



**U.S.NRC**

UNITED STATES NUCLEAR REGULATORY COMMISSION

*Protecting People and the Environment*

# **SPAR MODELS with “All Hazard” Categories**

## **SPAR-AHZ**

***SPAR Public Workshop***

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***North Bethesda, MD***

# HISTORY

- In 2004 NRC initiated a project to include other hazard categories into the SPAR models, which included only the internal events category.
- This project is implemented by NRC/RES in response to a user need from NRC/NRR.
- The project has been ongoing for the last 11 years; currently, 22 of the 79 SPAR models include models for all hazard categories applicable to a specific site.

# OBJECTIVE

- SPAR models containing AHZ categories are available for NRC PRA analysts in various analyses, such as
  - the significance determination process (SDP) in the Office of Nuclear Reactor Regulation and
  - accident sequence precursor (ASP) evaluation process in the Office of Nuclear Regulatory Research.
- Such evaluations are routinely done; SPAR-AHZ models are intended provide a comprehensive view of the plant risk profile.
- Evaluations performed by the NRC using the SPAR models are generally intended to inform and prioritize regulatory follow up to operational issues and are not used to support licensing basis changes.

# SCOPE

- A SPAR-AHZ model includes at least internal events, internal flooding and fires, seismic events, and wind-related events (tornados, hurricanes, and high winds applicable to the site).
- External flooding events may be modeled if applicable to the site.

## Example Output from a SPAR-AHZ Model for illustration purposes

		Number of IEs	IE Frequency (per RY)	CDF (per RY)
1	INTERNAL EVENTS	22	9.7E-01	6.3E-06
2	INTERNAL FLOODING EVENTS	5	1.3E-05	1.6E-06
3	INTERNAL FIRE EVENTS	56	5.7E-02	7.3E-05
4	SEISMIC EVENTS	5	4.6E-04	3.1E-06
5	EXTERNAL FLOODING EVENTS			
6	HIGH WIND EVENTS	1	1.8E-02	4.9E-07
7	TORNADO EVENTS	3	1.1E-05	5.6E-08
8	OTHER EXTERNAL EVENTS			
	Total =	92		8.4E-05

# Information Sources

- NRC uses readily available information to generate models for “other hazard” categories.
- In the recent years, NFPA 805 fire PRA model information available voluntarily from some utilities were used to include a more detailed set of fire scenarios in the SPAR-AHZ models.

# Nature of the Models

- The accident scenarios for all hazard categories are modeled in the SAPHIRE software by event trees placed in a single PRA model; internal events are considered to be one of the categories.
- CDF from all or some of the accident scenarios, and potential failure combinations that can lead to core damage can be quantified, as needed for a specific analysis.
- The picture on the next slide illustrates a SAPHIRE window showing a subset of scenarios that may be in a SPAR-AHZ model.



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**Basic Events** Standard ▾

**Fault Trees** Main Trees ▾

**Event Trees** Main Trees ▾

New event tree ...

+ EQK-BIN-1	Seismic Event Bin 1
+ EQK-BIN-2	Seismic Event Bin 2
+ EQK-BIN-3	Seismic Event Bin 3
+ EQK-BIN-4	Seismic Event Bin 4
+ <u>EQK-BIN-5</u>	<u>Seismic Event Bin 5</u>
+ FLE-BIN1	External Flooding Bin 1 (Up to 698' Elevation above Mean Sea Level)
+ FLE-BIN2	External Flooding Bin 2 (Between 702' and 705' Elevation above Mean Sea Level)
+ FLE-BIN3	External Flooding Bin 3 (Above 705' Elevation above Mean Sea Level)
+ FLI-CST_AB3C	Internal Flooding due to CST Drained into Aux Building
+ FLI-ERCW_AB2	Internal Flooding due to ERCW in Aux Building
+ FLI-ERCW_P_1A	Internal Flooding associated with ERCW Pump Room 1A/2A
+ FLI-ERCW_P_1B	Internal Flooding associated with ERCW Pump Room 1B/2B
+ FLI-ERCW_S_1A	Internal Flooding associated with ERCW Strainer Room 1A/2A
+ FLI-ERCW_S_1B	Internal Flooding associated with ERCW Strainer Room 1B/2B
+ FLI-RWST_AB3R	Internal Flooding due to RWST Drained into Aux Building
+ FLI-TB	Internal Flooding in Turbine Building
+ FRI-AUX-125VBD	125V Vital Board Room I
+ FRI-AUX-480-2B	Severe fire occurs in 480V Board Room 2B
+ FRI-AUX-480-A1	Severe fire in the 480V Shutdown Board Room 1A1
+ FRI-AUX-480-A2	Severe fire in the 480V Shutdown Board Room 1A2
+ FRI-AUX-480-B	Severe fire occurs in 480V Board Room B
+ FRI-AUX-480-B2	Severe fire occurs in 480V Board Room 1B2
+ FRI-AUX-6KSD-A	Subsumed severe fires in the 6.9-KV Shutdown Board Room A resulting in partial LOOP
+ FRI-AUX-6KSD-B	Subsumed severe fires in the 6.9-KV Shutdown Board Room B resulting in partial LOOP
+ FRI-AUX-AUXRM	Fire in the Auxiliary Control Room resulting in LOOP
+ FRI-AUX-C-690A	Subsumed severe fires in the Auxiliary Building Corridor (690' EI.)



# Current Uses of SPAR-AHZ Models

- The extent to which a SPAR-AHZ model is used is left to the discretion of the analysts.
- Use of these models within the NRC have been increasing.
- Within RES, they were used to illustrate and support probabilistic risk calculations in various projects.
- The results of these models, and the experience of generating them provided valuable insights to NRC staff that have been involved in them.

# Model Development Process

- For those model where voluntary utility participation is available, the following model construction process is performed:
  - Meet to gather information
  - Create a draft model and its documentation
  - Meet to go over the draft model
  - Revise the model and add it to the SPAR model library (website).
- This process may take about 12 months.
- The model and the SAPHIRE software to run it are available to the utility who owns the plant.

# CONCLUSIONS

- Development of additional SPAR-AHZ models that include internal fires fire and external hazards is the subject of continuing focus at the NRC.
- The desired outcome is to have more complete and integrated risk assessment for operational events and plant conditions and to improve the realism of reactor oversight processes such as the SDP and ASP programs.
- User feedback from increased use will further improve the realism and technical quality of these models, as it has been the case for internal events models.