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

Filtering Strategies Rulemaking Public Meeting

December 12, 2013

Purpose

- Provide staff's current understanding of the dominant core damage sequences, including their basis and assumptions, prior to staff's undertaking of MELCOR analysis in support of rulemaking
- Public meetings will be resumed after substantial completion of the MELCOR analysis
  - Anticipated date: February 2014

Agenda

1:00pm – 1:10pm	Welcome, introductions, and logistics
1:10pm – 2:45pm	NRC presentation
2:45pm – 3:00pm	Public comments
3:00pm – 3:15pm	Break
3:15pm – 4:45pm	Industry presentation
4:45pm – 5:00pm	Closing Remarks

Announcements

- Category 3 Public Meeting
  - Comments during presentations should be only on the material being presented
  - General public comments are provided at the end of the morning and afternoon
- This meeting is being transcribed
- Teleconference Number:
  - 800-369-2002, password: 26275
- Webinar:
  - Https://www1.gotomeeting.com/register/428258056

Announcements

- Please make sure to say your name before you make a statement for the transcriber
- Introductions around the room
- If you are on the telephone, please introduce yourself now if you are not on the webinar

Public Meeting Summaries and Related Documents

- November 2013 phone call between NRC/RES and EPRI/ERIN (in progress)
- November 12, 2013 NEI workshop presentation (ML13337A500)
- November 6, 2013 (ML13324A953)
- August 14, 2013 (ML13238A328)
- July 11, 2013 (ML13211A395)
- June 26, 2013 (ML13203A074)
- June 13, 2013 (ML13199A216)

Extension to Regulatory Basis and Proposed Rule

- Original Due Dates:
  - Regulatory Basis: March 19, 2014
  - Proposed Rule: March 19, 2015
- New Due Dates:
  - Regulatory Basis: December 19, 2014
  - Proposed Rule: December 19, 2015
- Final rule date has not changed
  - March 19, 2017

Requests for Information

- NRC submitted letter to NEI requesting the BWROG's EPG/SAG Rev 3 by January 2, 2014 (ML13325B094)
- Detailed cost estimates of options
  - Preliminary cost information provided at previous public meeting
- Changes to SAMGs due to filters

Contact Information

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Risk Evaluation Topics

- Insights about SBO mitigation strategies
- ELAP frequencies
- Core-damage event tree development
- Plant damage states
- Next steps

Review of SBO Mitigation Strategies

- Purpose:
  - Gain insights into how FLEX will be implemented in order to perform the risk evaluation
  - Not a regulatory review
- Scope: 11 BWRs with Mark I containments that have RCIC systems
- Basis: Initial responses to Order EA-12-049
- Insight:
  - FLEX implementation details are site-specific
  - Need to develop a representative case

Insights on SBO Mitigation Strategies

Topic	Insights
Start of RPV cooldown and depressurization	Wide range (10m to 6h)
RCIC pump room cooling	Not required – 5 plants Open doors/portable cooling – 4 plants Need further analysis – 1 plant Not mentioned – 1 plant
Battery lifetime	Wide range (2h w/o load shed to 13 h)
Containment heat removal	Venting – 10 plants Torus feed-and-bleed – 1 plant
Use of portable FLEX pump	Provide RHR HX cooling – 1 plant Provide SP makeup/backup RPV injection – 7 plants Planned transition from RCIC to FLEX – 3 plants

Definition of ELAP

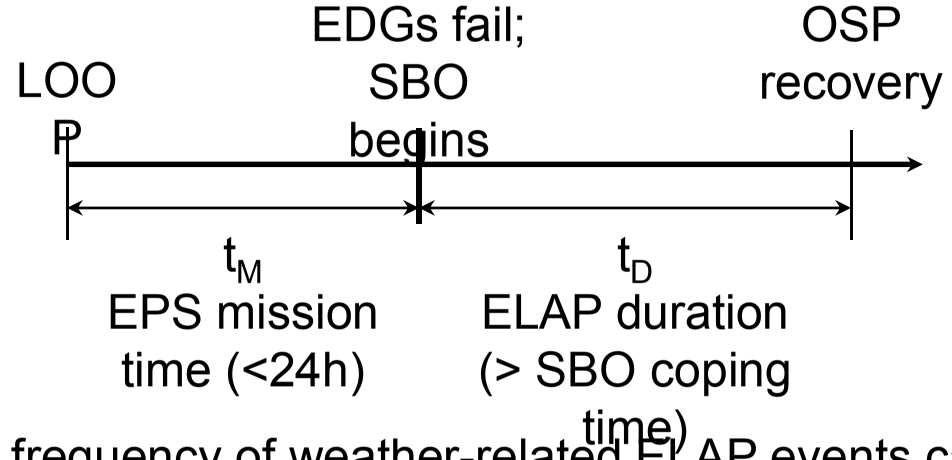
- Reference: Rulemaking for Station Blackout Mitigation Strategies: Regulatory Basis Document (April 2013)
- Pages 30-31: The definition of ELAP as currently envisioned would include:
  - A complete loss of ac power to the essential and non-essential switchgear buses
  - Loss of offsite electric power system concurrent with turbine trip
  - Unavailability of the onsite emergency ac power sources and offsite ac power sources for a duration that is longer than the specified duration determined in accordance with 10 CFR 50.63
  - Unavailability and potential non-recoverability of the offsite power source and onsite emergency and alternate ac power sources (with the exception of supplemental ac power sources per number 7 of this "Definitions" section) for beyond-design-basis external events
  - Exception: Initially ac power from inverters fed by safety-related batteries could be assumed available to support development of the strategies, provided this equipment is reasonably protected including the portions of the distribution system that are used.
  - Exception: Supplemental ac power sources that meet the new requirements (which would be specified in the new section) would be allowed to restore ac power.
  - Exception: Portable equipment that meets the new requirements would be allowed to maintain or restore functions.

ELAPS Initiated by External Hazards

<table>
<tr><th>External Hazards as Identified in NEI 12-06</th><th>Modeling Treatment</th></tr>
<tr><td>Seismic</td><td>Site-specific analysis using seismic hazard curves developed for GI-199 (2008 USGS, EPRI ground motion models)</td></tr>
<tr><td>External floods</td><td>Qualitative consideration; probabilistic flood hazard assessments (PFHAs) not developed for any site; see NUREG/CP-0302</td></tr>
<tr><td>Extreme cold, snow, ice</td><td rowspan="3">Weather-related LOOP frequency and offsite power (OSP) recovery curve from NUREG/CR-6890

Model does not include possible damage to plant systems, structures and components</td></tr>
<tr><td>High winds, tornados, hurricanes</td></tr>
<tr><td>High temperatures</td></tr>
</table>

Probabilistic Definition of Weather-Related ELAP

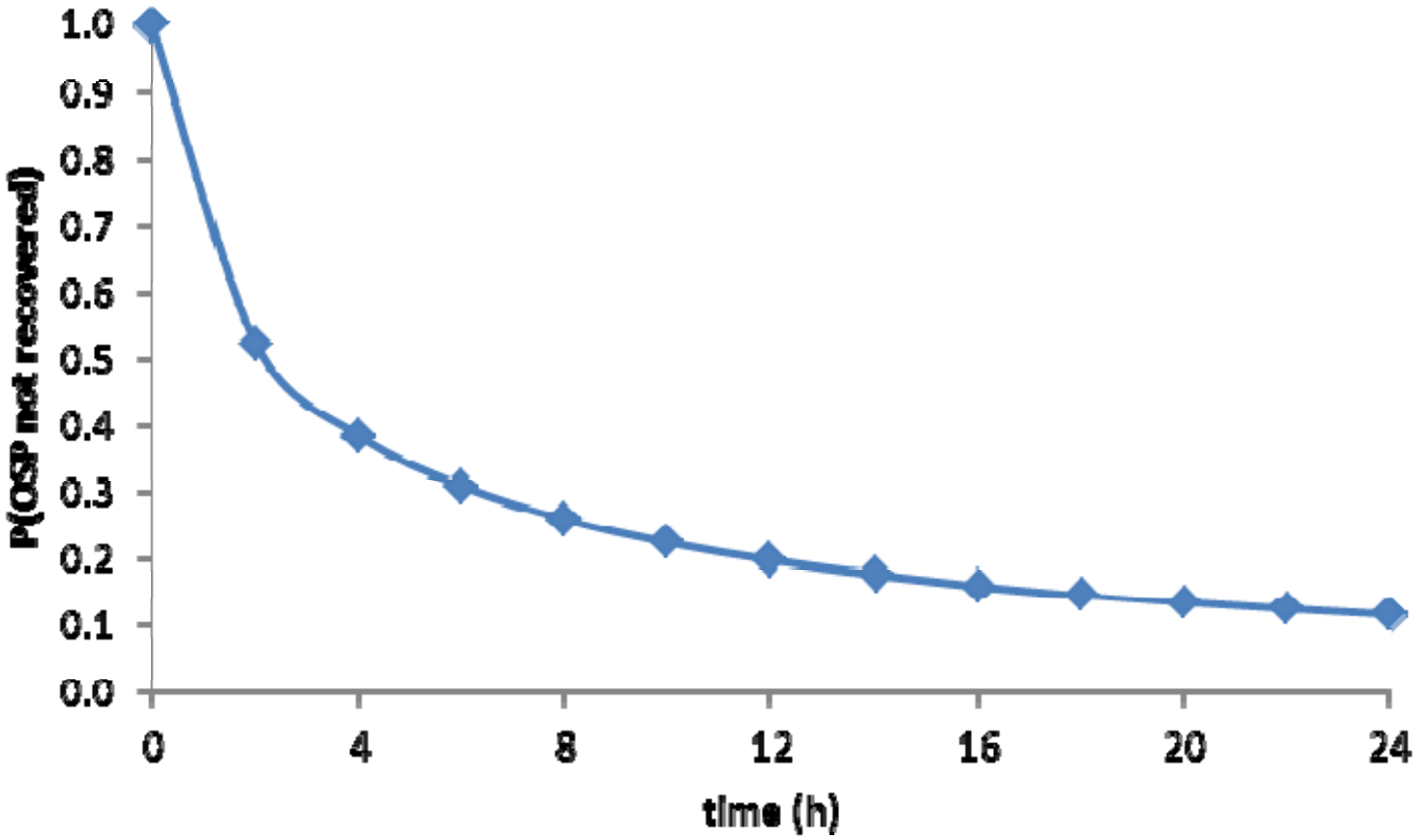


The frequency of weather-related ELAP events can be determined using probabilistic convolution.

$$f(WELAP) = f(WLOOP)P(EPS\ \ fails\ to\ start)P(OSP\ not\ restored\ by\ t_D)$$

$$+ f(WLOOP)\int_0^{t_M} P(OSP\ not\ restored\ by\ t + t_D)\lambda e^{-\lambda t}\, dt$$

Weather-Related LOOP Recovery Curve



Source: NUREG/CR-6890

EPS Failure Model

- Basis: 2011 Update (issued February 2013) to NUREG/CR-5500, Vol. 5
- Three EPS classes (2, 3, and 4) that account for the number of onsite ac power sources
- Model includes:
  - Random and common-cause failures (SPAR model)
  - Seismic failure of EDGs
  - Seismic failure of ac switchgear

Draft Site-Specific ELAP Frequencies

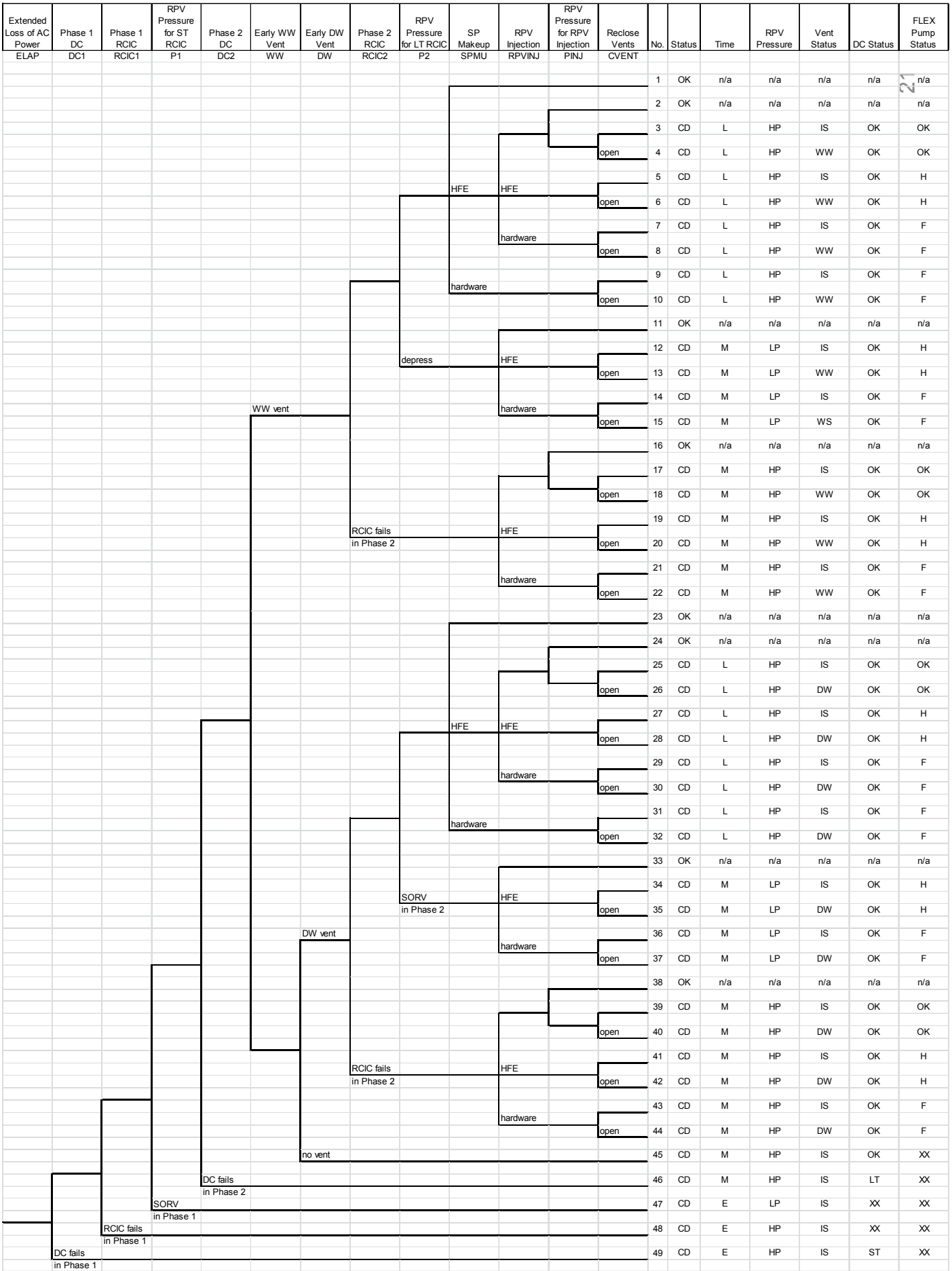
Site	Containment Type	EPS Class	SBO Coping Time	Weather Related ELAP	Seismic ELAP
Browns Ferry	Mark I	4	4	2.0E-07	1.4E-07
Brunswick	Mark I	2	4	3.6E-06	2.1E-06
Columbia	Mark II	2	4	3.6E-06	1.8E-06
Cooper	Mark I	2	4	3.6E-06	7.4E-07
Dresden	Mark I	4	4	2.0E-07	3.6E-07
Duane Arnold	Mark I	2	4	3.6E-06	4.5E-07
Fermi	Mark I	4	4	2.0E-07	1.6E-07
FitzPatrick	Mark I	4	4	2.0E-07	1.5E-07
Hatch	Mark I	3	4	1.8E-06	9.9E-08
Hope Creek	Mark I	3	4	1.8E-06	4.5E-07
La Salle	Mark II	3	4	1.8E-06	8.0E-07
Limerick	Mark II	4	4	2.0E-07	7.2E-07
Monticello	Mark I	2	4	3.6E-06	3.7E-07
Nine Mile Point	Mark I/II	2	4	3.6E-06	3.7E-07
Oyster Creek	Mark I	2	4	3.6E-06	6.7E-07
Peach Bottom	Mark I	3	8	1.4E-06	8.1E-07
Pilgrim	Mark I	2	8	2.8E-06	2.0E-06
Quad Cities	Mark I	4	4	2.0E-07	1.4E-07
Susquehanna	Mark II	3	4	1.8E-06	4.8E-07
Vermont Yankee	Mark I	2	8	2.8E-06	6.2E-07

Core-Damage Event Tree Assumptions

- Event tree applies to BWRs with Mark I containments and RCIC systems
- LOOP is externally initiated when plant is operating
- Event tree addresses the first two phases of SBO mitigation strategies:
  - Phase 1 (4h): rely on installed plant systems
    - Core cooling provided by RCIC
    - Portable FLEX pump not yet aligned
    - Containment heat removal by venting not required
  - Phase 2 (68h): use of onsite portable equipment
    - Core cooling provided by RCIC
    - Portable FLEX pump provides suppression pool makeup as needed
    - Portable FLEX pump can be aligned to provide RPV injection if RCIC fails
    - Containment heat removal provided by containment venting (WW, or DW if the WW vent fails closed)

Core-Damage Event Tree Assumptions (Con't.)

- Phase 1 failure modes:
  - Loss of dc power
    - Random failure
    - Seismic failure
  - RCIC pump
    - Fails to start
    - Fails to run during Phase 1
    - Seismic failure
  - RVP depressurized; inadequate steam to operate the RCIC pump
- Phase 2 failure modes
  - Loss of dc power (portable generator not aligned)
  - No containment venting
  - RCIC pump fails to continue running
  - RVP depressurized; inadequate steam to operate the RCIC pump
  - Suppression pool makeup fails during RCIC operation
  - RVP injection fails
    - Portable FLEX pump fails
    - RVP not depressurized below portable FLEXX pump shutoff head


Extended Loss of AC Power
ELAP
Phase 1 DC
DC1
Phase 1 RCIC
RCIC1
RPV Pressure for ST RCIC
P1
Phase 2 DC
DC2
Early WW Vent
WW
Early DW Vent
DW
Phase 2 RCIC
RCIC2
RPV Pressure for LT RCIC
P2
SP Makeup
SPMU
RPV Injection
RPVINJ
RPV Pressure for RPV Injection
PINJ
Reclose Vents
CVENT
No.
Status
Time
RPV Pressure
Vent Status
DC Status
FLEX Pump Status
WW vent
DW vent
no vent
HFE
hardware
depress
open
RCIC fails in Phase 2
SORV in Phase 2
DC fails in Phase 2
SORV in Phase 1
RCIC fails in Phase 1
DC fails in Phase 1
1 OK n/a n/a n/a n/a n/a
2 OK n/a n/a n/a n/a n/a
3 CD L HP IS OK OK
4 CD L HP WW OK OK
5 CD L HP IS OK H
6 CD L HP WW OK H
7 CD L HP IS OK F
8 CD L HP WW OK F
9 CD L HP IS OK F
10 CD L HP WW OK F
11 OK n/a n/a n/a n/a n/a
12 CD M LP IS OK H
13 CD M LP WW OK H
14 CD M LP IS OK F
15 CD M LP WS OK F
16 OK n/a n/a n/a n/a n/a
17 CD M HP IS OK OK
18 CD M HP WW OK OK
19 CD M HP IS OK H
20 CD M HP WW OK H
21 CD M HP IS OK F
22 CD M HP WW OK F
23 OK n/a n/a n/a n/a n/a
24 OK n/a n/a n/a n/a n/a
25 CD L HP IS OK OK
26 CD L HP DW OK OK
27 CD L HP IS OK H
28 CD L HP DW OK H
29 CD L HP IS OK F
30 CD L HP DW OK F
31 CD L HP IS OK F
32 CD L HP DW OK F
33 OK n/a n/a n/a n/a n/a
34 CD M LP IS OK H
35 CD M LP DW OK H
36 CD M LP IS OK F
37 CD M LP DW OK F
38 OK n/a n/a n/a n/a n/a
39 CD M HP IS OK OK
40 CD M HP DW OK OK
41 CD M HP IS OK H
42 CD M HP DW OK H
43 CD M HP IS OK F
44 CD M HP DW OK F
45 CD M HP IS OK XX
46 CD M HP IS LT XX
47 CD E LP IS XX XX
48 CD E HP IS XX XX
49 CD E HP IS ST XX

Failure Data

- SPAR 2010 Parameter Estimation Update
  - Failure-on-demand probabilities
  - Failure rates
- RASP Handbook, Vol. 2, Rev. 1.01 (ADAMS Accession No. ML080300179)
  - Seismic fragilities
- Human Reliability Analysis
  - All human failure events (HFEs) screened at 0.3

Plant Damage State Vector
T-P-V-D-F

- Sequence time
  - E: Phase 1 (0-4h)
  - M: Phase 2 (4-16h) RCIC and FLEX RPV injection fail
  - L: Phase 2 (16h) loss of suppression pool makeup
- RVP pressure
  - HP: high pressure (above FLEX pump shutoff head; MSL creep rupture is possible)
  - LP: low pressure
- Containment vent status
  - DW: drywell vent is open at the time of core damage
  - IS: both vents are isolated at the time of core damage
  - WW: wetwell vent is open at the time of core damage
- DC power status
  - LT: DC power fails in Phase 2
  - OK: DC power is available throughout the accident
  - ST: DC power fails in Phase 1
  - XX: DC power available in Phase 1; status in Phase 2 unknown
- FLEX pump status
  - F: FLEX pump hardware failed (no recovery is possible)
  - H: Operator fails to align FLEX pump prior to core damage (recovery is possible)
  - XX: unknown (FLEX pump status not asked in the core-damage event tree)

Draft Sequence Frequencies

		Browns Ferry			Brunswick			Cooper			Duane Arnold			Fermi			FitzPatrick		
No.	PDS	Weather	Seismic	Total	Weather	Seismic	Total	Weather	Seismic	Total	Weather	Seismic	Total	Weather	Seismic	Total	Weather	Seismic	Total
3	L-HP-IS-OK-OK	2.6E-09	1.4E-09	4.1E-09	4.7E-08	2.7E-08	7.4E-08	4.7E-08	9.4E-09	5.6E-08	4.7E-08	5.2E-09	5.2E-08	2.6E-09	1.6E-09	4.3E-09	2.6E-09	1.5E-09	4.1E-09
4	L-HP-WW-OK-OK	4.8E-10	2.6E-10	7.4E-10	8.6E-09	5.0E-09	1.4E-08	8.6E-09	1.7E-09	1.0E-08	8.6E-09	9.6E-10	9.5E-09	4.8E-10	3.0E-10	7.8E-10	4.8E-10	2.7E-10	7.5E-10
5	L-HP-IS-OK-H	2.8E-09	1.5E-09	4.3E-09	4.9E-08	2.9E-08	7.8E-08	4.9E-08	9.9E-09	5.9E-08	4.9E-08	5.5E-09	5.5E-08	2.8E-09	1.7E-09	4.5E-09	2.8E-09	1.5E-09	4.3E-09
6	L-HP-WW-OK-H	1.2E-09	6.4E-10	1.8E-09	2.1E-08	1.2E-08	3.3E-08	2.1E-08	4.3E-09	2.5E-08	2.1E-08	2.4E-09	2.4E-08	1.2E-09	7.4E-10	1.9E-09	1.2E-09	6.6E-10	1.9E-09
7	L-HP-IS-OK-F	1.4E-09	7.5E-10	2.1E-09	2.5E-08	1.4E-08	3.9E-08	2.5E-08	5.0E-09	3.0E-08	2.5E-08	2.8E-09	2.7E-08	1.4E-09	8.6E-10	2.3E-09	1.4E-09	7.7E-10	2.2E-09
8	L-HP-WW-OK-F	6.0E-10	3.2E-10	9.2E-10	1.1E-08	6.1E-09	1.7E-08	1.1E-08	2.1E-09	1.3E-08	1.1E-08	1.2E-09	1.2E-08	6.0E-10	3.7E-10	9.7E-10	6.0E-10	3.3E-10	9.3E-10
9	L-HP-IS-OK-F	4.6E-09	2.5E-09	7.1E-09	8.2E-08	4.8E-08	1.3E-07	8.2E-08	1.7E-08	9.9E-08	8.2E-08	9.2E-09	9.2E-08	4.6E-09	2.9E-09	7.5E-09	4.6E-09	2.6E-09	7.2E-09
10	L-HP-WW-OK-F	2.0E-09	1.1E-09	3.1E-09	3.5E-08	2.0E-08	5.6E-08	3.5E-08	7.1E-09	4.2E-08	3.5E-08	4.0E-09	3.9E-08	2.0E-09	1.2E-09	3.2E-09	2.0E-09	1.1E-09	3.1E-09
12	M-LP-IS-OK-H	3.2E-09	1.7E-09	4.9E-09	5.6E-08	3.3E-08	8.9E-08	5.6E-08	1.1E-08	6.8E-08	5.6E-08	6.3E-09	6.3E-08	3.2E-09	2.0E-09	5.2E-09	3.2E-09	1.8E-09	4.9E-09
13	M-LP-WW-OK-H	1.4E-09	7.3E-10	2.1E-09	2.4E-08	1.4E-08	3.8E-08	2.4E-08	4.9E-09	2.9E-08	2.4E-08	2.7E-09	2.7E-08	1.4E-09	8.4E-10	2.2E-09	1.4E-09	7.5E-10	2.1E-09
14	M-LP-IS-OK-F	1.6E-09	8.5E-10	2.4E-09	2.8E-08	1.6E-08	4.5E-08	2.8E-08	5.7E-09	3.4E-08	2.8E-08	3.2E-09	3.1E-08	1.6E-09	9.8E-10	2.6E-09	1.6E-09	8.8E-10	2.5E-09
15	M-LP-WS-OK-F	6.8E-10	3.7E-10	1.0E-09	1.2E-08	7.0E-09	1.9E-08	1.2E-08	2.4E-09	1.5E-08	1.2E-08	1.4E-09	1.3E-08	6.8E-10	4.2E-10	1.1E-09	6.8E-10	3.8E-10	1.1E-09
17	M-HP-IS-OK-OK	7.5E-12	4.0E-12	1.2E-11	1.3E-10	7.7E-11	2.1E-10	1.3E-10	2.7E-11	1.6E-10	1.3E-10	1.5E-11	1.5E-10	7.5E-12	4.6E-12	1.2E-11	7.5E-12	4.1E-12	1.2E-11
18	M-HP-WW-OK-OK	1.4E-12	7.4E-13	2.1E-12	2.4E-11	1.4E-11	3.9E-11	2.4E-11	4.9E-12	2.9E-11	2.4E-11	2.7E-12	2.7E-11	1.4E-12	8.5E-13	2.2E-12	1.4E-12	7.6E-13	2.1E-12
19	M-HP-IS-OK-H	7.9E-12	4.3E-12	1.2E-11	1.4E-10	8.1E-11	2.2E-10	1.4E-10	2.8E-11	1.7E-10	1.4E-10	1.6E-11	1.6E-10	7.9E-12	4.9E-12	1.3E-11	7.9E-12	4.4E-12	1.2E-11
20	M-HP-WW-OK-H	3.4E-12	1.8E-12	5.2E-12	6.0E-11	3.5E-11	9.5E-11	6.0E-11	1.2E-11	7.2E-11	6.0E-11	6.8E-12	6.7E-11	3.4E-12	2.1E-12	5.5E-12	3.4E-12	1.9E-12	5.3E-12
21	M-HP-IS-OK-F	4.0E-12	2.1E-12	6.1E-12	7.0E-11	4.1E-11	1.1E-10	7.0E-11	1.4E-11	8.4E-11	7.0E-11	7.9E-12	7.8E-11	4.0E-12	2.4E-12	6.4E-12	4.0E-12	2.2E-12	6.2E-12
22	M-HP-WW-OK-F	1.7E-12	9.1E-13	2.6E-12	3.0E-11	1.7E-11	4.8E-11	3.0E-11	6.0E-12	3.6E-11	3.0E-11	3.4E-12	3.3E-11	1.7E-12	1.0E-12	2.7E-12	1.7E-12	9.4E-13	2.6E-12
25	L-HP-IS-OK-OK	7.9E-10	4.2E-10	1.2E-09	1.4E-08	8.1E-09	2.2E-08	1.4E-08	2.8E-09	1.7E-08	1.4E-08	1.6E-09	1.6E-08	7.9E-10	4.9E-10	1.3E-09	7.9E-10	4.4E-10	1.2E-09
26	L-HP-DW-OK-OK	1.5E-10	7.8E-11	2.2E-10	2.6E-09	1.5E-09	4.1E-09	2.6E-09	5.2E-10	3.1E-09	2.6E-09	2.9E-10	2.9E-09	1.5E-10	9.0E-11	2.4E-10	1.5E-10	8.0E-11	2.3E-10
27	L-HP-IS-OK-H	8.4E-10	4.5E-10	1.3E-09	1.5E-08	8.6E-09	2.3E-08	1.5E-08	3.0E-09	1.8E-08	1.5E-08	1.7E-09	1.7E-08	8.4E-10	5.2E-10	1.4E-09	8.4E-10	4.6E-10	1.3E-09
28	L-HP-DW-OK-H	3.6E-10	1.9E-10	5.5E-10	6.4E-09	3.7E-09	1.0E-08	6.4E-09	1.3E-09	7.6E-09	6.4E-09	7.1E-10	7.1E-09	3.6E-10	2.2E-10	5.8E-10	3.6E-10	2.0E-10	5.6E-10
29	L-HP-IS-OK-F	4.2E-10	2.2E-10	6.4E-10	7.4E-09	4.3E-09	1.2E-08	7.4E-09	1.5E-09	8.9E-09	7.4E-09	8.3E-10	8.2E-09	4.2E-10	2.6E-10	6.8E-10	4.2E-10	2.3E-10	6.5E-10
30	L-HP-DW-OK-F	1.8E-10	9.6E-11	2.8E-10	3.2E-09	1.8E-09	5.0E-09	3.2E-09	6.4E-10	3.8E-09	3.2E-09	3.6E-10	3.5E-09	1.8E-10	1.1E-10	2.9E-10	1.8E-10	9.9E-11	2.8E-10
31	L-HP-IS-OK-F	1.4E-09	7.5E-10	2.1E-09	2.5E-08	1.4E-08	3.9E-08	2.5E-08	5.0E-09	3.0E-08	2.5E-08	2.8E-09	2.7E-08	1.4E-09	8.6E-10	2.3E-09	1.4E-09	7.7E-10	2.2E-09
32	L-HP-DW-OK-F	6.0E-10	3.2E-10	9.2E-10	1.1E-08	6.1E-09	1.7E-08	1.1E-08	2.1E-09	1.3E-08	1.1E-08	1.2E-09	1.2E-08	6.0E-10	3.7E-10	9.7E-10	6.0E-10	3.3E-10	9.3E-10
34	M-LP-IS-OK-H	9.6E-10	5.1E-10	1.5E-09	1.7E-08	9.8E-09	2.7E-08	1.7E-08	3.4E-09	2.0E-08	1.7E-08	1.9E-09	1.9E-08	9.6E-10	5.9E-10	1.5E-09	9.6E-10	5.3E-10	1.5E-09
35	M-LP-DW-OK-H	4.1E-10	2.2E-10	6.3E-10	7.3E-09	4.2E-09	1.1E-08	7.3E-09	1.5E-09	8.7E-09	7.3E-09	8.1E-10	8.1E-09	4.1E-10	2.5E-10	6.6E-10	4.1E-10	2.3E-10	6.4E-10
36	M-LP-IS-OK-F	4.8E-10	2.6E-10	7.3E-10	8.5E-09	4.9E-09	1.3E-08	8.5E-09	1.7E-09	1.0E-08	8.5E-09	9.5E-10	9.4E-09	4.8E-10	2.9E-10	7.7E-10	4.8E-10	2.6E-10	7.4E-10
37	M-LP-DW-OK-F	2.0E-10	1.1E-10	3.1E-10	3.6E-09	2.1E-09	5.7E-09	3.6E-09	7.3E-10	4.4E-09	3.6E-09	4.1E-10	4.0E-09	2.0E-10	1.3E-10	3.3E-10	2.0E-10	1.1E-10	3.2E-10
39	M-HP-IS-OK-OK	2.2E-12	1.2E-12	3.5E-12	4.0E-11	2.3E-11	6.3E-11	4.0E-11	8.0E-12	4.8E-11	4.0E-11	4.5E-12	4.4E-11	2.2E-12	1.4E-12	3.6E-12	2.2E-12	1.2E-12	3.5E-12
40	M-HP-DW-OK-OK	4.1E-13	2.2E-13	6.3E-13	7.3E-12	4.2E-12	1.2E-11	7.3E-12	1.5E-12	8.8E-12	7.3E-12	8.2E-13	8.1E-12	4.1E-13	2.6E-13	6.7E-13	4.1E-13	2.3E-13	6.4E-13
41	M-HP-IS-OK-H	2.4E-12	1.3E-12	3.7E-12	4.2E-11	2.4E-11	6.7E-11	4.2E-11	8.5E-12	5.1E-11	4.2E-11	4.7E-12	4.7E-11	2.4E-12	1.5E-12	3.9E-12	2.4E-12	1.3E-12	3.7E-12
42	M-HP-DW-OK-H	1.0E-12	5.5E-13	1.6E-12	1.8E-11	1.0E-11	2.9E-11	1.8E-11	3.6E-12	2.2E-11	1.8E-11	2.0E-12	2.0E-11	1.0E-12	6.3E-13	1.7E-12	1.0E-12	5.6E-13	1.6E-12
43	M-HP-IS-OK-F	1.2E-12	6.4E-13	1.8E-12	2.1E-11	1.2E-11	3.3E-11	2.1E-11	4.2E-12	2.5E-11	2.1E-11	2.4E-12	2.3E-11	1.2E-12	7.3E-13	1.9E-12	1.2E-12	6.6E-13	1.8E-12
44	M-HP-DW-OK-F	5.1E-13	2.7E-13	7.8E-13	9.0E-12	5.2E-12	1.4E-11	9.0E-12	1.8E-12	1.1E-11	9.0E-12	1.0E-12	1.0E-11	5.1E-13	3.1E-13	8.2E-13	5.1E-13	2.8E-13	7.9E-13
45	M-HP-IS-OK-XX	7.7E-09	4.1E-09	1.2E-08	1.4E-07	7.9E-08	2.1E-07	1.4E-07	2.7E-08	1.6E-07	1.4E-07	1.5E-08	1.5E-07	7.7E-09	4.7E-09	1.2E-08	7.7E-09	4.2E-09	1.2E-08
46	M-HP-IS-LT-XX	5.4E-08	2.9E-08	8.2E-08	9.5E-07	5.5E-07	1.5E-06	9.5E-07	1.9E-07	1.1E-06	9.5E-07	1.1E-07	1.1E-06	5.4E-08	3.3E-08	8.7E-08	5.4E-08	3.0E-08	8.3E-08
47	E-LP-IS-XX-XX	6.3E-08	3.4E-08	9.7E-08	1.1E-06	6.5E-07	1.8E-06	1.1E-06	2.3E-07	1.3E-06	1.1E-06	1.3E-07	1.2E-06	6.3E-08	3.9E-08	1.0E-07	6.3E-08	3.5E-08	9.8E-08
48	E-HP-IS-XX-XX	1.8E-09	1.6E-08	1.8E-08	3.2E-08	3.3E-08	6.6E-08	3.2E-08	1.7E-08	4.9E-08	3.2E-08	2.7E-08	5.9E-08	1.8E-09	2.2E-08	2.4E-08	1.8E-09	2.0E-08	2.2E-08
49	E-HP-IS-ST-XX	4.8E-13	1.2E-08	1.2E-08	8.5E-12	9.3E-09	9.3E-09	8.5E-12	6.4E-09	6.4E-09	8.5E-12	2.4E-08	2.4E-08	4.8E-13	1.6E-08	1.6E-08	4.8E-13	1.5E-08	1.5E-08
		1.6E-07	1.1E-07	2.7E-07	2.8E-06	1.6E-06	4.4E-06	2.8E-06	5.7E-07	3.3E-06	2.8E-06	3.6E-07	3.1E-06	1.6E-07	1.3E-07	2.9E-07	1.6E-07	1.2E-07	2.8E-07
	ELAP Frequency	2.0E-07	1.4E-07	3.4E-07	3.6E-06	2.1E-06	5.7E-06	3.6E-06	7.4E-07	4.4E-06	3.6E-06	4.5E-07	4.1E-06	2.0E-07	1.6E-07	3.7E-07	2.0E-07	1.5E-07	3.5E-07
	CCDP	76.5%	81.1%	78.3%	76.5%	76.7%	76.5%	76.5%	77.0%	76.5%	76.5%	78.9%	76.7%	76.5%	81.8%	78.8%	76.5%	81.9%	78.7%

Draft Sequence Frequencies (Con't.)

		Hatch			Hope Creek			Monticello			Peach Bottom			Pilgrim			Quad Cities		
No.	PDS	Weather	Seismic	Total	Weather	Seismic	Total	Weather	Seismic	Total	Weather	Seismic	Total	Weather	Seismic	Total	Weather	Seismic	Total
3	L-HP-IS-OK-OK	2.3E-08	1.3E-09	2.5E-08	2.3E-08	5.7E-09	2.9E-08	4.7E-08	4.2E-09	5.1E-08	1.8E-08	8.9E-09	2.7E-08	3.6E-08	2.5E-08	6.1E-08	2.6E-09	1.4E-09	4.0E-09
4	L-HP-WW-OK-OK	4.3E-09	2.3E-10	4.5E-09	4.3E-09	1.0E-09	5.3E-09	8.6E-09	7.8E-10	9.4E-09	3.3E-09	1.6E-09	5.0E-09	6.7E-09	4.6E-09	1.1E-08	4.8E-10	2.5E-10	7.4E-10
5	L-HP-IS-OK-H	2.5E-08	1.3E-09	2.6E-08	2.5E-08	6.0E-09	3.1E-08	4.9E-08	4.5E-09	5.4E-08	1.9E-08	9.4E-09	2.9E-08	3.9E-08	2.6E-08	6.5E-08	2.8E-09	1.5E-09	4.2E-09
6	L-HP-WW-OK-H	1.1E-08	5.8E-10	1.1E-08	1.1E-08	2.6E-09	1.3E-08	2.1E-08	1.9E-09	2.3E-08	8.3E-09	4.0E-09	1.2E-08	1.7E-08	1.1E-08	2.8E-08	1.2E-09	6.2E-10	1.8E-09
7	L-HP-IS-OK-F	1.2E-08	6.7E-10	1.3E-08	1.2E-08	3.0E-09	1.5E-08	2.5E-08	2.2E-09	2.7E-08	9.6E-09	4.7E-09	1.4E-08	1.9E-08	1.3E-08	3.2E-08	1.4E-09	7.3E-10	2.1E-09
8	L-HP-WW-OK-F	5.3E-09	2.9E-10	5.6E-09	5.3E-09	1.3E-09	6.6E-09	1.1E-08	9.6E-10	1.2E-08	4.1E-09	2.0E-09	6.1E-09	8.3E-09	5.6E-09	1.4E-08	6.0E-10	3.1E-10	9.1E-10
9	L-HP-IS-OK-F	4.1E-08	2.2E-09	4.3E-08	4.1E-08	1.0E-08	5.1E-08	8.2E-08	7.4E-09	9.0E-08	3.2E-08	1.6E-08	4.8E-08	6.4E-08	4.4E-08	1.1E-07	4.6E-09	2.4E-09	7.1E-09
10	L-HP-WW-OK-F	1.8E-08	9.6E-10	1.9E-08	1.8E-08	4.3E-09	2.2E-08	3.5E-08	3.2E-09	3.8E-08	1.4E-08	6.7E-09	2.0E-08	2.8E-08	1.9E-08	4.6E-08	2.0E-09	1.0E-09	3.0E-09
12	M-LP-IS-OK-H	2.8E-08	1.5E-09	3.0E-08	2.8E-08	6.9E-09	3.5E-08	5.6E-08	5.1E-09	6.2E-08	2.2E-08	1.1E-08	3.3E-08	4.4E-08	3.0E-08	7.4E-08	3.2E-09	1.7E-09	4.8E-09
13	M-LP-WW-OK-H	1.2E-08	6.6E-10	1.3E-08	1.2E-08	2.9E-09	1.5E-08	2.4E-08	2.2E-09	2.6E-08	9.4E-09	4.6E-09	1.4E-08	1.9E-08	1.3E-08	3.2E-08	1.4E-09	7.1E-10	2.1E-09
14	M-LP-IS-OK-F	1.4E-08	7.7E-10	1.5E-08	1.4E-08	3.4E-09	1.8E-08	2.8E-08	2.6E-09	3.1E-08	1.1E-08	5.4E-09	1.6E-08	2.2E-08	1.5E-08	3.7E-08	1.6E-09	8.3E-10	2.4E-09
15	M-LP-WS-OK-F	6.0E-09	3.3E-10	6.4E-09	6.0E-09	1.5E-09	7.5E-09	1.2E-08	1.1E-09	1.3E-08	4.7E-09	2.3E-09	7.0E-09	9.4E-09	6.4E-09	1.6E-08	6.8E-10	3.5E-10	1.0E-09
17	M-HP-IS-OK-OK	6.6E-11	3.6E-12	7.0E-11	6.6E-11	1.6E-11	8.3E-11	1.3E-10	1.2E-11	1.4E-10	5.2E-11	2.5E-11	7.7E-11	1.0E-10	7.1E-11	1.7E-10	7.5E-12	3.9E-12	1.1E-11
18	M-HP-WW-OK-OK	1.2E-11	6.6E-13	1.3E-11	1.2E-11	3.0E-12	1.5E-11	2.4E-11	2.2E-12	2.7E-11	9.5E-12	4.6E-12	1.4E-11	1.9E-11	1.3E-11	3.2E-11	1.4E-12	7.2E-13	2.1E-12
19	M-HP-IS-OK-H	7.0E-11	3.8E-12	7.4E-11	7.0E-11	1.7E-11	8.7E-11	1.4E-10	1.3E-11	1.5E-10	5.5E-11	2.7E-11	8.2E-11	1.1E-10	7.5E-11	1.8E-10	7.9E-12	4.1E-12	1.2E-11
20	M-HP-WW-OK-H	3.0E-11	1.6E-12	3.2E-11	3.0E-11	7.3E-12	3.7E-11	6.0E-11	5.5E-12	6.6E-11	2.4E-11	1.1E-11	3.5E-11	4.7E-11	3.2E-11	7.9E-11	3.4E-12	1.8E-12	5.2E-12
21	M-HP-IS-OK-F	3.5E-11	1.9E-12	3.7E-11	3.5E-11	8.5E-12	4.4E-11	7.0E-11	6.4E-12	7.7E-11	2.7E-11	1.3E-11	4.1E-11	5.5E-11	3.7E-11	9.2E-11	4.0E-12	2.1E-12	6.0E-12
22	M-HP-WW-OK-F	1.5E-11	8.2E-13	1.6E-11	1.5E-11	3.7E-12	1.9E-11	3.0E-11	2.7E-12	3.3E-11	1.2E-11	5.7E-12	1.7E-11	2.4E-11	1.6E-11	4.0E-11	1.7E-12	8.8E-13	2.6E-12
25	L-HP-IS-OK-OK	7.0E-09	3.8E-10	7.4E-09	7.0E-09	1.7E-09	8.7E-09	1.4E-08	1.3E-09	1.5E-08	5.5E-09	2.7E-09	8.1E-09	1.1E-08	7.5E-09	1.8E-08	7.9E-10	4.1E-10	1.2E-09
26	L-HP-DW-OK-OK	1.3E-09	7.0E-11	1.4E-09	1.3E-09	3.1E-10	1.6E-09	2.6E-09	2.3E-10	2.8E-09	1.0E-09	4.9E-10	1.5E-09	2.0E-09	1.4E-09	3.4E-09	1.5E-10	7.6E-11	2.2E-10
27	L-HP-IS-OK-H	7.4E-09	4.0E-10	7.8E-09	7.4E-09	1.8E-09	9.2E-09	1.5E-08	1.3E-09	1.6E-08	5.8E-09	2.8E-09	8.6E-09	1.2E-08	7.9E-09	1.9E-08	8.4E-10	4.4E-10	1.3E-09
28	L-HP-DW-OK-H	3.2E-09	1.7E-10	3.4E-09	3.2E-09	7.7E-10	4.0E-09	6.4E-09	5.8E-10	6.9E-09	2.5E-09	1.2E-09	3.7E-09	5.0E-09	3.4E-09	8.4E-09	3.6E-10	1.9E-10	5.5E-10
29	L-HP-IS-OK-F	3.7E-09	2.0E-10	3.9E-09	3.7E-09	9.0E-10	4.6E-09	7.4E-09	6.7E-10	8.1E-09	2.9E-09	1.4E-09	4.3E-09	5.8E-09	4.0E-09	9.7E-09	4.2E-10	2.2E-10	6.4E-10
30	L-HP-DW-OK-F	1.6E-09	8.7E-11	1.7E-09	1.6E-09	3.9E-10	2.0E-09	3.2E-09	2.9E-10	3.5E-09	1.2E-09	6.0E-10	1.8E-09	2.5E-09	1.7E-09	4.2E-09	1.8E-10	9.3E-11	2.7E-10
31	L-HP-IS-OK-F	1.2E-08	6.7E-10	1.3E-08	1.2E-08	3.0E-09	1.5E-08	2.5E-08	2.2E-09	2.7E-08	9.6E-09	4.7E-09	1.4E-08	1.9E-08	1.3E-08	3.2E-08	1.4E-09	7.3E-10	2.1E-09
32	L-HP-DW-OK-F	5.3E-09	2.9E-10	5.6E-09	5.3E-09	1.3E-09	6.6E-09	1.1E-08	9.6E-10	1.2E-08	4.1E-09	2.0E-09	6.1E-09	8.3E-09	5.6E-09	1.4E-08	6.0E-10	3.1E-10	9.1E-10
34	M-LP-IS-OK-H	8.5E-09	4.6E-10	8.9E-09	8.5E-09	2.1E-09	1.1E-08	1.7E-08	1.5E-09	1.8E-08	6.6E-09	3.2E-09	9.8E-09	1.3E-08	9.0E-09	2.2E-08	9.6E-10	5.0E-10	1.5E-09
35	M-LP-DW-OK-H	3.6E-09	2.0E-10	3.8E-09	3.6E-09	8.8E-10	4.5E-09	7.3E-09	6.6E-10	7.9E-09	2.8E-09	1.4E-09	4.2E-09	5.7E-09	3.9E-09	9.5E-09	4.1E-10	2.1E-10	6.2E-10
36	M-LP-IS-OK-F	4.2E-09	2.3E-10	4.5E-09	4.2E-09	1.0E-09	5.3E-09	8.5E-09	7.7E-10	9.2E-09	3.3E-09	1.6E-09	4.9E-09	6.6E-09	4.5E-09	1.1E-08	4.8E-10	2.5E-10	7.3E-10
37	M-LP-DW-OK-F	1.8E-09	9.9E-11	1.9E-09	1.8E-09	4.4E-10	2.3E-09	3.6E-09	3.3E-10	4.0E-09	1.4E-09	6.9E-10	2.1E-09	2.8E-09	1.9E-09	4.8E-09	2.0E-10	1.1E-10	3.1E-10
39	M-HP-IS-OK-OK	2.0E-11	1.1E-12	2.1E-11	2.0E-11	4.8E-12	2.5E-11	4.0E-11	3.6E-12	4.3E-11	1.6E-11	7.6E-12	2.3E-11	3.1E-11	2.1E-11	5.2E-11	2.2E-12	1.2E-12	3.4E-12
40	M-HP-DW-OK-OK	3.7E-12	2.0E-13	3.9E-12	3.7E-12	8.9E-13	4.5E-12	7.3E-12	6.6E-13	8.0E-12	2.9E-12	1.4E-12	4.2E-12	5.7E-12	3.9E-12	9.6E-12	4.1E-13	2.1E-13	6.3E-13
41	M-HP-IS-OK-H	2.1E-11	1.1E-12	2.2E-11	2.1E-11	5.1E-12	2.6E-11	4.2E-11	3.8E-12	4.6E-11	1.6E-11	8.0E-12	2.4E-11	3.3E-11	2.3E-11	5.5E-11	2.4E-12	1.2E-12	3.6E-12
42	M-HP-DW-OK-H	9.0E-12	4.9E-13	9.5E-12	9.0E-12	2.2E-12	1.1E-11	1.8E-11	1.6E-12	2.0E-11	7.1E-12	3.4E-12	1.0E-11	1.4E-11	9.6E-12	2.4E-11	1.0E-12	5.3E-13	1.6E-12
43	M-HP-IS-OK-F	1.1E-11	5.7E-13	1.1E-11	1.1E-11	2.6E-12	1.3E-11	2.1E-11	1.9E-12	2.3E-11	8.2E-12	4.0E-12	1.2E-11	1.6E-11	1.1E-11	2.8E-11	1.2E-12	6.2E-13	1.8E-12
44	M-HP-DW-OK-F	4.5E-12	2.5E-13	4.8E-12	4.5E-12	1.1E-12	5.6E-12	9.0E-12	8.2E-13	9.8E-12	3.5E-12	1.7E-12	5.2E-12	7.1E-12	4.8E-12	1.2E-11	5.1E-13	2.7E-13	7.7E-13
45	M-HP-IS-OK-XX	6.8E-08	3.7E-09	7.2E-08	6.8E-08	1.6E-08	8.4E-08	1.4E-07	1.2E-08	1.5E-07	5.3E-08	2.6E-08	7.9E-08	1.1E-07	7.2E-08	1.8E-07	7.7E-09	4.0E-09	1.2E-08
46	M-HP-IS-LT-XX	4.8E-07	2.6E-08	5.0E-07	4.8E-07	1.2E-07	5.9E-07	9.5E-07	8.6E-08	1.0E-06	3.7E-07	1.8E-07	5.5E-07	7.4E-07	5.1E-07	1.2E-06	5.4E-08	2.8E-08	8.2E-08
47	E-LP-IS-XX-XX	5.6E-07	3.1E-08	5.9E-07	5.6E-07	1.4E-07	7.0E-07	1.1E-06	1.0E-07	1.2E-06	4.4E-07	2.1E-07	6.5E-07	8.8E-07	6.0E-07	1.5E-06	6.3E-08	3.3E-08	9.6E-08
48	E-HP-IS-XX-XX	1.6E-08	1.6E-09	1.8E-08	1.6E-08	1.3E-08	2.9E-08	3.2E-08	2.3E-08	5.5E-08	1.3E-08	7.6E-08	8.8E-08	2.5E-08	5.9E-08	8.4E-08	1.8E-09	1.9E-08	2.0E-08
49	E-HP-IS-ST-XX	4.2E-12	3.3E-10	3.3E-10	4.2E-12	4.8E-09	4.8E-09	8.5E-12	2.1E-08	2.1E-08	3.3E-12	5.4E-08	5.4E-08	6.6E-12	2.7E-08	2.7E-08	4.8E-13	1.4E-08	1.4E-08
		1.4E-06	7.6E-08	1.5E-06	1.4E-06	3.5E-07	1.7E-06	2.8E-06	2.9E-07	3.1E-06	1.1E-06	6.5E-07	1.7E-06	2.2E-06	1.5E-06	3.7E-06	1.6E-07	1.1E-07	2.7E-07
	ELAP Frequency	1.8E-06	9.9E-08	1.9E-06	1.8E-06	4.5E-07	2.3E-06	3.6E-06	3.7E-07	4.0E-06	1.4E-06	8.1E-07	2.2E-06	2.8E-06	2.0E-06	4.8E-06	2.0E-07	1.4E-07	3.4E-07
	CCDP	76.5%	76.7%	76.5%	76.5%	77.2%	76.6%	76.5%	79.1%	76.7%	76.5%	80.0%	77.8%	76.5%	77.3%	76.8%	76.5%	81.8%	78.6%

Draft Significant PDS Vectors

Index	PDS	Seq.	Phase	Sequence Nos. and Short Description	Average Frequency	Percent of Total CDF	Cumulative Percentage
1	E-LP-IS-XX-XX	47	1	RPV pressure too low for RCIC operation	7.8E-07	39.8%	39.8%
2	M-HP-IS-LT-XX	46	2	Loss of DC power	6.6E-07	33.8%	73.6%
3	L-HP-IS-OK-F	7, 9, 29, 31	2	FLEX pump fails	9.7E-08	4.9%	78.5%
4	M-HP-IS-OK-XX	45	2	Operator fails to vent containment	9.5E-08	4.8%	83.3%
5	M-LP-IS-OK-H	12, 34	2	RPV pressure too low for RCIC operation; operator fails to align FLEX pump	5.1E-08	2.6%	86.0%
6	L-HP-IS-OK-H	5, 27	2	Operator fails to align FLEX pump for SP makeup or RPV injection	4.5E-08	2.3%	88.2%
7	E-HP-IS-XX-XX	48	1	RCIC fails to operate	4.4E-08	2.3%	90.5%
8	L-HP-IS-OK-OK	3, 25	2	Operator fails to depressurize RPV for FLEX RPV injection	4.2E-08	2.2%	92.7%
9	L-HP-WW-OK-F	8, 10	2	FLEX pump fails; operator fails to reclose containment vents	3.2E-08	1.6%	94.3%
10	M-LP-IS-OK-F	14, 36	2	RPV pressure too low for RCIC operation; FLEX pump fails	2.6E-08	1.3%	95.6%
11	E-HP-IS-ST-XX				1.7E-08	0.9%	96.4%
12	M-LP-WW-OK-H				1.7E-08	0.9%	97.3%
13	L-HP-WW-OK-H				1.5E-08	0.8%	98.1%
14	L-HP-DW-OK-F				9.6E-09	0.5%	98.5%
15	M-LP-WS-OK-F				8.4E-09	0.4%	99.0%
16	L-HP-WW-OK-OK				6.0E-09	0.3%	99.3%
17	M-LP-DW-OK-H				5.1E-09	0.3%	99.5%
18	L-HP-DW-OK-H				4.4E-09	0.2%	99.8%
19	M-LP-DW-OK-F				2.5E-09	0.1%	99.9%
20	L-HP-DW-OK-OK				1.8E-09	0.1%	100.0%
21	M-HP-IS-OK-H				1.3E-10	0.0%	100.0%
22	M-HP-IS-OK-OK				1.2E-10	0.0%	100.0%
23	M-HP-IS-OK-F				6.4E-11	0.0%	100.0%
24	M-HP-WW-OK-H				4.2E-11	0.0%	100.0%
25	M-HP-WW-OK-F				2.1E-11	0.0%	100.0%
26	M-HP-WW-OK-OK				1.7E-11	0.0%	100.0%
27	M-HP-DW-OK-H				1.3E-11	0.0%	100.0%
28	M-HP-DW-OK-F				6.3E-12	0.0%	100.0%
29	M-HP-DW-OK-OK				5.1E-12	0.0%	100.0%
					2.0E-06		

Risk Evaluation Next Steps

- Complete human reliability analysis (HRA)
- Complete containment event tree
- Complete MELCOR calculations
- Complete MACCS2 calculations
- Perform risk integration
  - Focus on estimating the change in risk when containment filtration strategies are implemented
- Develop qualitative risk insights
- Complete review (extent to be determined)

Consideration of Analysis Options
(6/11/13)

- RCIC operation
  - RCIC duration: 16 hr., 4 hr., 0 hr.
  - Flow rate: 600 gpm (or EPG/SAG specification, if any)
- RPV depressurization and vessel injection (?)
  - Reliability of vessel injection under SA condition
  - Injection source, capacity, and effectiveness
- Drywell spray
  - Spray actuation time: @RCIC stop, @ vessel breach, other (?)
  - Spray flow rate: 500 gpm, variation (if any)
- Containment venting
  - Vent sizing: variable between wetwell and drywell, same
  - Vent cycling criteria: (PCPL)/(PCPL-15), other (if any)?
  - Transition from WW to DW venting: SP high water level, other (?)
  - Early venting option: criteria (?)
- Duration of transients: 72 hours, other (?)

MELCOR Calculation Matrix
(from 6/11/13 mtg.)

Case Description	Input Parameters	Case 1	Case 2	Case 3	Case 4	Case 5
Main Steam Line Creep Rupture	RCIC failure (hr.)	16	4	0	16	4
	Drywell spray actuation	@ RCIC failure	@ RCIC failure	@ vessel breach	@ vessel breach	@ vessel breach
	Drywell spray flow rate (gpm)	500	500	500	500	500
	Wetwell vent cycling	(PCPL)/ (PCPL-15)	(PCPL)/ (PCPL-15)	(PCPL)/ (PCPL-15)	(PCPL)/ (PCPL-15)	(PCPL)/ (PCPL-15)
	Drywell vent cycling	(PCPL)/ (PCPL-15)	(PCPL)/ (PCPL-15)	(PCPL)/ (PCPL-15)	(PCPL)/ (PCPL-15)	(PCPL)/ (PCPL-15)
	Run time (hr.)	72	72	72	72	72

Options for Rulemaking

1. Base Case
   - FLEX injection to Reactor pressure vessel (RPV), EA-13-109, EPG/SAG Rev. 3
2. External RPV Water Injection Point
   A. Option 1 plus external injection to RPV
   B. Option 2A plus wetwell/drywell (WW/DW) vent cycling
3. External Drywell (DW) Water Injection Point
   A. Option 1 plus external injection to DW
   B. Option 3A plus WW/DW vent cycling
   C. Option 3B plus water management to prevent the need for DW venting
4. Small Filter (not based on DF)
   - Option 3A plus small filter
5. Large Filter
   - Option 3A plus large filter

Mapping of MELCOR Cases to Industry Alternatives and SRM Requirements (MSL Creep Rupture Example) – from 8/14/13 mtg

Industry Alternatives	SRM Requirements/Guidance	Revised (8/9/13) MELCOR Cases*
Option 1 (base case)	Benefits of EA-13-109 (HCVS); 10CFR50.54 procedure availability + early venting	Case 1
Option 2A	Above + additional industry measures to maintain core in-vessel	Case 3
Option 2B	Above + modified operational procedure	Case 4
Option 3A	Maintain core coolability and containment integrity	Case 5
Option 3B	Maintain core coolability and containment integrity	Case 6
Option 3C	Above + modified venting strategy	Case 7
Option 4	External filtration	All MELCOR cases w/small DF filter
Option 5	External filtration	All MELCOR cases w/large DF filter

*** MELCOR Case 2 is without early venting (no comparable industry option); Cases 8 and 9 are sensitivities of RCIC duration; Case 10 is variation of the base case (Case 1) with drywell injection at RCIC failure.**

Industry options 4 and 5 are included for all MELCOR cases (Option 4 w/small DF filter, Option 5 w/large DF.

Preliminary Results (from 9/19/13 mtg.)

Index	PDS	Frequency	Percent	Cumulative	Notes
1	E-LP-IS-XX-U	8.7E-06	43.9%	43.9%	Stuck-open SRV depressurizes RPV; RCIC fails before FLEX can be aligned
2	M-LP-IS-XX-H	3.6E-06	18.3%	62.2%	Failure to align FLEX
3	M-LP-IS-XX-F	1.9E-06	9.4%	71.6%	FLEX hardware failure
4	L-LP-IS-XX-H	1.4E-06	7.1%	78.7%	Failure to align FLEX
5	L-LP-IS-XX-F	7.2E-07	3.7%	82.4%	FLEX hardware failure
6	M-HP-IS-LT-U	6.4E-07	3.2%	85.6%	Failure to depressurize for FLEX
7	M-LP-IS-XX-U	4.7E-07	2.4%	88.0%	No containment venting
8	L-HP-IS-OK-U	4.3E-07	2.2%	90.2%	Failure to depressurize for FLEX
9	M-LP-WW-XX-H	3.5E-07	1.7%	91.9%	Failure to align FLEX
10	L-HP-IS-LT-U	3.3E-07	1.7%	93.6%	Failure to depressurize for FLEX
11	E-HP-IS-UK-U	3.3E-07	1.7%	95.2%	RCIC fails before FLEX can be aligned
12	M-HP-IS-OK-U	2.9E-07	1.5%	96.7%	Failure to depressurize for FLEX
Core-Damage Frequency		2.0E-5			

Updated Results (at this mtg.)

Index	PDS	Frequency	Percent	Cumulative	Notes
1	E-LP-IS-XX-XX	7.8E-07	39.8%	39.8%	Stuck-open SRV depressurizes RPV; RCIC fails before FLEX can be aligned
2	M-HP-IS-LT-XX	6.6E-07	33.8%	73.6%	Vessel at high pressure; FLEX hardware failure
3	L-HP-IS-OK-F	9.7E-08	4.9%	78.5%	Vessel at high pressure; FLEX pump failure
4	M-HP-IS-OK-XX	9.5E-08	4.8%	83.3%	Vessel failure at high pressure
5	M-LP-IS-OK-H	5.1E-08	2.6%	86.0%	Vessel failure at low pressure
6	L-HP-IS-OK-H	4.5E-08	2.3%	88.2%	Vessel failure at high pressure
7	E-HP-IS-XX-XX	4.8E-08	2.3%	90.5%	Vessel failure at high pressure
8	L-HP-IS-OK-OK	4.2E-08	2.2%	92.7%	Vessel failure at high pressure
9	L-HP-WW-OK-F	3.2E-08	1.6%	94.3%	Vessel failure at high pressure; wetwell vent open
10	M-LP-IS-OK-F	2.6E-08	1.3%	95.6%	Vessel failure at low pressure
11	E-HP-IS-ST-XX	1.7E-08	0.9%	96.4%	Early loss of dc power
Core-Damage Frequency		2.0E-6			

Staff needs from the industry

- Specifics of anticipatory early venting
  - Venting at what containment pressure?
  - Any other early venting criteria?
- Specifics of RCIC operation
  - Suction from CST? Suppression pool? From CST transitioning to suppression pool? CST refill?
  - Flow rate: 600 gpm (or EPG/SAG specification, if any)
  - RPV level control during RCIC operation (e.g., L2/L8 cycling, throttling)
  - RCIC failure criteria?
- Specifics of SRV cycling
  - Cycle bandwidth at high pressure? At low pressure?
  - How is SRV operation controlled? Manual? Automatic? Passive?
  - DC power availability for SRV control
  - SRV failure criteria? Stochastic failure? Thermal seizure?

Staff needs from the industry

- Specifics of RPV depressurization and vessel injection timing and criteria for initiation of RPV depressurization
  - Criteria for RPV depressurization? Depressurization rate?
  - DC power availability for RPV level control?
  - Reliability of vessel injection under SA condition
  - Injection source, capacity, and effectiveness
- Specifics of drywell water management
  - Water management hardware – spray? Others?
  - If spray, actuation time: @RCIC stop, @ vessel breach, others (?)
  - Spray flow rate: 500 gpm? variation (if any)?
- Specifics of containment venting
  - Vent sizing: variable between wetwell and drywell? Same?
  - Vent cycling criteria: (PCPL)/(PCPL-15), other (if any)?
  - Transition from WW to DW venting: SP high water level, others (?)