public reaction to contaminated food would also be extreme and anything even remotely associated with the contaminated area would be eschewed. There is no technical document establishing this outcome, it is just the nature of current society as alternative food sources would be widely available. It cannot be said the "no contaminated food would be consumed"' as very low levels of radioactivity currently exist in food currently, but the point is that no significant amount of contaminated food would be consumed. Pursuit of dose consequences through this exposure pathway seems inappropriate.

Response: Latent cancer fatalities are no longer being reported, and MACCS2 does not treat this pathway in individual LCF risk, and therefore the report no longer reports any type of LCF metric from ingestion.

RES/DE

This report provides the methodology and results of a limited-scope consequence study to update the best-estimate consequences expected from the application of a postulated beyond-design-basis earthquake (with an estimated frequency of occurrence of one event in 61,000 years) to a selected U.S. Mark I boiling-water reactor spent fuel pool. The primary objective of the study is to provide updated and publicly available consequence estimates of a representative, postulated spent fuel pool severe accident under high-density and low-density loading conditions. These estimates can then inform ongoing discussions as to whether action should be taken to require operators of U.S. nuclear power plants to expedite movement of fuel from the spent fuel pool to onsite, dry cask storage.

I would delete the last sentence and replace it with this:

These estimates can be used to confirm that the current industry strategy favoring high density fuel storage in spent fuel pools remains adequately safe and whether a change in strategy towards low density fuel storage in spent fuel pools might represent a significant safety improvement.

Response: We did not change the wording as suggested, but we did revise the wording to say "The study will be used to inform regulatory decision-making regarding whether expedited transfer of spent fuel from spent fuel pools to casks is justified." Additionally, a paragraph has been added to the report to describe the study's relationship to the Tier 3 activities and how the study will be used in the current regulatory process.

Mrowca, Lynn

From: Rodriguez, Veronica
Sent: Wednesday, May 25, 2011 9:55 AM
To: Coe, Doug; Demoss, Gary
Cc: Mitman, Jeffrey; Wong, See-Meng; Mrowca, Lynn; Coyne, Kevin; Beasley, Benjamin; Correia, Richard; Siu, Nathan; Stutzke, Martin; Barnes, Valerie; Nicholson, Thomas; Peters, Sean; Ott, William; Hudson, Daniel; Ibarra, Jose; Drouin, Mary; Lee, Samson; Cheok, Michael
Subject: RE: Join Us ... DRA Seminar: Risk Assessment of Fukushima Daiichi Reactors and Spent Fuel Pools

NRR

Outside of Scope

From: Coe, Doug
Sent: Wednesday, May 25, 2011 8:00 AM
To: Rodriguez, Veronica; Demoss, Gary
Cc: Mitman, Jeffrey; Wong, See-Meng; Mrowca, Lynn; Coyne, Kevin; Beasley, Benjamin; Correia, Richard; Siu, Nathan; Stutzke, Martin; Barnes, Valerie; Nicholson, Thomas; Peters, Sean; Ott, William; Hudson, Daniel; Ibarra, Jose; Drouin, Mary; Lee, Samson; Cheok, Michael
Subject: RE: Join Us ... DRA Seminar: Risk Assessment of Fukushima Daiichi Reactors and Spent Fuel Pools

RES

Thanks very much Veronica! What a great idea. I'm just afraid that because of the late notice and scheduled date on the Friday before a 3-day weekend, many interested staff may not be able to attend.

Gary - Perhaps we could also do a joint NRR/RES seminar within the next couple months and include Mary Drouin's work on providing Event Sequence Diagrams to the Ops Center. Maybe even engage some of the RST directors (e.g. Fred Brown) and NSIR/IRC staff to provide their perspectives? This is a marvelous KT opportunity while these things are still fresh in our minds.

From: Rodriguez, Veronica
Sent: Tuesday, May 24, 2011 6:02 PM
To: Mrowca, Lynn; Demoss, Gary; Coyne, Kevin; Beasley, Benjamin; Coe, Doug
Cc: Mitman, Jeffrey; Wong, See-Meng
Subject: FW: Join Us ... DRA Seminar: Risk Assessment of Fukushima Daiichi Reactors and Spent Fuel Pools

NRR

Outside of Scope

From: Rodriguez, Veronica
Sent: Tuesday, May 24, 2011 5:59 PM
To: NRR_DRA Distribution
Subject: Join Us ... DRA Seminar: Risk Assessment of Fukushima Daiichi Reactors and Spent Fuel Pools

NRR

DRA SEMINAR

Risk Assessment of Fukushima Daiichi Reactors and Spent Fuel Pools

In support of the NRC's Team in Japan, NRR's Division of Risk Assessment developed risk models of the Fukushima Daiichi reactors and spent fuel pools (SFP). These models characterized the "temporary" systems put in place to cool the fuel in the reactors and SFPs. The models were built in SAPHIRE using basic risk methods including: event and fault trees, human reliability analysis, etc. This seminar will present an overview of the risk models and the risk insights gained from the analysis. The primary insights were a list of vulnerabilities and risk prioritization for lowering the risk of a future large release.

A6-6

WHEN? Friday, May 27, 2011
TIME? 11:00am–12:00pm (ET)
WHERE? T-7A01

Presentation to be provided by:
Jeffrey Mitman and See-Meng Wong

Schaperow, Jason

F3ME

From: Wagner, Katie
Sent: Tuesday, May 29, 2012 5:33 PM
To: Lee, Richard; Coyne, Kevin; Hogan, Rosemary; Santiago, Patricia
Cc: Schaperow, Jason; Madni, Imtiaz; Esmaili, Hossein; Helton, Donald; Murphy, Andrew; Nosek, Andrew; Pires, Jose
Subject: DRAFT SFPSS report for review by EOB on June 4th
Attachments: SFPSS Report.pdf; Equation (SFPSS Report).docx; Comment Tracker - Unresolved or Refuted.xlsx

Good Afternoon Richard, Kevin, Rosemary, and Pat,

Attached is the draft SFPSS report for your review, which is about 200 pages long. We ask that you complete your review by EOB on Monday, June 4th. Here are a few notes about this document:

- The SFPSS team is still working to resolve comments and have not reviewed each other's sections in detail. However, the team is comfortable sending this draft forward for review at this time.
- The equations do not show up in this version of the document, so an equation list is attached for your information.
- Some MACCS2 runs have not been completed at this time due to the pending implementation of new evacuation models developed by NSIR in cooperation with Sandia staff. The team does not expect most of the results to change dramatically once those are complete and I will send you the final offsite consequences chapter once that chapter is complete.
- The concurrence package is currently in the process of coming together. In the package, the report will be an enclosure to a memo with the following characteristics (I will write the memo and send it to you in the next day or two):
  - Will be from B. Sheron to E. Leeds.
  - Content:
    - Discuss that the SFPSS is a RES product that was executed as laid out in the July 2011 project plan.
    - Discuss that the SFPSS is for NRR consideration as part of the Tier 3 Japan Lessons Learned item.
    - Will contain a placeholder for a few main conclusions.

(b)(5) Ex. 5

- OPA sent extensive comments on the abstract and executive summary of the report on the afternoon of Thursday, May 24th. The SFPSS team has not processed these comments yet.
- I received comments from QTE on the afternoon of Tuesday, May 29th. The SFPSS team has not processed these comments yet either.

Note: Jason and Imtiaz have been cc'ed since they are acting for Pat this week.

Thanks,

Katie Wagner
General Engineer
U.S. Nuclear Regulatory Commission
(301) 251.7917
Katie.Wagner@nrc.gov

A6-7

#	Comment	response
1	Seismic initiator - The analysis does not include a concurrent reactor accident.	This is clearly articulated in the report assumptions, and is consistent with the state-of practice.
2	Arrangement of fuel - Peach Bottom uses a 1x8 arrangement of fuel, not the 1x4 arrangement assumed in the study.	The 1x8 arrangement currently in use at Peach Bottom is believed to be highly atypical, is not required by regulation, and is not expected to have a large effect on the study results (i.e., the 1x4 configuration achieves much of the benefit of dispersing fuel). In addition, the timing of obtaining the actual pool configuration, along with conveniences associated with how the MELCOR SFP model is currently designed, also played a role in the decision to use the 1x4 configuration. In cases where the 1x8 might affect conclusions, this is identified.
3	Pool damage - Fukushima shows that an earthquake would not make a hole in a spent fuel pool	Along with being a different hazard characterization, and being a different site (propagation of the seismic hazard), it is important to recall that our study shows it is unlikely that damage to the pool would occur. The report discusses the relationship between this study and the Japanese earthquakes
4	Mitigation - Peach Bottom-specific mitigation measures are not credited.	That is not true. In a few cases, PB-specific capacities are not credited, based on discussions with NRR.
5	Mitigation - Makeup and spray are likely, because the spent fuel pool is an open system and there is a long time available until draindown and fuel damage. Also, offsite equipment began arriving at Fukushima within about 6 hours (INPO report of November 2011)	The Japanese reference is a bit misleading, given that they were still frantically trying to add water to the pool many days in to the event. Regardless, the approach of doing mitigated versus unmitigated was established as part of the project's original design
6	Mitigation - The operators are likely to make openings in the reactor building to aid in spent fuel pool cooling and to prevent a buildup of hydrogen from a concurrent reactor accident.	To my understanding, and having been involved in the most recent inspection at PB on these strategies, I do not believe their procedures would direct this. Also note that industry was very reluctant to implement such actions (which to my understanding are not generally required) because of the loss of secondary containment (holdup).
7	Mitigation - For one of the "mitigated" cases, the analysis assumes makeup when spray is needed (and available) to prevent fuel overheating.	The report discusses this, and deployment mode reflects the lack of instrumentation and clear guidance to drive this decision. Note that, in some cases, the mode selection did not affect the results
8	Mitigation - The "unmitigated" cases include some B.5.b mitigation, namely, arranging the fuel in a favorable pattern for cooling.	That is a pre-event action, not deployed mitigation, and (as I understand it) is actually prescribed in Part 73, not 50.54(hh)(2).
9	Release from clad-pellet gap - The assumed release of cesium (magnitude of 0.05, chemical form: CsOH) is conservative.	In the report, it mentions the following – "The gap inventory is specified in Table 25 based on NUREG-1465 [NRC, 1995]. It should be noted that in NUREG-1465, it is stated that for accidents where long term cooling is maintained (e.g., postulated spent fuel handling accident), the gap release could be as low as 3%. However, in the unmitigated scenarios in this work, the fuel experiences prolonged high temperatures (and even failure in some instances). Therefore, in the present work, it is conservatively assumed that 5% applies to all scenarios." — Additional thought from KC - I think your approach is fine. It allows some room for uncertainty in inventory. Actually, I think that the gap Cs is split between CsI and CsOH. There is no I-131 for the older fuel but there can be other stable iodine isotopes.
10	Release from fuel pellet - The modeling was validated using in-pile tests for reactor accidents, which is not prototypical of spent fuel pool accidents which progress more slowly and have lower fuel temperatures.	The release models are time-at-temperature models, so they inherently include the effect of lower temperatures. As for the lack of validation of the release models for spent fuel pool accidents, that is an unavoidable situation when using the tool "as is," and at best could be addressed using sensitivity studies that would likely show that this particular item has no more uncertainty on the overall results than do any number of modeling assumptions. — Additional thoughts from KC - I think that I could make an argument that the in-pile tests are not characteristic of reactor accidents and better represent SFP accidents. At the start of the (reactor) MOX project, it was expected that MOX releases would be much higher because the VERCOS (I think) tests showed higher MOX releases at intermediate temperatures. When we ran characteristic reactor severe accident scenarios, the fuel temperatures shot past those carefully controlled temperatures to very high values. At that point, the MOX releases were really, really, really fast and the LEU was just releasing really, really fast. It did not matter. All the volatile fission products came out at about the same rate. I think the test data is much better for long sustained heat ups. But I might
11	Hydrogen combustion - A single node is used for the area between the refueling floor the reactor building roof. Simple parametric modeling is used for determining whether there will be a burn.	Again, this is an uncertainty associated with using the code "as is." Some sensitivity studies have been carried out and the report will acknowledge this as an important assumption. In addition, CFD analysis showed very strong mixing currents in the refueling bay and uniform mixing would be expected.
12	Public evacuation - Assuming that we can evacuate tens and even hundreds of thousands of people but we cannot get a couple of people up to the spent fuel pool with a fire hose seems illogical.	You need equipment, you need access, you may have a leak rate that exceeds your pumping capability, you may be trying to use a firewater system that did not survive the event, you may be dealing with the reactor accident. It is more accurate to say that we are able to evacuate tens or hundreds of thousands of people from areas largely unaffected by the seismic event, while we may be unable to ensure adequate inventory in the SFP based on a large leak rate, radiological impediments, seismic damage, etc.
13	Public evacuation - NRC recommended a 50-mile evacuation for Fukushima.	We agree, but we're not sure what the point is relative to SFPSS.

14	Public evacuation - MELCOR and MACCS analysis was used for developing evacuation and relocation assumptions, instead of RASCAL.	Yes, that is the nature of a research project rather than a actual event (the approach is the same as SOARCA) We actually thought it would be best to use the SOARCA evacuation models as is so if your concern is with the modified models you'll have to take that up with NSIR. Also, it is our understanding that Eric (NSIR) did do some RASCAL analysis.
15	Results - The consequence/risk results presented in the study assume the probability of mitigation is zero.	The mitigated results assume the failure probability for successful deployment of mitigation is 0. The unmitigated results assume it is 1

SECY

NRO's OK to release.

Schaperow, Jason

From: Schaperow, Jason
Sent: Wednesday, August 22, 2012 10:37 AM
To: Mrowca, Lynn
Subject: FW SRM -as requested (EOM)
Attachments: SRM 07-16 M120607C.DOCX; Spent Fuel Pool Scoping Study.doc

Regarding the Spent Fuel Pool Scoping Study, the Commission issued the attached SRM on July 16, 2012. The SRM contains additional requirements on:

- Comparing against risk associated with expedited movement to casks.
- Quantifying the risk reduction associated with mitigation.
- Considering the performance of spent fuel pools during actual earthquakes.

I have other comments on the Spent Fuel Pool Scoping Study, which I provided to RES in May 2012. They are attached for your information.

Jason

From: Wagner, Katie
Sent: Tuesday, August 21, 2012 1:56 PM
To: Schaperow, Jason
Subject: SRM -as requested (EOM)

A6-8

SECY

ML121980043

July 16, 2012

IN RESPONSE, PLEASE
REFER TO: M120607C

MEMORANDUM TO: Edwin M. Hackett, Executive Director
Advisory Committee on Reactor Safeguards

R. W. Borchardt
Executive Director for Operations

FROM: Andrew L. Bates, Acting Secretary /RA/

SUBJECT: STAFF REQUIREMENTS – MEETING WITH THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS, 9:30 A.M., THURSDAY, JUNE 7, 2012, COMMISSIONERS' CONFERENCE ROOM, ONE WHITE FLINT NORTH, ROCKVILLE, MARYLAND (OPEN TO PUBLIC ATTENDANCE)

The Commission met with the Advisory Committee on Reactor Safeguards (ACRS) to discuss the Committee's recent accomplishments and its ongoing and future activities. The ACRS presented updates on the following specific issues: 1. Spent Fuel Pool Scoping Study (SFPSS), 2. Implementation of Fukushima Recommendations, 3. State-of-the-Art Reactor Consequences Analyses (SOARCA), and 4. NRC Research Program.

As the ACRS noted in its April 25, 2012, letter on the SFPSS and reiterated during its meeting with the Commission, "since the study will not address the safety consequences of the same severe seismic events on cask loading, transportation, or long-term storage, the overall safety benefit will not be quantified. The possibility that there could be negative safety consequences associated with the expedited loading, transfer, and long-term storage of possibly thousands of DCSS [dry cask storage systems] would need to be considered."

The Office of Nuclear Regulatory Research should conduct a comparative assessment of SFPSS results against previous studies of safety consequences associated with loading, transfer, and long-term dry storage. These previous studies should be updated as necessary to conduct the comparative assessment.

The staff should also conduct a human reliability analysis focused on the capability to implement effective spent fuel pool cooling mitigating strategies, such as those required by 10 CFR 50.54(hh) or the recently issued Order EA-12-49, "Mitigation Strategies for Beyond-Design-Basis External Events."

In addition, the SFPSS should consider the evidence from the performance of the spent fuel pools during the real incidents identified in the additional comments by ACRS members in the April 25, 2012, letter.

The results of the SFPSS and the comparative assessment should be provided to the ACRS for its review, and subsequently provided to the Office of Nuclear Reactor Regulation for use in disposition of the Near-Term Task Force Tier 3 item on spent fuel storage, and sent to the Commission as an information paper after the staff has addressed the ACRS's comments.

cc: Chairman Macfarlane
Commissioner Svinicki
Commissioner Apostolakis
Commissioner Magwood
Commissioner Ostendorff
OGC
CFO
OCA
OIG
OPA
Office Directors, Regions, ASLBP (via E-Mail)
PDR

Patel, Amrit

From: Patel, Amrit
Sent: Thursday, March 31, 2011 8:24 AM
To: Wood, Kent
Cc: VanWert, Christopher
Subject: RE: Neutron Absorber Degradation in Full Density Water
Attachments: Optimum Moderation of BWR REFFE Lattice With Full Absorber Degradation.xlsx

Kent,

See attached.

NRO - OK

Regards,

Amrit D. Patel
U.S. Nuclear Regulatory Commission
General Engineer
NRO/DSRA/SRSB

From: Wood, Kent
Sent: Wednesday, March 30, 2011 10:43 AM
To: Patel, Amrit
Cc: VanWert, Christopher
Subject: RE: Neutron Absorber Degradation in Full Density Water

Refer to NRR

Amrit,

I found this yesterday after we talked. What I took from it was that from 100% absorber in place to 0% absorber in place was a 20-30% increase in keff

If you have some time I'd appreciate if you could run some case and see if there is a optimum moderation effect, both with and without the absorber.

Thanks,

Kent

From: Patel, Amrit
Sent: Wednesday, March 30, 2011 10:02 AM
To: Wood, Kent
Cc: VanWert, Christopher
Subject: Neutron Absorber Degradation in Full Density Water

Kent,

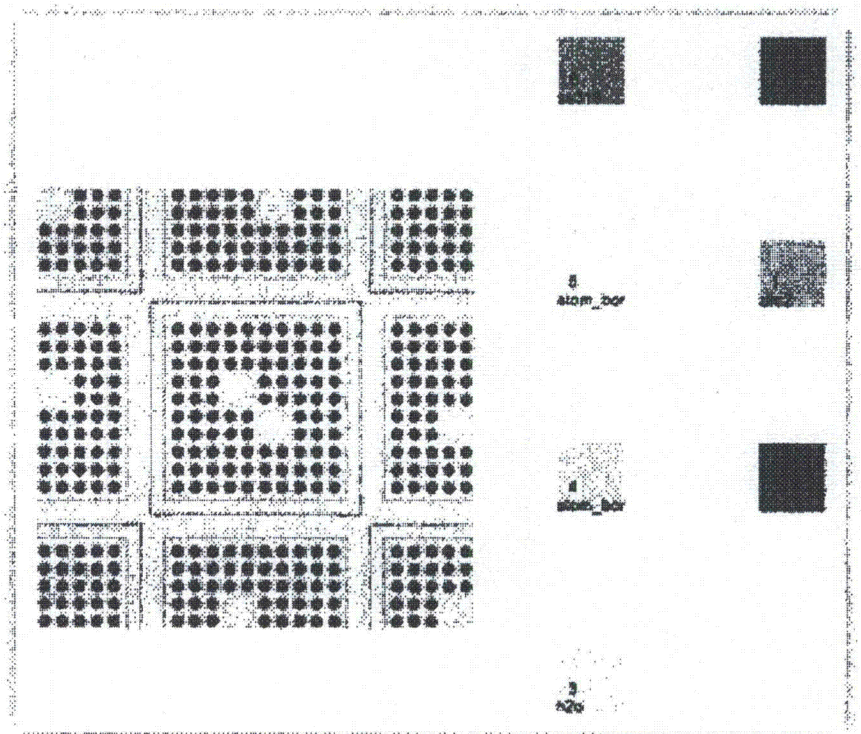
NRO - OK

The figures below are from the papers I prepared while on rotation in SRXB. The rack design is based on the Peach Bottom pool. The BWR fuel assembly type was a 10 x 10 array modeled with fresh fuel isotopics. The reactivity equivalent fresh fuel enrichment (REFFE) of 2.67 wt% U-235 was used to simulate the maximum reactivity state of the in-reactor depleted fuel. The lattice used for the criticality calculation with the REFFE fuel includes no vanished rods and no gadolinium.

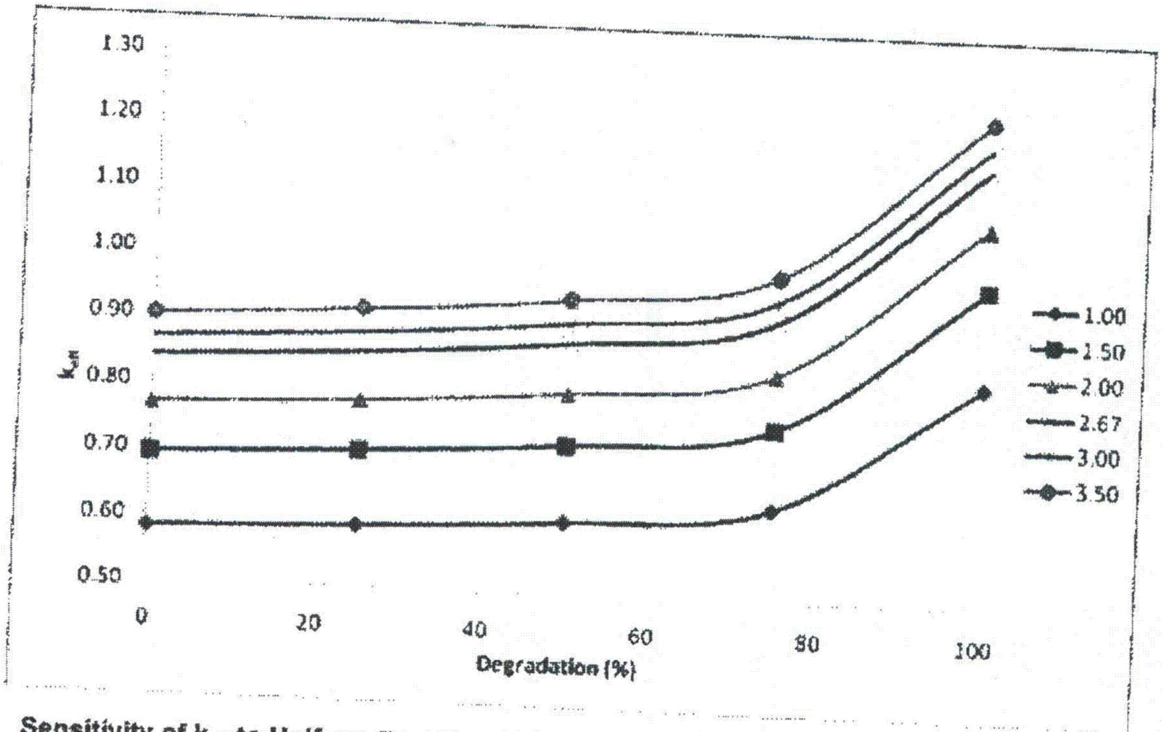
A6-9

The purple curve would likely be of most interest since this corresponds to the reactivity equivalent of spent fuel at peak reactivity. Of course, this is for full density water. If you still want, I can do a criticality search iterating over moderator density at 100% absorber degradation to find the optimum moderation. Let me know.

I'm not sure how helpful this particular case is considering we don't know their pool design and management scheme.



X-Y View of Unit Cell at Axial Mid-Plane for the BWR rack.



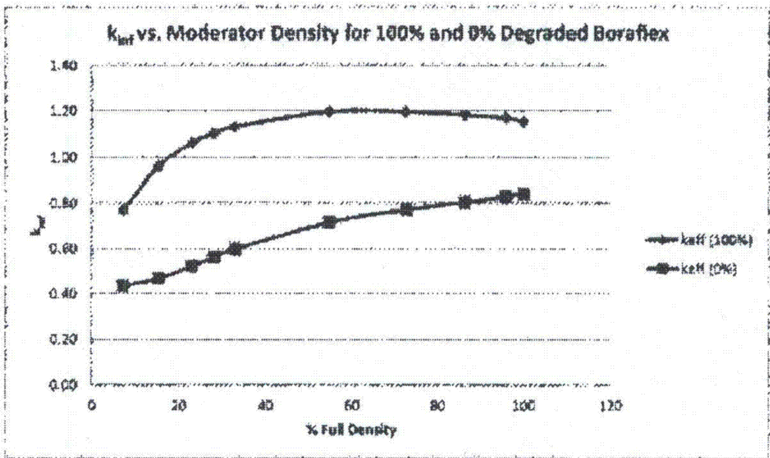
Sensitivity of k_{eff} to Uniform Boraflex Degradation for Various Fresh Fuel Enrichments.

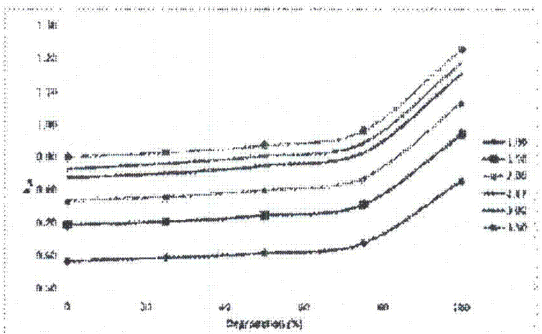
Regards,

Amrit D. Patel
U.S. Nuclear Regulatory Commission
General Engineer
NRO/DSRA/SRSB

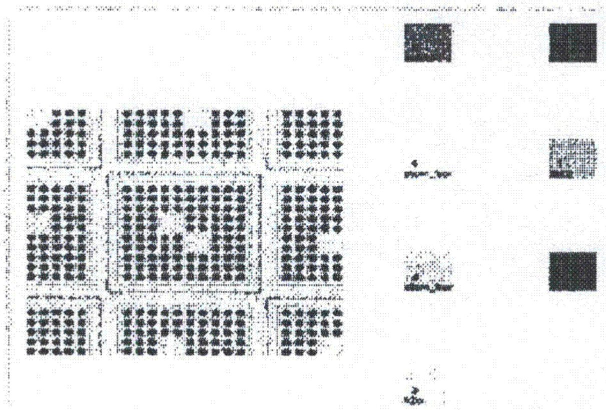
Optimum Moderation Search

Temperature (°F)	Temperature (°C)	Temperature (K)	Density	% Full Density	k_{eff} (100%)	k_{eff} (0%)
68	20	293	0.9982	100	1.16557	0.83987
212	100	373	0.9581	96	1.17000	0.83086
392	200	473	0.8623	86	1.18367	0.80383
572	300	573	0.7246	72	1.19837	0.77094
752	400	673	0.5466	55	1.19747	0.71616
932	500	773	0.3289	33	1.13351	0.59873
968	520	793	0.2807	28	1.10396	0.56373
1004	540	813	0.2308	23	1.08238	0.52361
1058	570	843	0.1531	15	0.981453	0.46962
1112	600	873	0.0719	7	0.766694	0.43511





Sensitivity of k_{eff} to Uniform Boraflex Degradation for Various Fresh Fue Enrichments (Full Density Moderator).



X-Y View of Unit Cell at Axial Mid-Plane for the BWR rack.

NRR

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

Post 9/11 Spent Fuel Pool Mitigation Measure Requirements

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April 29, 2011

Regulatory Requirements

- IMC Order EA-02-026, Section B.5.b
- License Conditions
- 10 CFR 50.54(hh)(2)
  - 10 CFR 50.34(i)
  - 10 CFR 52.80(d)
- 10 CFR 50.150 (new reactors only)

B.5.b

"Develop specific guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities using existing or readily available resources (equipment and personnel) that can be effectively implemented under the circumstances associated with the loss of large areas of the facility due to explosions or fire."

License Condition

Develop and maintain strategies for addressing large fires and explosions and that include the following key areas:

(1) Fire fighting response strategy with the following elements:

1. **Pre-defined coordinated fire response strategy and guidance**
2. **Assessment of mutual aid fire fighting assets**
3. **Designated staging areas for equipment and materials**
4. **Command and control**
5. **Training of response personnel**

(2) Operations to mitigate fuel damage considering the following:

1. **Protection and use of personnel assets**
2. **Communications**
3. **Minimizing fire spread**
4. **Procedures for implementing integrated fire response strategy**
5. **Identification of readily-available pre-staged equipment**
6. **Training on integrated fire response strategy**
7. **Spent fuel pool mitigation measures***

(3) Actions to minimize release to include consideration of:

1. **Water spray scrubbing**
2. **Dose to onsite responders**

*** Omitted from those that screened out in Phase 2 Assessments**

Phase 2 Assessment Results

- 3 Licensees screened out
  - Farley
  - Indian Point 2
  - Seabrook
- Criteria:
  - SFP below grade
  - Walls protected by backfill
  - Inadequate volume to drain

10 CFR 50.54(hh)(2)

Each licensee shall develop and implement guidance and strategies intended to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities under the circumstances associated with loss of large areas of the plant due to explosions or fire, to include strategies in the following areas:

(i) Fire fighting;

(ii) Operations to mitigate fuel damage; and

(iii) Actions to minimize radiological release.

10 CFR 50.150(a) Aircraft Impact Assessment

- Applies to applicants for CP, OL, DC or COL issued after July 13, 2009.
- Applicants must perform rigorous aircraft impact assessment.
- Applicants must incorporate design features to show that, with reduced use of operator action:
  - Either the reactor core remains cooled <u>OR</u> the containment remains intact,

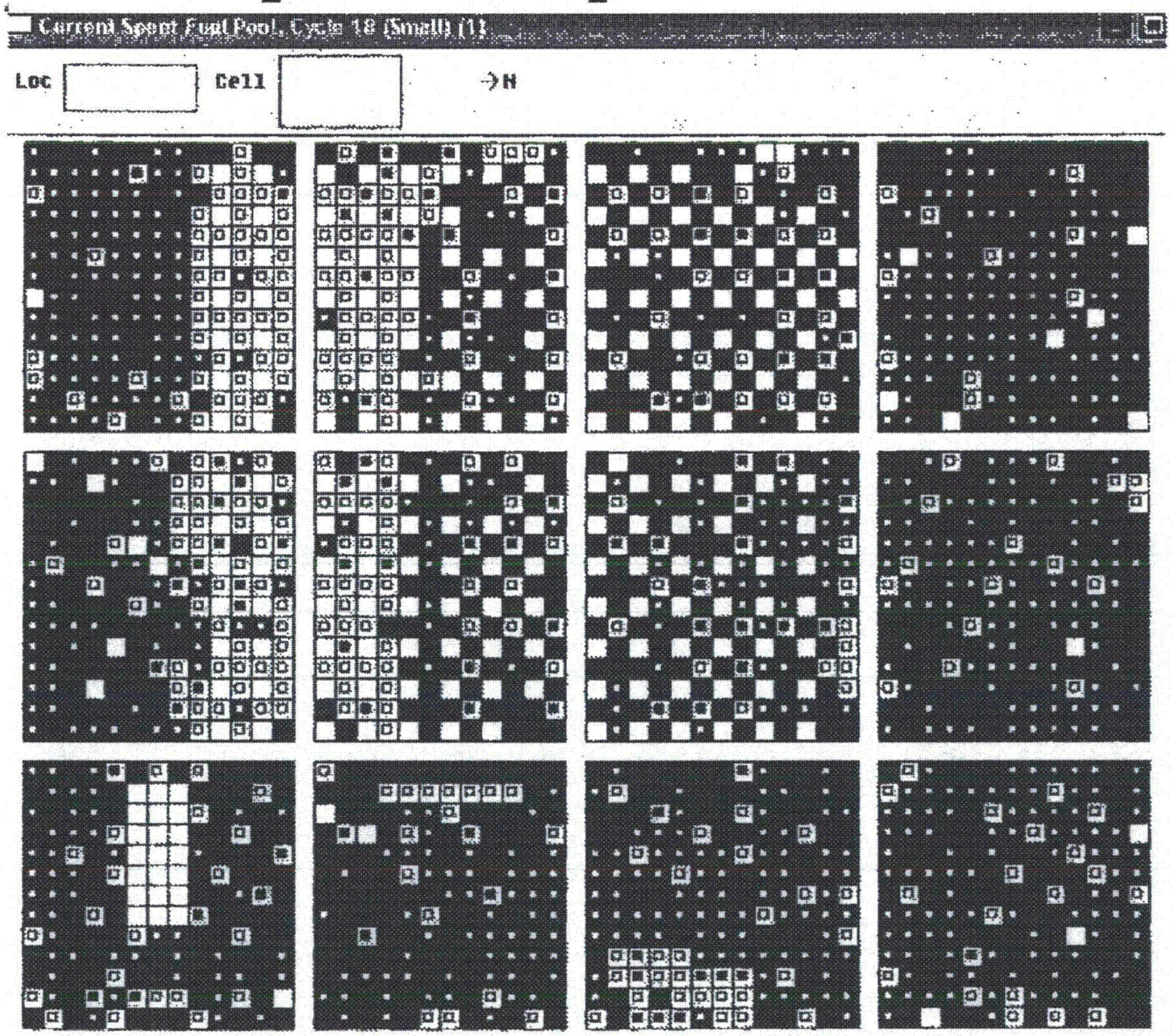
  <u>AND</u>

  - Either spent fuel cooling <u>OR</u> spent fuel pool integrity is maintained

Phase 1 Guidance Expectation B.2.m.1

Licensees are expected to put spent fuel in a 1 x 4 repeating pattern or equivalent, unless otherwise proven to be not applicable or achievable. Licensees who choose to conform to the NRC-approved resolution (NRC letter dated March 16, 2006 (ML060690339)) are expected to include the following concept in procedures: "Where feasible and practical, consistent with safe fuel handling practices, the licensee should make every attempt to pre-configure the spent fuel pool to enable direct placement of the expended assemblies from the vessel to the final distributed fuel pattern. Where this is not feasible or practical, licensees should distribute the fuel into the final pattern as soon as possible but no later than 60 days after subcritcality." NRC staff also accepted alternate strategies for the timing to achieve the appropriate pattern, which may be discussed in the site specific inspection assessments. Licensees' adopting the use of the NRC-approved resolution documented their plans in a letter to the NRC.

Example Dispersal



Phase 1 Guidance Expectation B.2.m.2

Licensees are expected to ensure that hot fuel is not placed over spent fuel pool rack feet. This restriction should be proceduralized. If a licensee's analysis concludes that flow is not restricted by rack feet, then this element is not applicable.

Phase 1 Guidance Expectation B.2.m.3

Licensees are expected to ensure that a contiguous area is established in the spent fuel pool and that procedures ensure sufficient space is available to support the downcomer effect. This space may be limited by spent fuel pool loading issues (such as space, criticality, tech spec issues, boraflex degradation). The downcomer area should be maximized based on limiting conditions in the pool.

NEI 06-12 Strategies

2.2 SFP Internal Makeup

- 500 gpm beyond normal
- Diverse components, piping, and power supplies external to SFP building

NEI 06-12 Strategies, cont.

2.3.1 SFP External Makeup

- Portable, Power-independent Pump
- 500 gpm for 12 hours
- 2 hours to implement
- Not concurrent for multi-unit sites
- Not concurrent w/spray

NEI 06-12 Strategies, cont.

2.3.2 SFP Spray

- Portable, Power-independent Pump
- 200 gpm per unit for 12 hours for shared pools
- Some newly designed plants will have hard piped spray headers mounted on walls above SFP.
- 2 hours to implement
- Not concurrent for multi-pool sites
- Not concurrent w/spray

NEI 06-12 Equipment

- Stored on-site > 100 yds from SFP
- Not safety related (no QA, seismic, EQ, etc.)
- May take off site for training
- May take out of service for routine maintenance

Example Pump and Nozzle

For Official Use Only – Security Related Information

Spray Testing