



# **U.S NRC Ongoing PSA Work**

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# Outline

- Objective
- Background Information
- Questions to be addressed
  - Risk metrics used
  - PSA screening approaches
  - Other Hazards PSA – Biological Hazards and Lightning PSA
  - Treatment of multi-unit PSA

# Objective

- The objective of this presentation is to address questions presented by IRSN and provide references for additional information.

# Background Information

- PRA
  - PRA insights are used at the U.S. NRC in the reactor oversight process (ROP).
    - The ROP uses the Significance Determination Process (SDP) to estimate the risk increase due to a performance deficiency determine an appropriate regulatory response.
    - The U.S NRC also uses performance indicators (MSPI) which incorporate the use of importance measures
  - Using PRA to evaluate a performance deficiency or a plant event provides a quantitative measure which can be combined with other qualitative risk insights to assign a level of importance within a risk-informed decision-making framework.

# Background Information

- **SPAR Models**
  - PRA models that are representative of all commercial nuclear power plants operating in the USA.
  - Evaluations performed by the NRC using the SPAR models are generally intended to inform and prioritize regulatory follow up to operational issues . Although they are not used to support licensing basis changes, should be to provide a “sanity check” for licensee’s submittals.
  - All SPAR models include Level 1 PRA for internal events. Some models include all hazards, low power shutdown, and/or Level 2 PRA.
- **Ongoing efforts to complete a full-scope site Level 3 PRA model**
  - Model will include Level 1,2, 3 PRA, all hazards, all radiological sources (including multi-source accidents), and all modes of plant operation.

# Risk Metrics Used

- Level 1 PRA
  - Core Damage Frequency (CDF),  $\Delta$ CDF
- Level 2 PRA:
  - Large early release frequency (LERF), large release, early release, large late release, small release,  $\Delta$  LERF
- Importance measures
  - Fussell-Vesely, Risk Achievement Worth (RAW), Risk Reduction Worth, Birnbaum (BI) , uncertainty analysis
  - NUREG-1855, “Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decision Making”, explains the processes for quantifying risk metrics.
  - NUREG-2122, “Glossary of Risk-Related Terms in Support of Risk-Informed Decisionmaking”, provides definitions for these risk metrics and importance measures as used by the U.S NRC.

# PSA Screening Approaches for Hazard Events

- The general process for screening missing PRA scope or level-of-detail items is a progressive process that can involve different levels and various combinations of qualitative and quantitative screening. In general, qualitative screening is performed prior to any quantitative screening analysis. (NUREG-1855)
- The ASME/ANS PRA standard provides various screening criteria that were developed to ensure that risk-significant items (e.g., hazards, events, sequences, or failure modes) are not eliminated.
- For those hazards that can not be screened out, the ASME/ANS PRA standard provides requirements for the development of other external hazards PRA models.

# Other Hazards PSA –Biological Hazards and Lightning

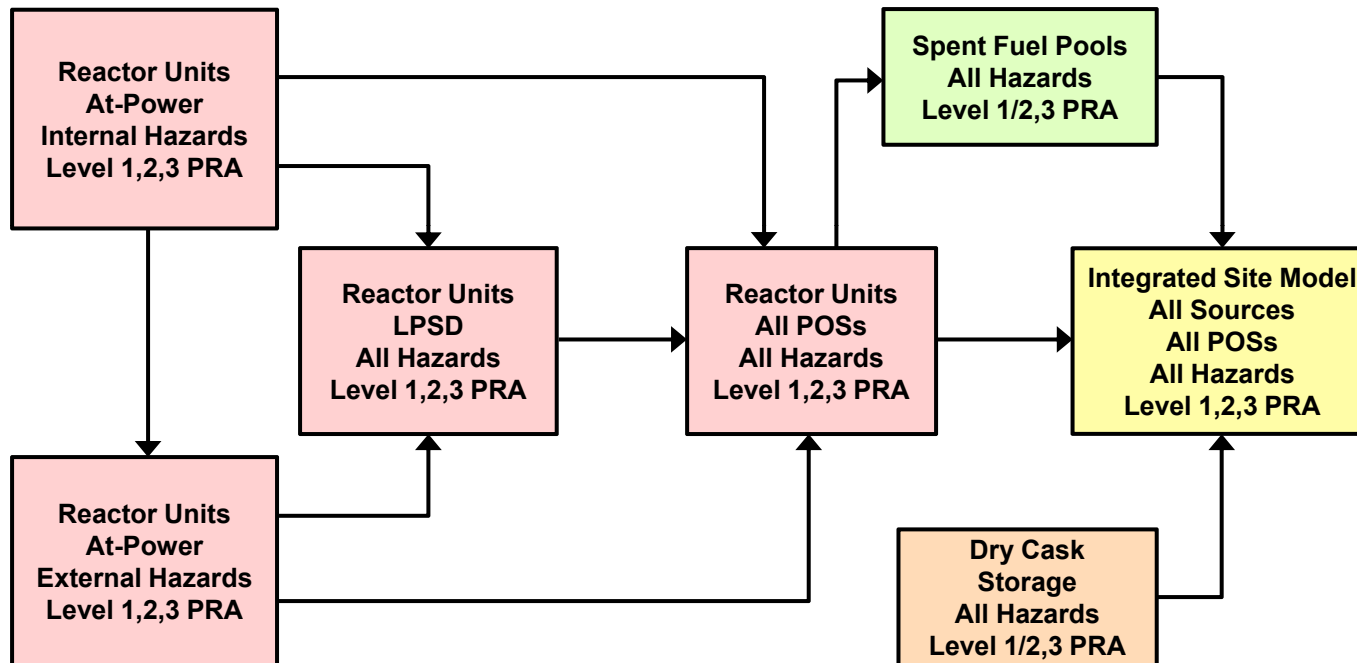
- Biological events (e.g., fish intrusion, biological fouling) are not explicitly modeled in SPAR models, but are taken into account under loss of service water (LOSW) events (Level 1 PRA) and Loss of Condenser Heat Sink (LOCHS) .
- Similarly, lightning events are not modeled explicitly in a PRA, but are included under Loss of Offsite Power weather-related (LOOPWR) events.



# Multi-Unit Work

- University of Maryland Grant
  - “Study of the Implication of Multi-Unit Accidents in the Context of NRC’s Quantitative Health Objectives” - ongoing work. Results expected late 2016.
- International Common-cause failure Data Exchange (ICDE) Project
  - Ongoing task to identify multi-unit CCF events in the database and extract some qualitative insights.
- PRA Standards Development
  - Ongoing development of non-mandatory appendix on multi-unit risk for ASME/ANS Level 1/Large Early Release Frequency (LERF) PRA standard
- USNRC Integrated Site Level 3 PRA Project

# Integrated Site Level 3 PRA Project Overall Approach

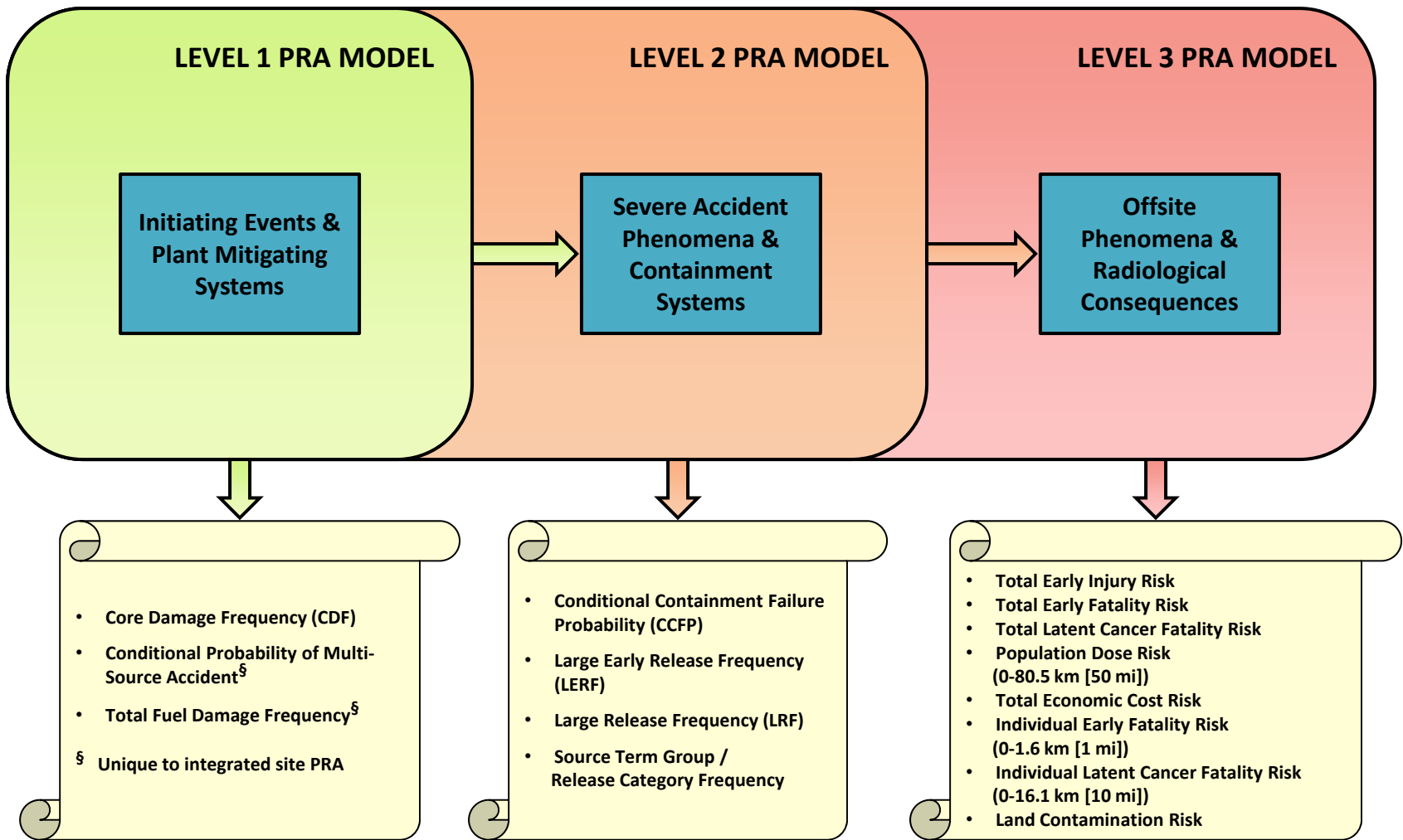


**Acronyms**

LPSD: Low-Power and Shutdown

POS: Plant Operating State

# Integrated Site Level 3 PRA Project Metrics for Consideration



**KEY CHALLENGE: BALANCING INFORMATION UTILITY VS. PROJECT CONSTRAINTS**



## Questions

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# Backup Slides

# All Hazard (AHZ) Models

- A SPAR-AHZ model is a PRA model that includes event trees for categories such as: internal events, internal flooding and fires, seismic events, and wind-related events, airplane accidents and other external events.
- Only those events that are applicable the NPP site are modeled, however internal events, internal flooding, internal fires and seismic events are always included.
- Events during shutdown operations are not considered in the scope of all hazard SPAR models; but they are modeled as additional scope as needed.

# Level 3 PSA Project

- **Project objectives:**
  - Develop a Level 3 PSA generally based on current state of practice that
    - Reflects technical advances since the last NRC-sponsored Level 3 PSAs
    - Addresses scope considerations not previously considered
  - Extract new insights to enhance regulatory decision-making and to help focus limited agency resources on issues most directly related to the agency's mission
  - Enhance PRA staff capability and expertise and improve documentation practices
  - Demonstrate technical feasibility and evaluate the realistic cost of developing new Level 3 PRAs

# Level 3 PSA Scope

- All major site radiological sources (all reactor cores, spent fuel pools, and dry storage casks).
- All internal and external hazards, and all modes of plant operation. Excludes initiating events involving malevolent acts.
- Incorporates improvements in PRA technology as well as changes in plant operational performance and safety since completion of NUREG-1150
- Excludes some aspects for which no risk model or analytical method has been established (e.g., software failure and aging)
- Single multi-unit site (not likely to provide insights applicable to all sites and all technical issues).



# Guidance for External Event Conditions

- **NUREG-1855**, “Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decisionmaking”
- **Regulatory Guide 1.78**, “Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release”
- **Regulatory Guide 1.91**, “Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants”
- **Regulatory Guide 1.115**, “Protection Against Low-Trajectory Turbine Missiles”
- **JLD-ISG-2012-05**, “Guidance for Performing Integrated Assessment for Flooding”. (Federal *Register* , 77FR59675, dated September 28, 2012).
- **JLD-ISG-2012-06**, “Guidance for Performing a Tsunami, Surge, or Seiche Hazard Assessment,” (Federal Register, 77FR65417, dated October 26, 2012)