



Risk-Informed Systems Engineering (RISE) Platform

Mike Mankosa, Chris Gosdin
FPoliSolutions, LLC

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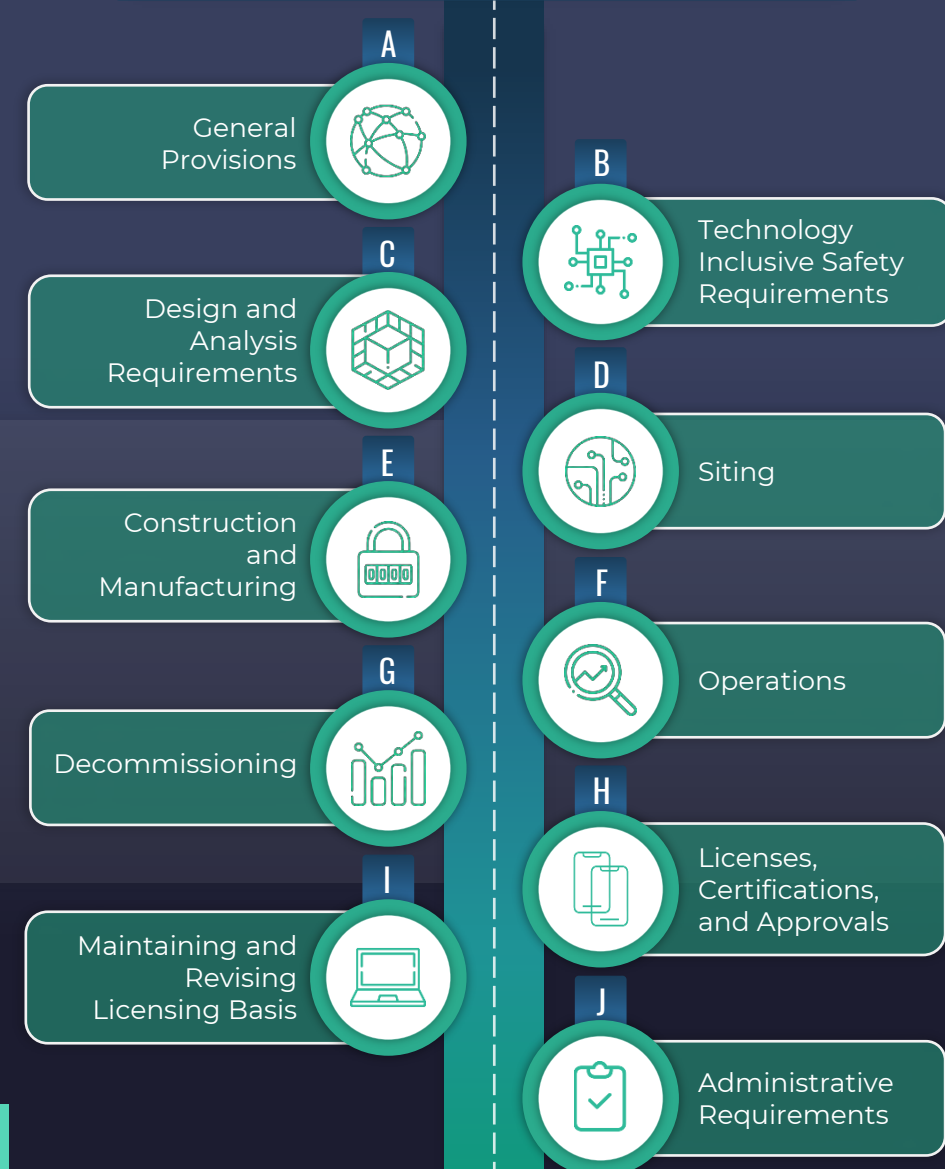
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FPoliSolutions' Vision is for RISE to become the framework of choice to enable the full benefits from a risk-informed approach for both advanced reactors and the operating fleet as envisioned by the Licensing Modernization Project (LMP) and NEI 18-04

RISE: Risk-Informed System Engineering

10 CFR PART 53 ROADMAP



RISE – Purpose



RISE

Cutting edge solution to help NPP operators and advanced reactor developers to orchestrate the complexities associated with implementing a risk-informed design process while reducing design cycle and costs like no other generic productivity tool.

This state-of-the-art software helps to:



- Create a collaborative environment for engineering teams and stakeholders within their organization as they build the 'safety case' for their plant
- Digest large and complex data structures needed to characterize the engineered safety features and relationships with scenarios and events
- Optimize design to satisfy safety and economics goals.
- Guide analysts through complex workflows of simulations, data processing and qualification, analyses, and documentation.
- Maximize the value of enterprise technical data with enhanced security and process automation.
- Automate the creation of documentation and smart procedures for quality, transparency and expedited regulatory review.
- Provide a platform for maintaining the safety case throughout the life of the plant.
- Fit seamlessly within established processes of the organization.

RISE: A Smart Safety Case Builder for The Design and Licensing of Nuclear Reactors.



Development Status

- SBIR Phase I
 - Content of this presentation
- SBIR Phase II
 - Current development
- SBIR Topic is assessment of Risk Informed Methods for application to LWRs



RISE

RISE

- RISE project was motivated by the LMP and NEI 18-04 which was directed to facilitate licensing of Advanced Reactors.
- FPoli extended the LMP methodology to the current operating LWRs fleet
- RIPB paradigm can uncover safety margin still embedded in the NPP operating fleet safety case
- A parallel can be drawn with the introduction of Best-Estimate Plus Uncertainty (BEPU) methodologies starting from the 1990's to replace the conservative Appendix-K methods:

BEPU methods made extended power uprates possible in the US NPP fleet during the 2000's for a total of 8 GW added to the grid without a single power plant built in the same time period

RISE S16.1: Collect results from PRA

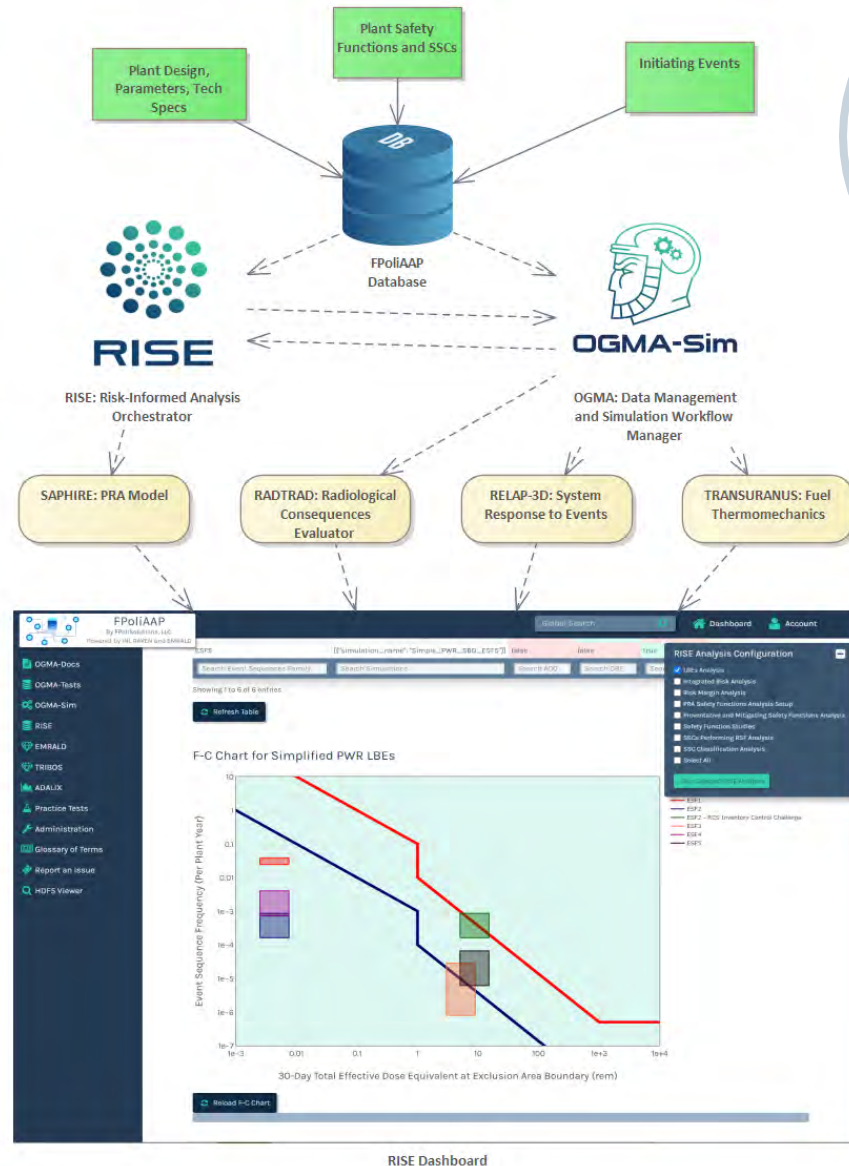
RISE S16.2 (LBE Task 7a): Evaluate each LBE (Event Sequence Family) against F-C targets

RISE S16.3 (LBE Task 7b): Evaluate Integrated Plant Risk against Quantitative Health Objectives (QHOs) and 10 CFR 20

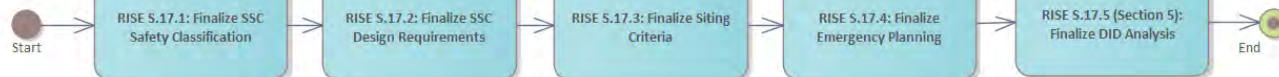
RISE S16.4 (LBE Task 7c): Evaluate Risk Significance of LBEs and SSCs Including Barriers

RISE S16.5 (LBE Task 7d): Perform Deterministic Safety Analyses Against 10 CFR 50.34

RISE S16.6 (LBE Task 7e): Risk-Informed, Performance-Based Evaluation of Defense-in-Depth



RISE Dashboard



RISE Plant Entry



FPoliAAP
By FPoliSolutions, LLC.

Global Search

Dashboard

Account

OGMA-Calcs

OGMA User Manual

RISE

Nuclear Power Plants

Plant Parameters

Safety Functions

SSCs

Initiating Events

Event Sequences

Event Sequence Families

Defense in Depth Adequacy

Fault Trees

Basic Events

Distributions

RISE Administration

RISE User Manual

Nuclear Power Plants

Import CSV

Export CSV

Import JSON

Export JSON

Import RISE Hierarchy

Search in Table:

Show **50** entries

Plant Name	Consequence Metric	Event Classification	Plant Type	Operating Licensee	Operation Start	Rated Power
Standard Modular HTGR	30-Day Total Effective Dose Equivalent at Exclusion Area Boundary	NEI-18-04	HTGR	DOE	1986	558

HTGR

Search Consequence Metric

Search Event Classific

Search Pl

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Search Rat

Showing 1 to 1 of 1 entries (filtered from 15 total entries)

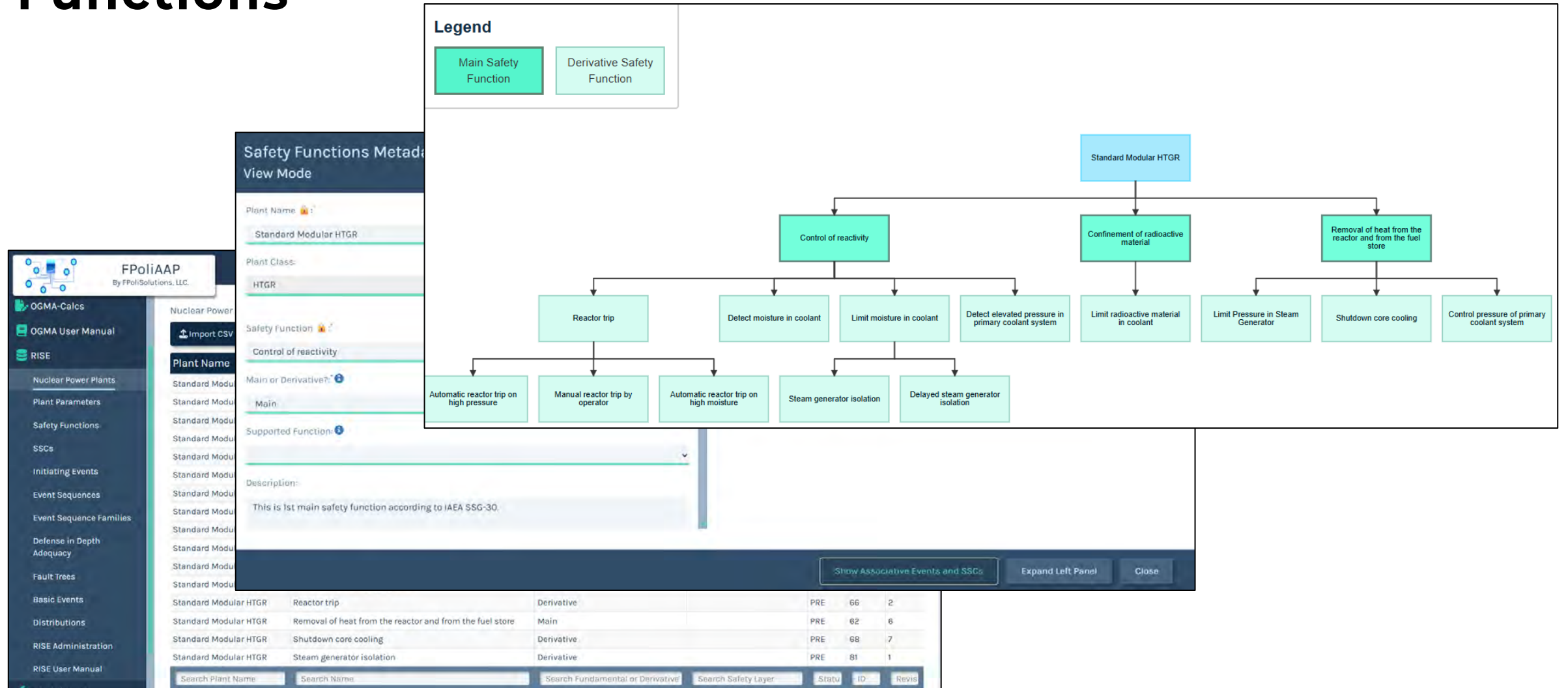
Previous

1

Next

Refresh Table

Defining Safety Functions



Plant SSC Entry and Visualization

Systems and Components Metadata View Mode

System Name: Primary Coolant System

Description: See Figure C-3 of DOE-HTGR-88-011. In the event of an earth...

System Acronym: PCS

Tag ID: SCC-1239

Sub-Systems:

System Name	System Acronym	Tag ID	Sub-System
Reactor Vessel	SR		
Neutron Control Sub-system	?		
Primary Coolant System	SR		
Steam Generator	?		
Vessel Heat Removal Systems	?		
Plant Protection Instrumentation System	?		
Helium Purification System	?		

System Name	System Acronym	Tag ID	Sub-System
Reactor Vessel	SR		
Neutron Control Sub-system	?		
Primary Coolant System	SR		
Steam Generator	?		
Vessel Heat Removal Systems	?		
Plant Protection Instrumentation System	?		
Helium Purification System	?		

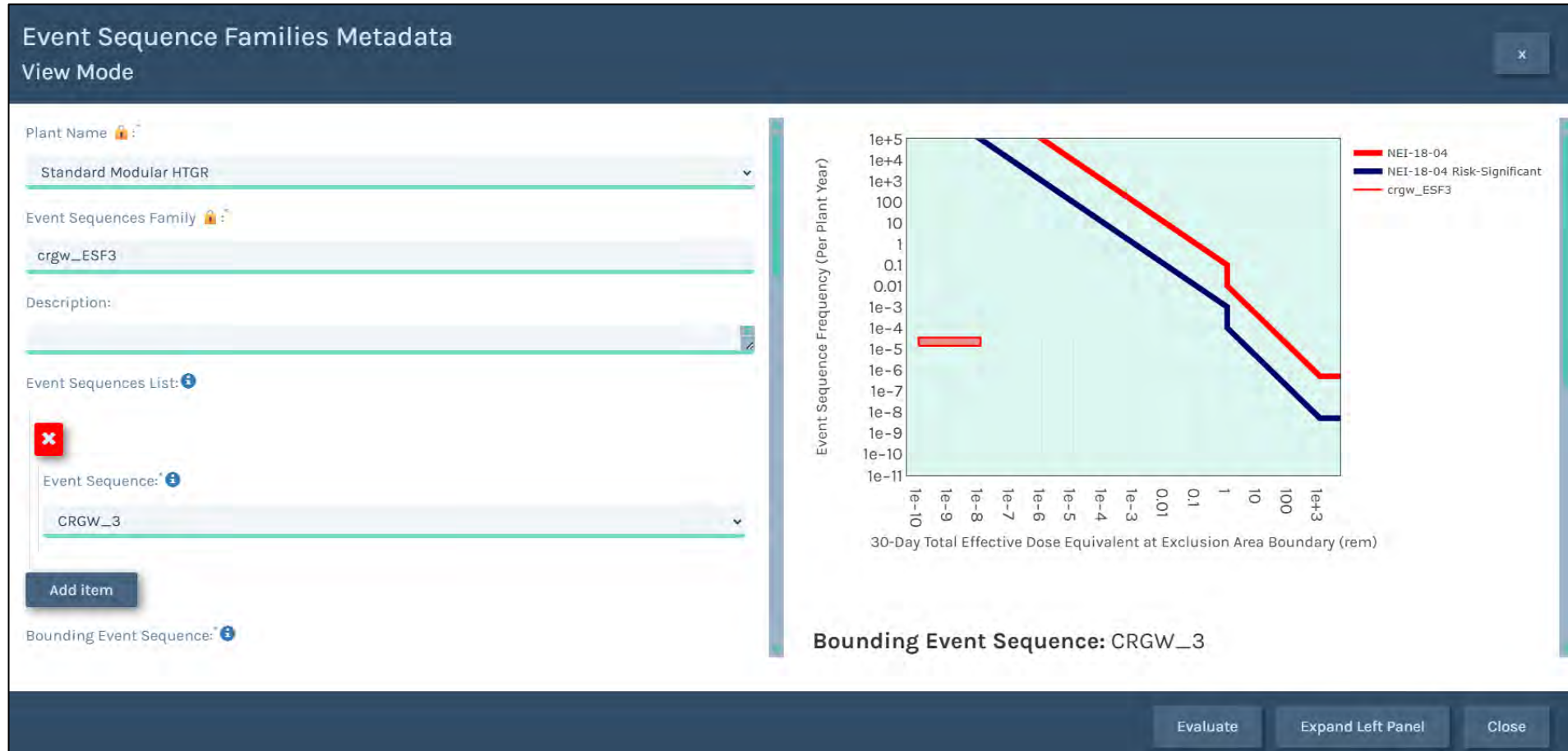
Initiating Events, Event Sequences, and Event Sequence Families

The screenshot displays the FPoliAAP web application interface. The top navigation bar includes a 'Global Search' field, a 'Dashboard' link, and an 'Account' link. The left sidebar contains a menu with the following items: OGMA-Calcs, OGMA User Manual, RISE, Nuclear Power Plants (selected), Plant Parameters, Safety Functions, SSCs, Initiating Events, Event Sequences, Event Sequence Families, Defense in Depth Adequacy, Fault Trees, Basic Events, Distributions, and RISE Administration. The main content area shows the 'Event Sequence Families for Standard Modular HTGR' table. The table has columns for Plant, Event Sequences Family, Bounding Event Sequence, Status, DBID, and DBRV. The table is filtered to show 50 entries. The first 10 entries are as follows:

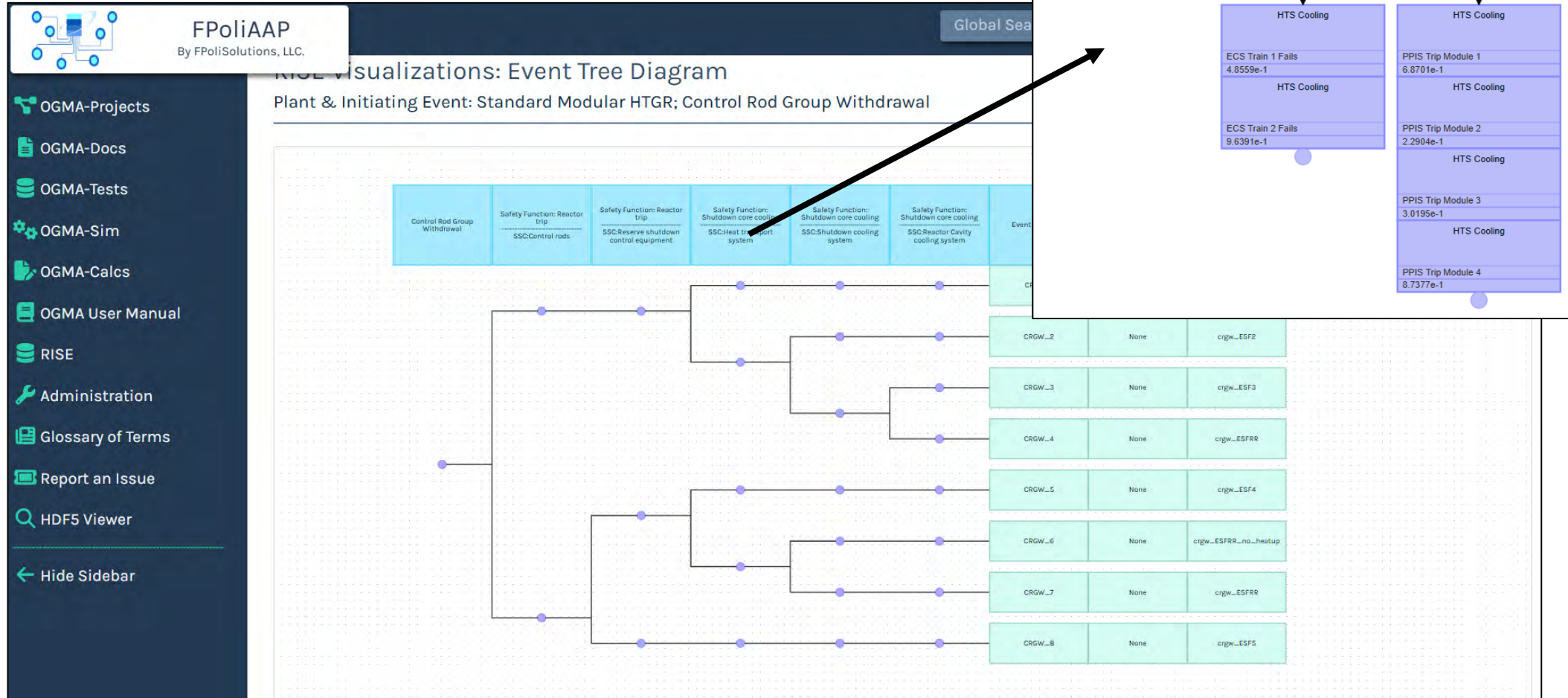
Plant	Event Sequences Family	Bounding Event Sequence	Status	DBID	DBRV
Standard Modular HTGR	atws_ESF1	ATWS_01	PRE	103	188
Standard Modular HTGR	atws_ESF2	ATWS_02	PRE	104	186
Standard Modular HTGR	atws_ESF3	ATWS_03	PRE	105	189
Standard Modular HTGR	atws_ESF4	ATWS_08	PRE	106	186
Standard Modular HTGR	atws_ESF5	ATWS_09	PRE	107	191
Standard Modular HTGR	atws_ESF6	ATWS_10	PRE	108	186
Standard Modular HTGR	atws_ESF7	ATWS_05	PRE	171	164
Standard Modular HTGR	atws_ESFRR	ATWS_13	PRE	109	187
Standard Modular HTGR	atws_ESFRR_no_heatup	ATWS_04	PRE	172	163
Standard Modular HTGR	crgw_ESF1	CRGW_1	PRE	110	186

The table also includes a 'Search in Table' field and a 'Show 50 entries' dropdown. Below the table, there is a 'Refresh Table' button and a pagination control showing 'Showing 1 to 11 of 11 entries'.

Event Sequence Families



Event and Fault Trees



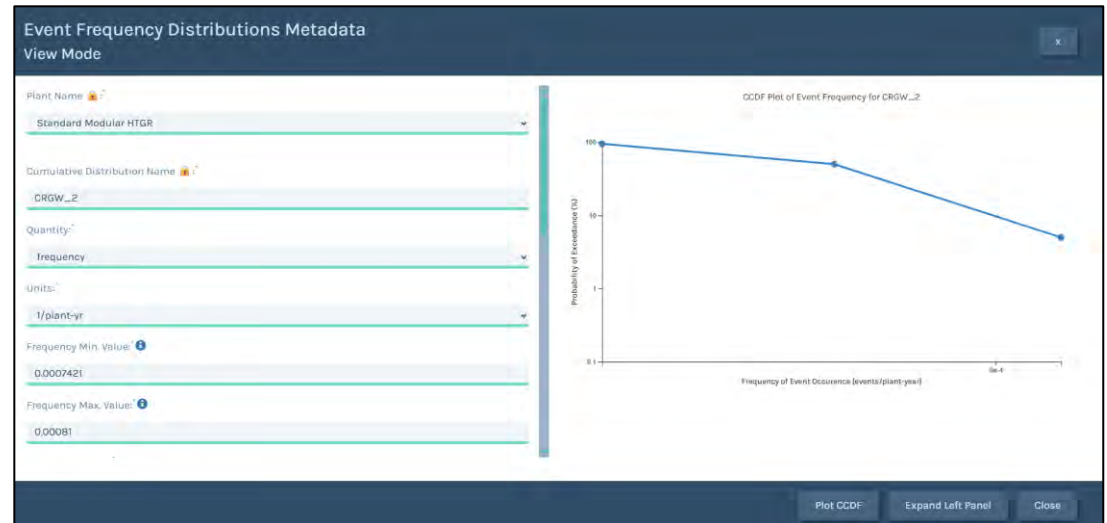
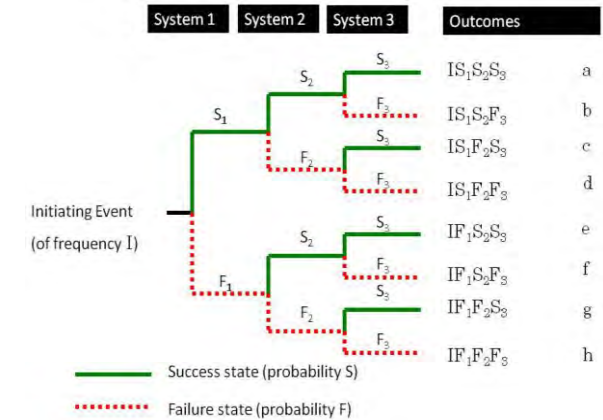
Frequency Distributions

- Manual Input of PRA Artifacts
- Automated Importation of PRA data
 - API for import

PRA Model: Event Trees and Event Frequencies



CAFTA



Consequence Distributions

- Manual Input of Dose Values
- Calculation of Dose Values through OGMA Simulation Manager RAVEN
 - External Couplings
 - Uncertainty Propagation

Severe Accident Progression and Radiological Consequence Dose Assessment

RELAP5-3D +  RADTRAD

MELCOR +  MACCS
Accident Consequence Model

Custom Python Scripts for Dose Assessment

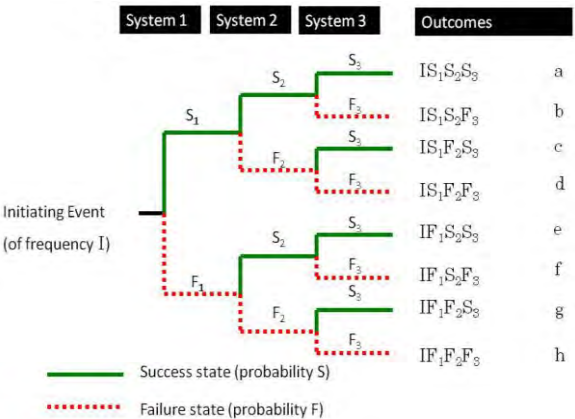


Risk Informed Decision Making

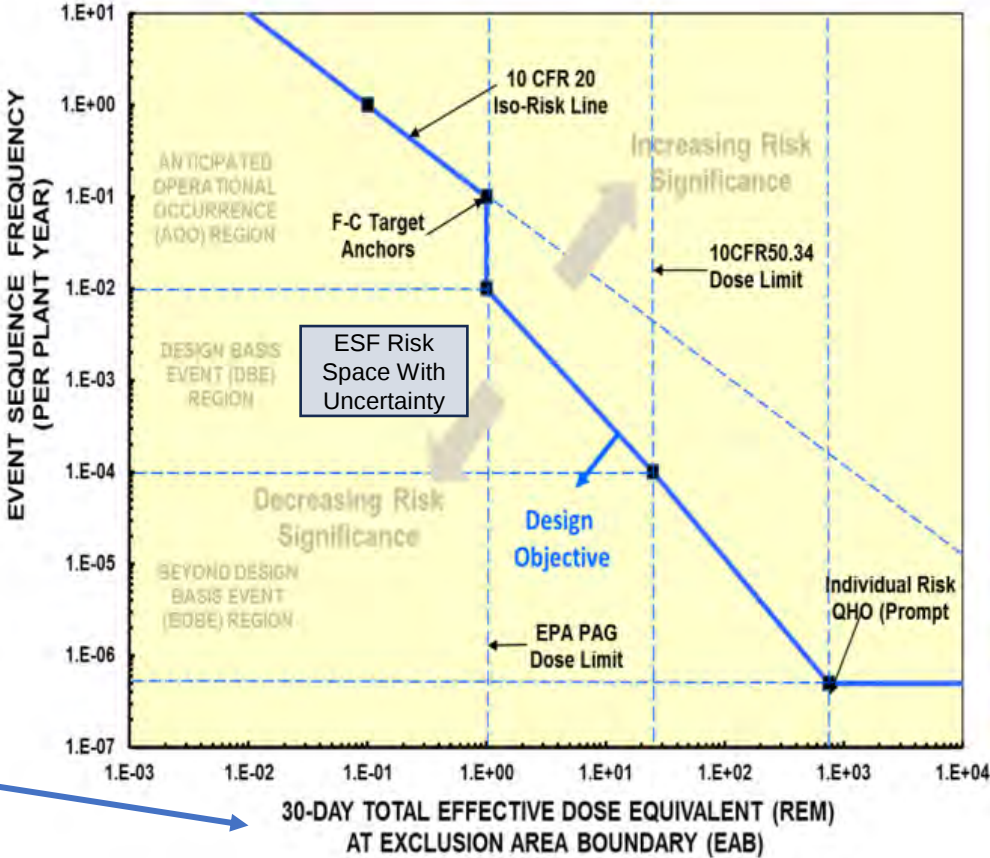
PRA Model: Event Trees and Event Frequencies



CAFTA



Frequency – Consequence (FC) Chart



Severe Accident Progression and Radiological Consequence Dose Assessment



RADTRAD



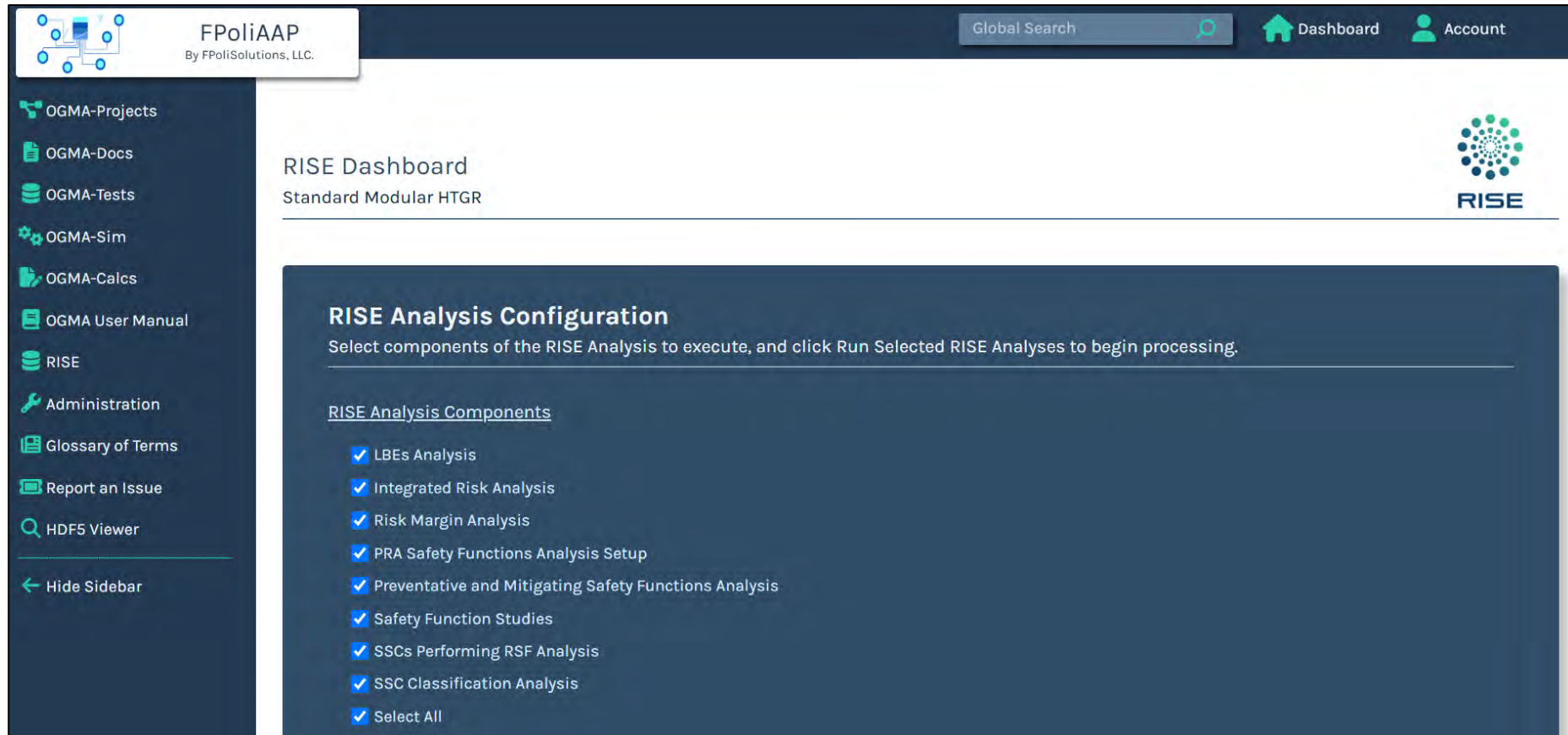
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Custom Python Scripts for Dose Assessment



RISE Analysis Dashboard



The screenshot displays the RISE Analysis Dashboard. At the top, a dark blue header bar contains the 'FPoliAAP' logo and name on the left, a 'Global Search' input field in the center, and 'Dashboard' and 'Account' links on the right. A dark blue sidebar on the left lists navigation items: OGMA-Projects, OGMA-Docs, OGMA-Tests, OGMA-Sim, OGMA-Calcs, OGMA User Manual, RISE, Administration, Glossary of Terms, Report an Issue, and HDF5 Viewer. The main content area has a white header with 'RISE Dashboard' and 'Standard Modular HTGR', followed by the RISE logo. Below this is a dark blue section titled 'RISE Analysis Configuration' with the instruction: 'Select components of the RISE Analysis to execute, and click Run Selected RISE Analyses to begin processing.' Underneath is a list of 'RISE Analysis Components' with checkboxes, all of which are checked: LBEs Analysis, Integrated Risk Analysis, Risk Margin Analysis, PRA Safety Functions Analysis Setup, Preventative and Mitigating Safety Functions Analysis, Safety Function Studies, SSCs Performing RSF Analysis, SSC Classification Analysis, and Select All.

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Global Search

Dashboard Account

RISE Dashboard
Standard Modular HTGR

RISE

RISE Analysis Configuration

Select components of the RISE Analysis to execute, and click Run Selected RISE Analyses to begin processing.

RISE Analysis Components

- ☒ LBEs Analysis
- ☒ Integrated Risk Analysis
- ☒ Risk Margin Analysis
- ☒ PRA Safety Functions Analysis Setup
- ☒ Preventative and Mitigating Safety Functions Analysis
- ☒ Safety Function Studies
- ☒ SSCs Performing RSF Analysis
- ☒ SSC Classification Analysis
- ☒ Select All

RISE Dashboard – LBE Classification

157 Event Sequences > 82 ESFs > 60 LBEs

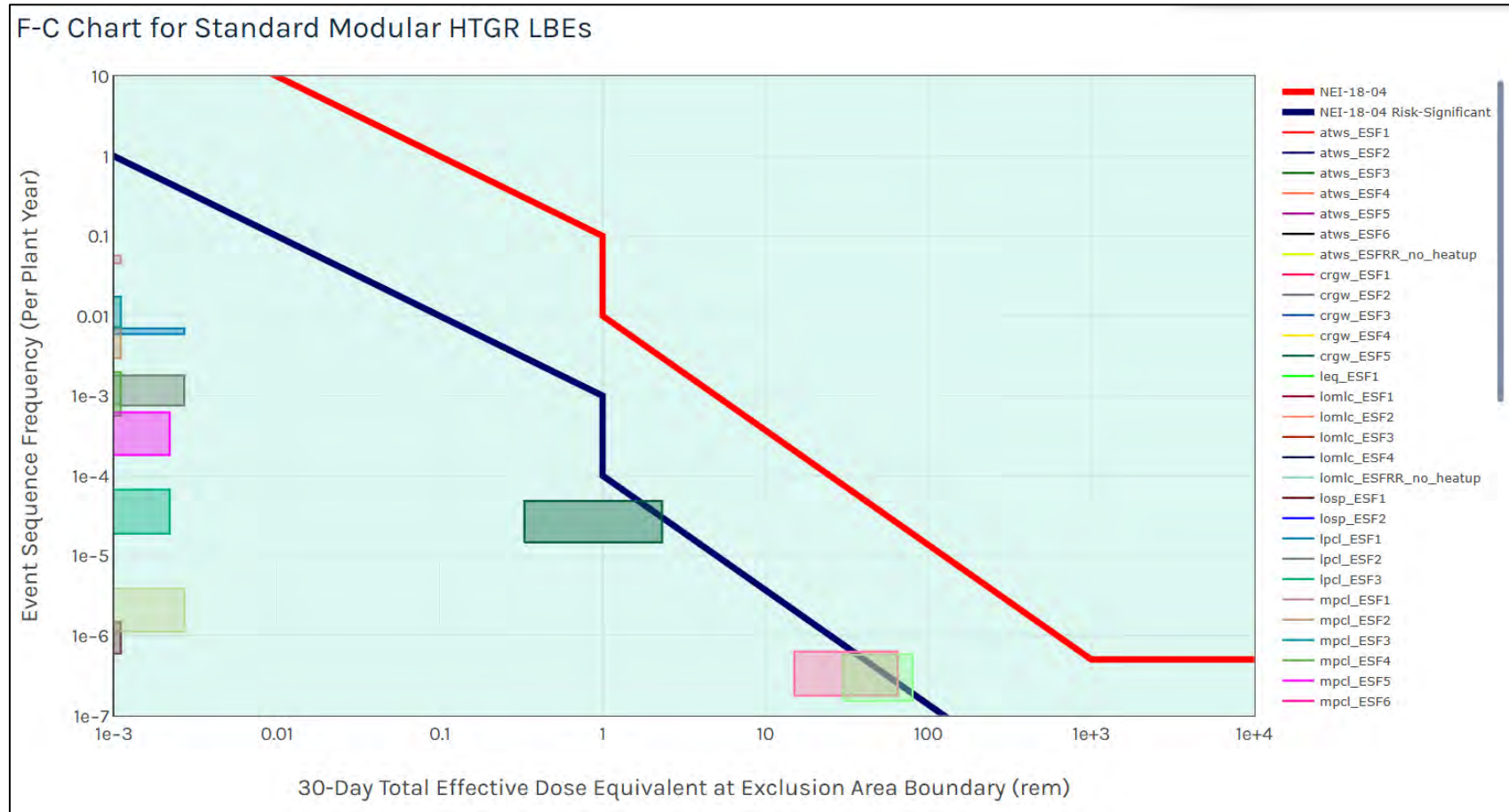
LBEs Classification for Standard Modular HTGR

[Import CSV](#)
[Export CSV](#)
[Import JSON](#)
[Export JSON](#)

Search in Table: Show **50** entries

Event Sequences Family	Simulations	AOO	DBE	DBBE	Status	DBID	DBRV
atws_ESF1		true	false	false	PRE	93	184
atws_ESF2		true	false	false	PRE	95	184
atws_ESF3		true	false	false	PRE	96	184
atws_ESF4		false	true	false	PRE	98	184
atws_ESF5		false	true	true	PRE	100	184
atws_ESF6		false	false	true	PRE	101	184
atws_ESFRR_no_heatup		false	false	true	PRE	151	162
crgw_ESF1		true	false	false	PRE	105	184
crgw_ESF2		false	true	false	PRE	107	184
crgw_ESF3		false	false	true	PRE	109	184
crgw_ESF4		false	false	true	PRE	111	184
crgw_ESF5		false	false	true	PRE	155	134
leq_ESF1		false	false	true	PRE	165	112
lomlc_ESF1		true	false	false	PRE	116	184
lomlc_ESF2		true	false	false	PRE	118	184
lomlc_ESF3		false	false	true	PRE	120	183
lomlc_ESF4		false	false	true	PRE	122	184
lomlc_ESFRR_no_heatup		false	false	true	PRE	152	163
losp_ESF1		false	true	false	PRE	126	184
losp_ESF2		false	false	true	PRE	128	184
lpci_ESF1		false	true	false	PRE	131	184
lpci_ESF2		false	true	false	PRE	133	184

RISE Dashboard – FC Chart



RISE Dashboard – Integrated Risk Metrics

Integrated Risk Against Cumulative Metrics for Standard Modular HTGR

Import CSV Export CSV Import JSON Export JSON

Search in Table: Show 50 entries

Target	Metric Definition	Units	Regulatory Guidance	RISE Estimated Value	Acceptable?	Comments
Cumulative Dose Exceedance Frequency	Total frequency of exceeding site boundary dose of 10...	1/plant-year	1.0	0.00004927855376619	Yes	
Cumulative Early Fatality Risk	Average individual risk of early fatality within 1 miles ...	1/plant-year	5.0E-7	0.000000600000000000000004	No	
Cumulative Latent Fatality Risk	Average individual risk of latent cancer fatalities with...	1/plant-year	2.0E-6	0.000000610000000000000004	Yes	

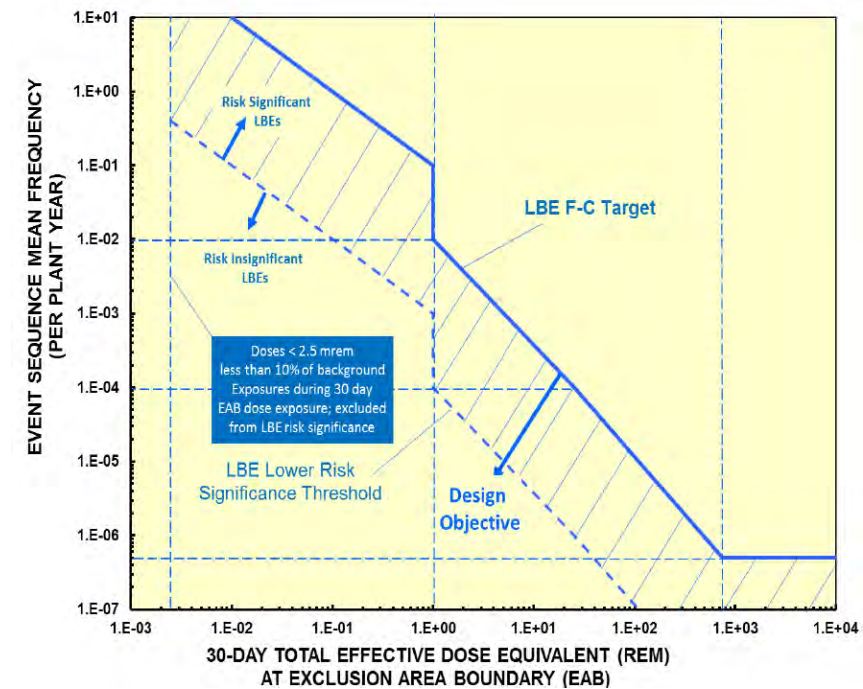
Search Target Search Metric Definition Search U Search Regulatory Guic Search RISE Estimated Val Search Acce Search

Showing 1 to 3 of 3 entries

Previous 1 Next

Refresh Table

RISE Dashboard – Risk Margin Quantification



Risk Margin Quantification

Import CSV

Export CSV

Import JSON

Export JSON

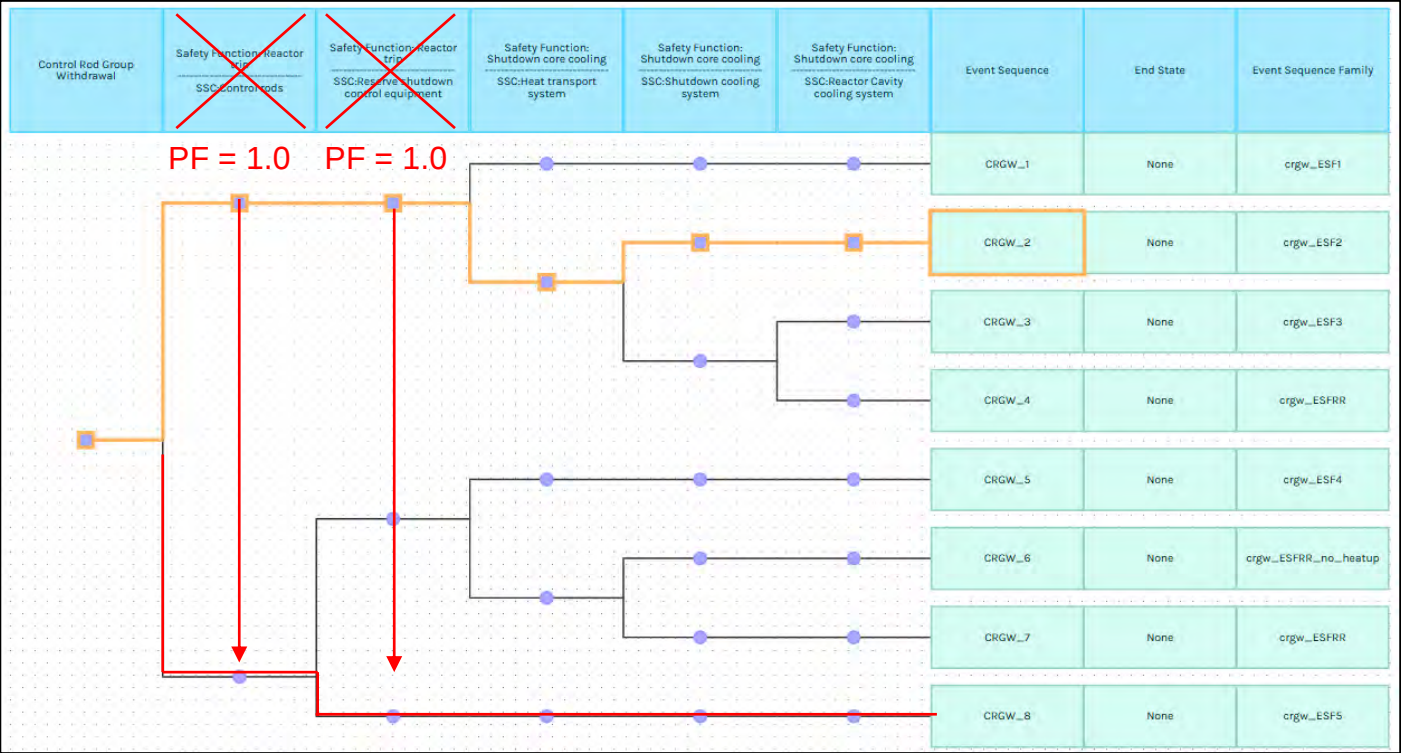
Search in Table:

LBE	Mean Frequency Margin [-]	Mean Consequence Margin [-]	95th Percentile Frequency Margin [-]	95th Percentile Consequence Margin [-]	Risk Significant?
atws_ESF1	2.43e-07	2.43e-07	2.54e-06	2.54e-06	No
atws_ESF2	2.58e-08	2.58e-08	3.64e-07	3.63e-07	No
atws_ESF3	1.34e-09	1.34e-09	2.19e-08	2.19e-08	No
atws_ESF4	7.29e-12	1.60e-10	7.74e-11	1.67e-09	No
atws_ESF5	7.66e-13	3.32e-11	1.08e-11	4.23e-10	No
atws_ESF6	4.09e-14	4.32e-12	6.66e-13	6.07e-11	No
atws_ESFRR_no_heatup	4.36e-15	0.00e+00	7.24e-14	1.29e-11	No
crgw_ESF1	9.92e-10	1.00e-09	9.92e-09	1.00e-08	No
crgw_ESF2	7.76e-12	1.67e-10	8.10e-11	1.73e-09	No
crgw_ESF3	2.40e-13	1.48e-11	3.39e-12	1.89e-10	No
crgw_ESF4	9.90e-15	1.61e-12	1.41e-13	2.06e-11	No
crgw_ESF5	9.86e-05	5.70e-03	1.60e-02	5.57e-02	Yes
leq_ESF1	1.18e-13	9.01e-12	1.19e-12	9.07e-11	No
lomlc_ESF1	2.47e-08	2.47e-08	2.52e-07	2.52e-07	No
lomlc_ESF2	1.31e-09	1.31e-09	1.84e-08	1.84e-08	No
lomlc_ESF3	4.94e-13	2.45e-11	5.17e-12	2.53e-10	No
lomlc_ESF4	2.59e-14	3.14e-12	3.65e-13	3.99e-11	No

RISE Dashboard –Safety Function Classification

LBEs Associations and Safety Functions for Standard Modular HTGR					
PRA Safety Functions	Preventative Safety Functions	Mitigating Safety Functions	Safety Function Studies	Required Safety Functions	
↑ Import CSV	↓ Export CSV	↑ Import JSON	↓ Export JSON	Search in Table:	Show 50 entries
DBE	Safety Function Challenged	Are FC Targets Met?	Status	DBID	DBRV
atws_ESF4	Control pressure of primary coolant system	Yes	PRE	17	37
atws_ESF4	Manual reactor trip by operator	Yes	PRE	15	37
atws_ESF4	Reactor trip	No	PRE	14	37
atws_ESF4	Shutdown core cooling	Yes	PRE	16	37
atws_ESF5	Control pressure of primary coolant system	Yes	PRE	13	37
atws_ESF5	Manual reactor trip by operator	Yes	PRE	11	37
atws_ESF5	Reactor trip	No	PRE	10	37
atws_ESF5	Shutdown core cooling	Yes	PRE	12	37
crgw_ESF2	Reactor trip	Yes	PRE	40	37
crgw_ESF2	Shutdown core cooling	Yes	PRE	41	37
losp_ESF1	Reactor trip	Yes	PRE	83	37
losp_ESF1	Shutdown core cooling	Yes	PRE	84	37
lpci_ESF1	Control pressure of primary coolant system	Yes	PRE	66	37

RISE Dashboard – Safety Functions Studies



RISE Dashboard – SSC Classification

SSCs Classifications											
SSC Classification											
SSC Performing Safety Function											
Risk-Significant SSC Studies											
SR SSCs											
NSRST SSCs											
NST SSCs											
SSC Table Instructions											
Show											
Full-Screen Table View											
Event Data						Required Safety Functions					
LBE	Initiating Event	Is DBE?	Is BDBE?	FC Target Met?	ES	Reactor trip			Shutdown core cooling		
						Control rods	Reserve shutdown control equipment Safety Related	FC Met for SF Study?	Reactor Cavity cooling system Safety Related	Shutdown cooling system	Heat tr sys
atws_ESF4	Anticipated Transient Without Scram	true	false	Yes	ATWS_08	Failure (0.00003 prob.)	Success (0.99996 prob.)	No	Pass Through	Pass Through	Success (prob.)
atws_ESF5	Anticipated Transient Without Scram	true	true	Yes	ATWS_09	Failure (0.00003 prob.)	Success (0.99996 prob.)	No	Pass Through	Success (0.95 prob.)	Failure (0 prob.)
spcl_ESFRR	Small Primary Coolant Leak	false	true	Yes	SPCL_15	Failure (2.0E-5 prob.)	Failure (4.0E-5 prob.)	No	Pass Through	Pass Through	Pass Thro
					SPCL_14	Failure (2.0E-5 prob.)	Success (0.99996 prob.)		Failure (1.0E-6 prob.)	Failure (0.03 prob.)	Failure (0 prob.)
					SPCL_13	Failure (2.0E-5 prob.)	Success (0.99996 prob.)		Success (0.999999 prob.)	Failure (0.03 prob.)	Failure (0 prob.)

RISE OPPORTUNITIES



ADVANCED REACTOR LICENSING

Generate the **RIPB safety case**

Provide **transparency, scrutability, and collaboration**

Provide risk insights for design changes

Maintain safety case through plant lifetime

Guide analysts through complex workflows

Automate documentation

OPERATIONAL MARGINS AND FLEXIBILITY for LWRs

Challenge/remove artificial surrogate safety limits while maintaining safety-in-depth

Improve fuel utilization

Facilitate **management of operational incidents/issues/non-compliance**

Commoditize fuel supply (reduce fuel product transition costs)

Streamline safety analysis methods and enhanced transparency for safety determinations

Risk insights (F-C) for SSC safety classification

Expand benefits from **10 CFR 50.69 programs**

PROMOTE INNOVATION AND PUBLIC ACCEPTANCE

Enable deployment of **Highly Enriched-High burnup and/or Accident Tolerant Fuel** products

Siting and Emergency Planning Zone (EPZ) Management activities

Facilitate disposition Generic Safety Issues (GSI)

Questions?

Risk-Informed
Systems
Engineering (RISE)

Mike Mankosa, Cesare Frepoli
FPoliSolutions, LLC.
Pittsburgh, PA
mmankosa@fpolisolutions.com

