


Crediting FLEX in PRA Models

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Presentation Objectives

1. Discuss Use of Portable Equipment in Risk Informed Operations and Industry Guidance
2. Discuss Dominion examples of modeling FLEX in site PRAs



Industry Initiatives

- FLEX was implemented to meet NRC Order 12-049
- NEI Task Force initiated - FLEX in Risk Informed Decision Making (FRIDM)
 - NEI 16-06 “Crediting Mitigating Strategies in Risk Informed Operations”
 - NEI 16-08 “Guidance for Optimizing the Use of Portable Equipment”
- EB 17-10 issued “Maximizing the Benefit of Portable Equipment”



Overall Objective

- Maximize the Benefit of Portable Equipment
 - Utilize portable equipment, including equipment procured as a part of the B.5.b and FLEX programs, in risk-informed regulatory programs to increase station safety and reduce operating costs.



Two Guidance Documents

- NEI 16-06 “Crediting Mitigating Strategies in Risk Informed Operations”
 - How to model and credit portable equipment in PRA
- NEI 16-08 “Guidance for Optimizing the Use of Portable Equipment”
 - Process recommendations, templates, examples



Modeling FLEX – Dominion Example Plant A

- Issue – Internal flooding represents greater than 50% of the total internal event/flooding model core damage risk
- Dominated by Turbine Building Flooding migrating to Emergency Switchgear Room and causing a total loss of AC and DC power



Key Issues

- Loss of DC causes loss of MCR indication
- Loss of AC requires manual operation of MOVs to control supply water to the steam generators
- Need long term water supply to steam generator



Restoration of MCR Indication

- Post-Fukushima plant modification installed UPS on Appendix R Remote Monitoring Panel (RMP)
 - UPS provides 12 hours power to RMP after loss of power and ability to install portable 120V power for continued operation.
 - RMP provides both units key instrumentation (steam generator level/pressure, RCS temperature, pressurizer pressure, Gamma metrics)



Procedure Flow

- AP 13 and AP 13-01 – Turbine Building Flooding APs which identifies flooding condition and directs isolation attempts
- ECA 0-0 “Loss of AC Power”
 - Declaration of ELAP within 45-60 minutes
 - Implement FSG procedures
 - FSG 7 –
 - Directs actions to establish control at Remote Monitoring Panel
 - Directs actions to verify running or start Turbine Driven Aux Pump
 - Maintain control of Steam Generator levels
 - Establish cooldown to intermediate shutdown conditions



Local Controls and Monitoring

- Operators relocate to RMP
- Local starting/restarting TDAWP upon loss of DC.
- Local control of Steam Generator PORVs allow for pressure control and cooldown capability
- Local alignment of additional water source prior to 8 hours
- Provide 120V generator source to backup RMP prior to 12 hours.



Human Error Probabilities

- Modeled Human Failure Events
 - Operator fails to locally control AFW (within 1 hour)
 - Operator fails to establish UPS to RMP (within 1 hour)
 - Operator fails to align AFW makeup from fire main within 4 hours.
 - Operator fails to establish generator power to the remote monitoring panel within 12 hours



Key Issues – Human Error Probability

- Human Error Probabilities for control of in-plant equipment similar to other modeling
- Human Error Probabilities for actions to deliver portable equipment to the plant uses a surrogate with technical justification
 - Large margin to perform task (1.5 hour action/12 hours to perform)
 - Electrical Connections using color coded “quick-connects”
 - Operator instructions with equipment based industry templates
 - Procedure steps are clear
 - Training for operators and personnel delivering equipment (SAT process used)



Electrical Connection



Key Issues-Equipment Data

- Data used for modeling portable equipment failures
 - Multiple equipment available to perform task and adequate time should a failure occur
 - Dominion review of portable equipment and associated failures
 - Sensitivity performed
- EPRI is collecting data and will update results when available.

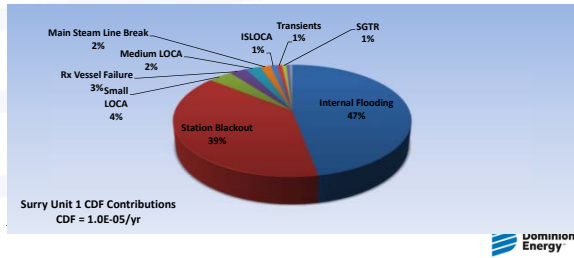


Data Sensitivity

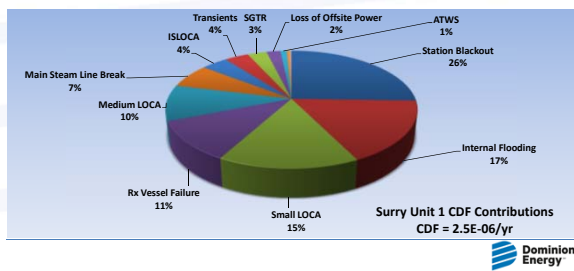
- Model two portable generators each capable of providing enough power supply for instrumentation
- EDG failure rate increased by a factor of 5 for every failure mode
- CCF modeled for every failure mode assuming non-staggered testing
- Review Dominion specific failures of portable equipment
- Results show minor CDF reduction



Plant A Risk Profile (before FLEX implementation)



Results Following FLEX



Conclusions

- FLEX can provide a significant improvement to qualitative and quantitative risk
- FLEX improvements are site specific
- Modifications may be required for maximum credit
- There are some unique issues that must be considered when incorporating portable equipment into PRA
- The use of estimated failure rates for portable generators is appropriate until enough test data have been obtained
- Data should be considered in uncertainty analysis



