Public Meeting on FLEX and RIDM

Insights from Implementing FLEX in the Peach Bottom Seismic PRA Model

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Overview

- Purpose - Determine the benefit of crediting FLEX in the PBAPS internal events and seismic PRA models
- Discussion points
  - FLEX Related Procedure Changes
  - FLEX Alternatives Modeled
  - Preliminary Full Power Internal Events Results and Insights
  - Preliminary Seismic PRA Model Results and Insights
  - Conclusions and Recommendations

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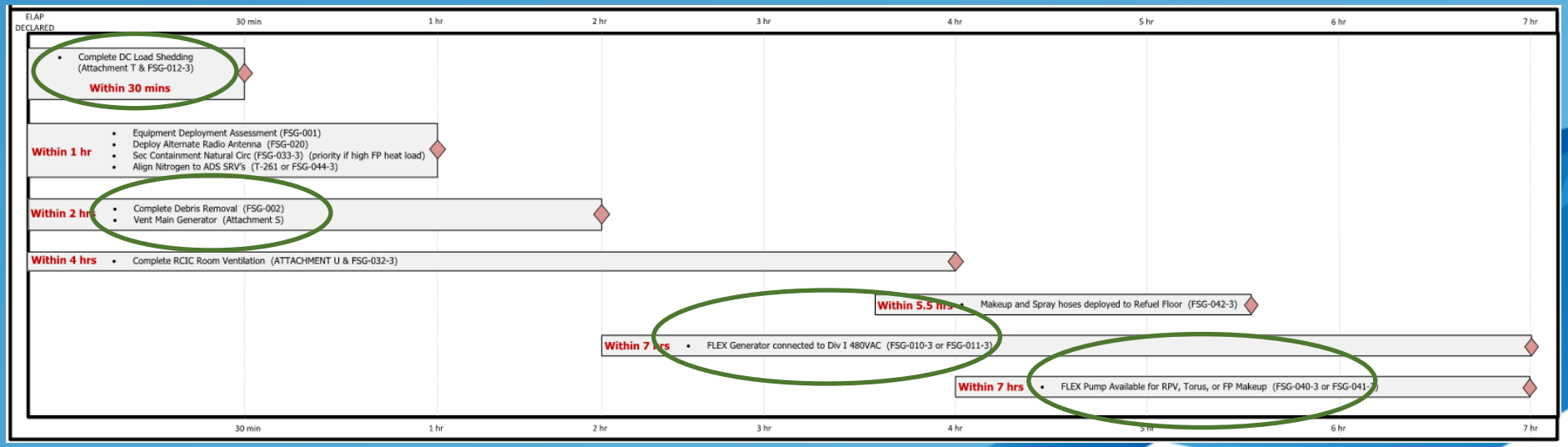
FLEX Related Procedures

- SE-11 provides direction in all LOOP scenarios at PBAPS
- Extended Loss of Offsite Power (ELAP) declaration at 1 hour if power not restored to any 4 kV bus (Sheet 5)
- Key Actions Identified from ELAP Sheet 6 from SE-11



FLEX Alternatives Modeled

- DC load shed commences early in SE-11 prior to declaration of ELAP
  - Battery calculation review indicated that performance of these initial steps would be sufficient to avoid LERF potential if HPCI or RCIC is available
  - ELAP declaration results in additional load shedding steps to further extend battery life for deployment of FLEX generators
  - Bundled execution steps by impacted DC panels
- Alignment of FLEX Generators to Div I 480 VAC
  - Allows for RPV depressurization capabilities via SRVs
  - Allows for continued RCIC operation with DC available
- FLEX pump alignment
  - Allows for RPV injection or Makeup to torus
  - With RCIC initially available, either leads to long term success state

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FLEX Related Human Failure Events

- NEI 16-06 Attributes

HEP Description	Feasible in Scenario	Available and Reliable	Time Margin	Command and Control	Environ-mental Conditions
Operators Fail DC Load Shed (SBO, Div I Only)	SBO	Yes	Yes	SE-11, Att. T	Varies
Operators Fail DC Load Shed (ELAP)	ELAP	Yes	Yes	FSG-012	Varies
Operators Fail to Align Flex Generator to Div I	ELAP	Yes	Yes	FSG-010 FSG-011	Varies
Operator Fails to Partially Depressurize RPV and Vent Cont. to Prolong RCIC	SBO	Yes	Yes	T-101 T-102	Varies
Operators Fail to Align Flex Flow Path to RPV	ELAP	Yes	Yes	FSG-040 FSG-041	Varies

FLEX Related Human Error Probabilities

- Values Obtained Using EPRI HRA Approach

HEP Description	FPIE Value	SPRA Value
Operators Fail DC Load Shed (SBO, Div I Only)	2.5E-02	5.2E-02
Operators Fail DC Load Shed (ELAP)	3.8E-02	9.8E-02
Operators Fail to Align Flex Generator to Div I	3.6E-02	3.7E-02
Operator Fails to Partially Depressurize RPV and Vent Cont. to Prolong RCIC	(<7.2E-02)	7.2E-02
Operators Fail to Align Flex Flow Path to RPV	2.5E-02	2.5E-02

FLEX Related Human Error Probabilities

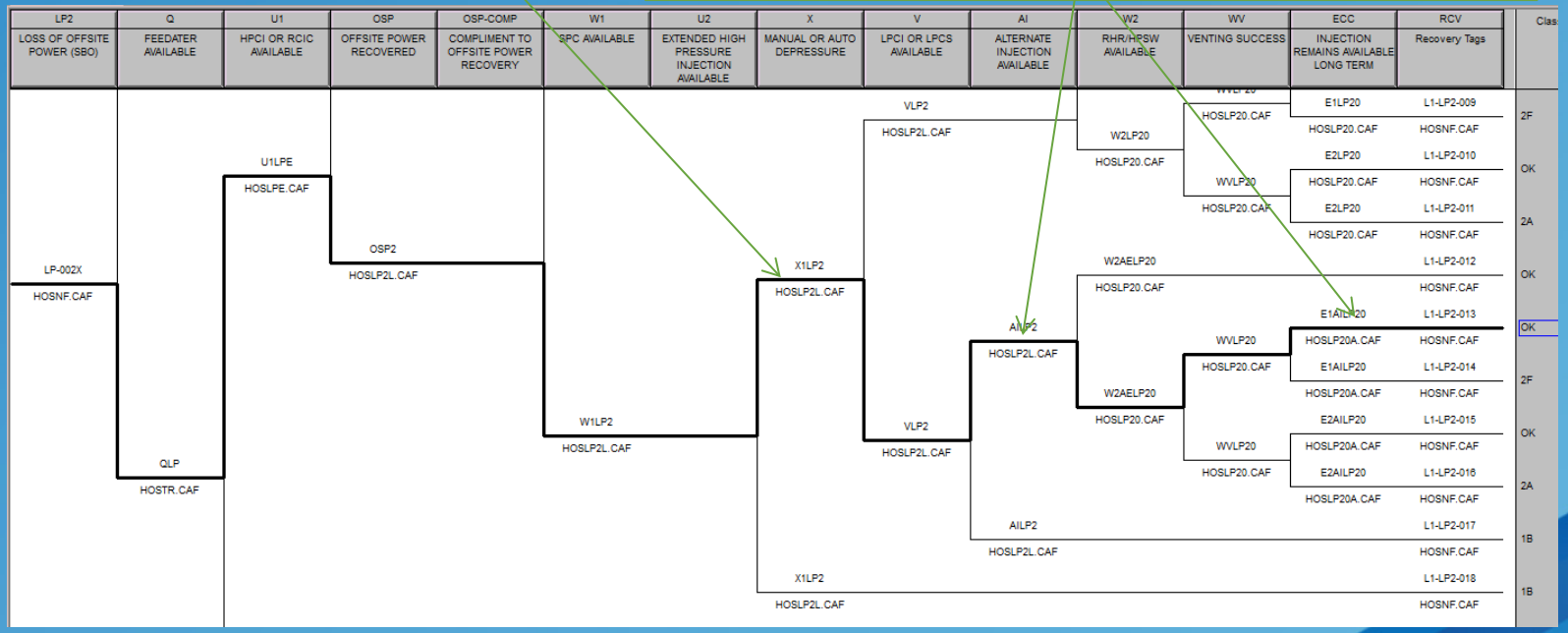
- Deep load shed action more significantly impacted for seismic since
  - Only one EO is available
  - Action needs to be completed as soon as possible - little margin normally available for success
  - High workload assumed for seismic vs. moderate for FPIE
- Leveraged availability of the FLEX procedures, training, and timing validation for Peach Bottom
  - Allowed detail to first be developed for the FPIE FLEX actions
  - Required little change/enhancement for seismic

FLEX Related Human Error Probabilities

- FLEX actions are considered to apply across all HRA damage state bins because the SSCs that drive the individual bin adjustments become irrelevant for FLEX
  - Operators would proceed to FLEX actions on the ELAP basis of no 4kV bus being able to be repowered within 1 hour regardless of the seismic bin-related SSC failures
  - Since the whole idea of FLEX is for this type of catastrophic event, applying the individual seismic bin adjustments is not necessary

SBO SEQUENCE LOGIC

- Extended RPV Depressurization
- Continued RCIC or FLEX Injection



- DC load shed required for alignment of generators
- Alignment of generators required for extended RPV depressurization and continued RCIC operation

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FPIE RESULTS

- Full Power Internal Events Results

Case Description	CDF Value	LERF Value
Unit 2 w/ No Credit for FLEX	3.4E-06 / yr	4.9E-07 / yr
Unit 2 w/ Credit for FLEX in ELAP scenarios	3.0E-06 / yr	4.4E-07 / yr

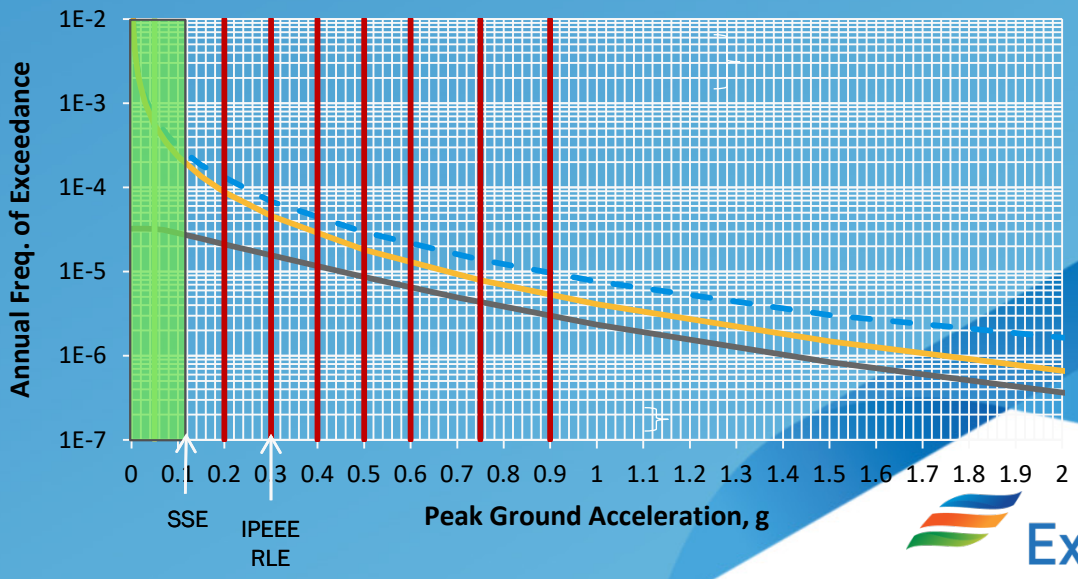
- Benefit consistent with SBO contribution w/ HPCI or RCIC Available
  - ~10% CDF reduction from SBO and SBO-like conditions (i.e., LOOP and CCF of EDGs, or Trip and CCF of 4 kV buses)
  - ~10% LERF reduction from similar scenarios
- Additional credit could be obtained if credit for FLEX generators was not limited to ELAP scenarios

SPRA RESULTS

- Seismic PRA Model Results

Case Description	CDF Value	LERF Value
Base Case w/ No Credit for FLEX	2.0E-5 / yr	3.9E-6 / yr
Base Case w/ Credit for FLEX	1.9E-5 / yr	3.7E-6 / yr

- Site considering many options for finalization
  - Currently limited by relatively flat hazard curve at high g levels



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SUMMARY

- Conclusions
  - Reduction in CDF and LERF values can be obtained in internal events and seismic results with nominal credit for FLEX systems when procedurally directed
  - HRA benefited from strong inputs; specifically validation, procedures, and training
  - Seismic benefit limited by unique site hazard curve (that is relatively flat at high g levels)

- Recommendations
  - Work with site to help optimize path forward for SPRA model completion
  - As FPRA update is completed, identify when alignment of FLEX generators may be beneficial to include in the Fire Area Safe Shutdown Guides

Additional Questions?

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