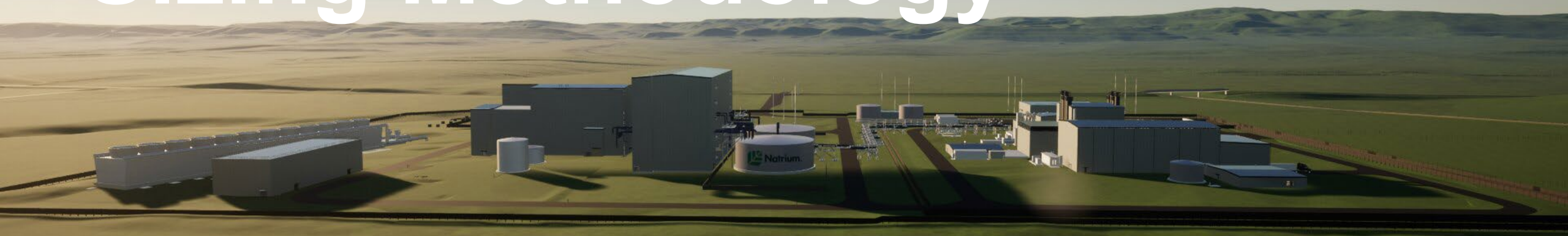
Plume Exposure Pathway Emergency Planning Zone Sizing Methodology



ACRS Full Committee Meeting

November 2024

TP-LIC-PRSNT-0031

TerraPower Natrium

Natrium reactor is a TerraPower & GE Hitachi technology

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Guidance Used

- Regulatory Guide 1.242, *"Performance-Based Emergency Preparedness for Small Modular Reactors, Non Light-Water Reactors, and Non-Power Production or Utilization Facilities"* was utilized in developing the overall methodology.
- Supporting information from NUREG-0396, *"Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants"* was used to assist in the development of the evaluation criteria.

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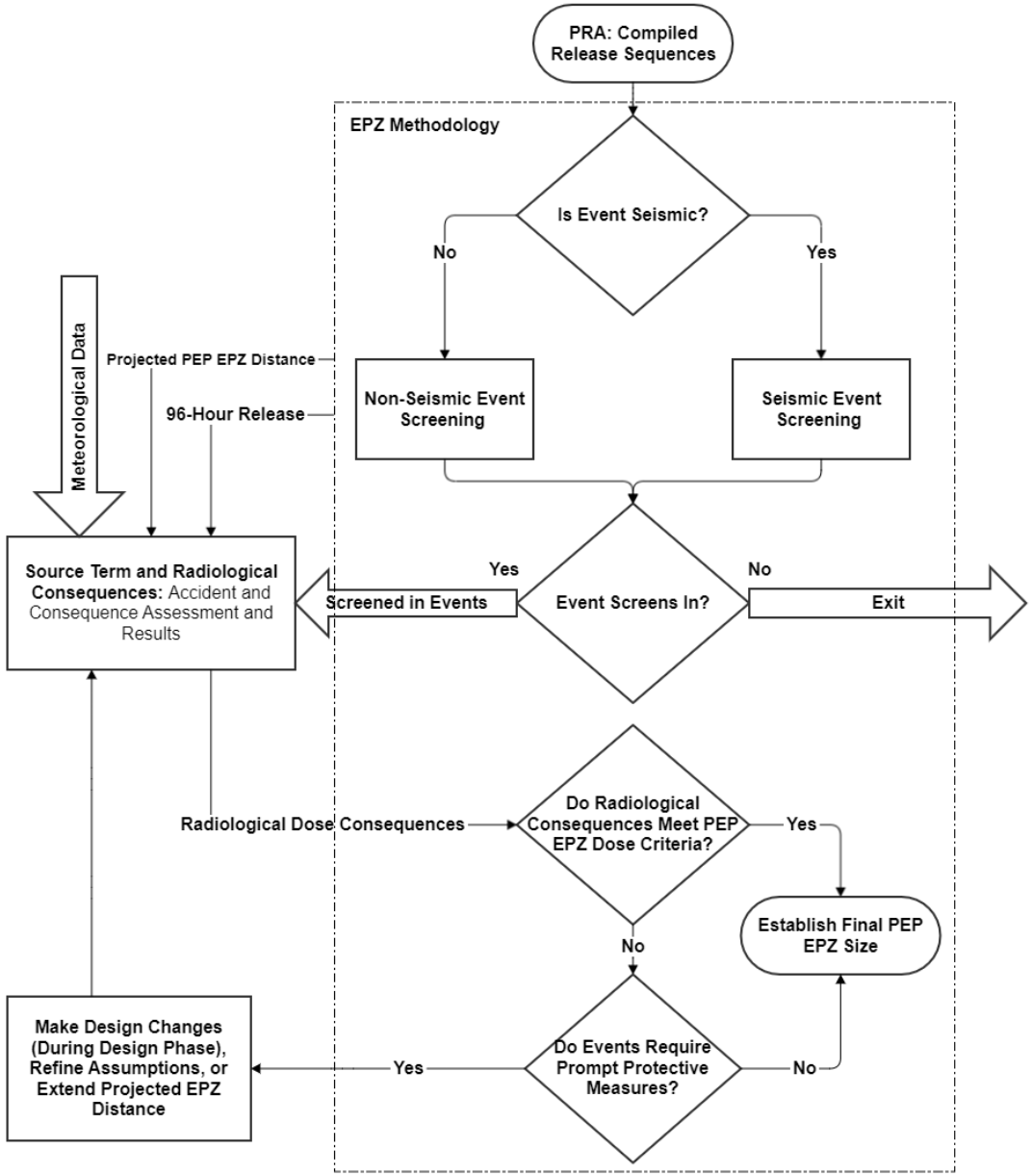
Overall EPZ methodology

- Assesses all modes and all hazards
- Incorporates site specific meteorological data
- Assesses radiological consequences
- Identifies prompt protective measures
- Establishes final PEP EPZ Size



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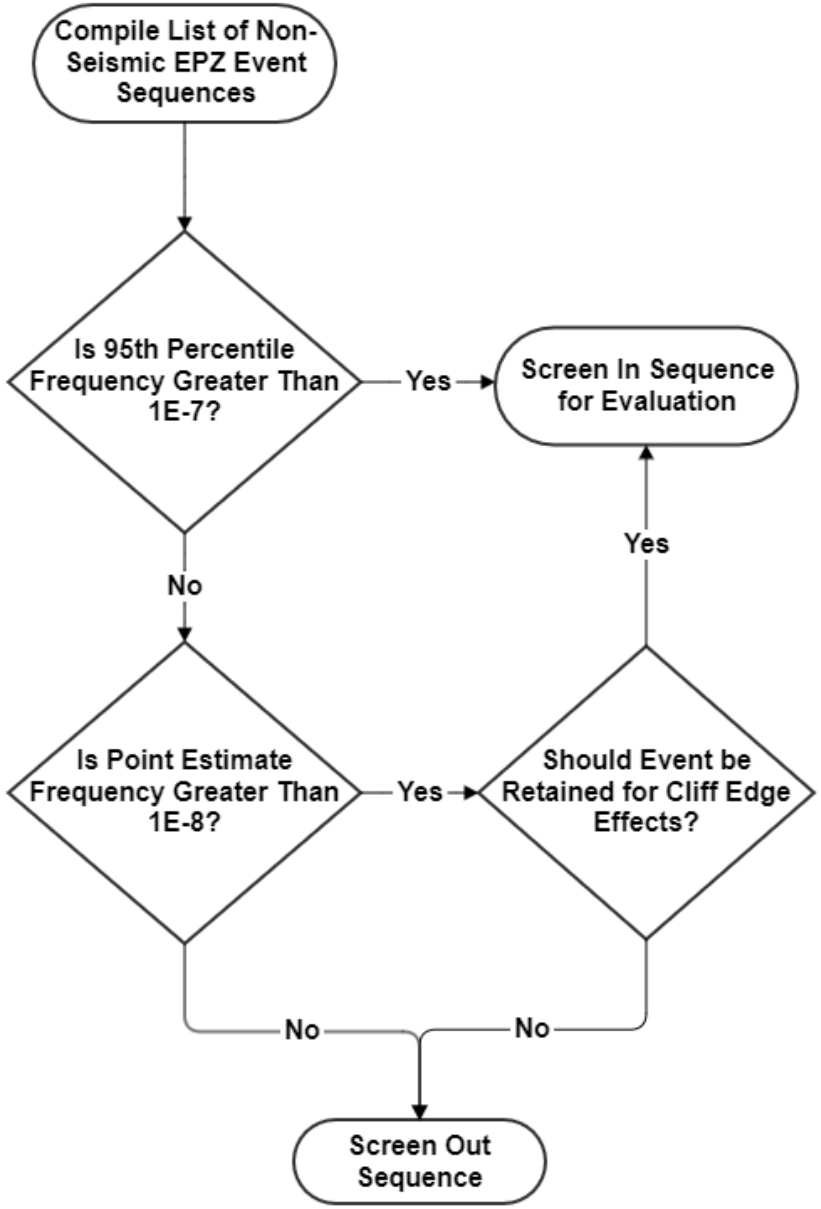
Non-seismic Event Selection

- Includes DBAs
- Includes events with a 95th percentile release frequency greater than 1E-7
- Includes events for cliff-edge consideration if they have a release frequency greater than 1E-8



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Non-Seismic Event Selection Example

- Mean: 2E-7, 95th percentile: 6E-7 screened into EPZ evaluation
- Mean: 8E-8, 95th percentile: 2E-7 screened into EPZ evaluation
- Mean: 2E-8, 95th percentile: 6E-8 considered for cliff-edge effects
- Mean: 8E-9, 95th percentile: 2E-8 screened out of EPZ evaluation

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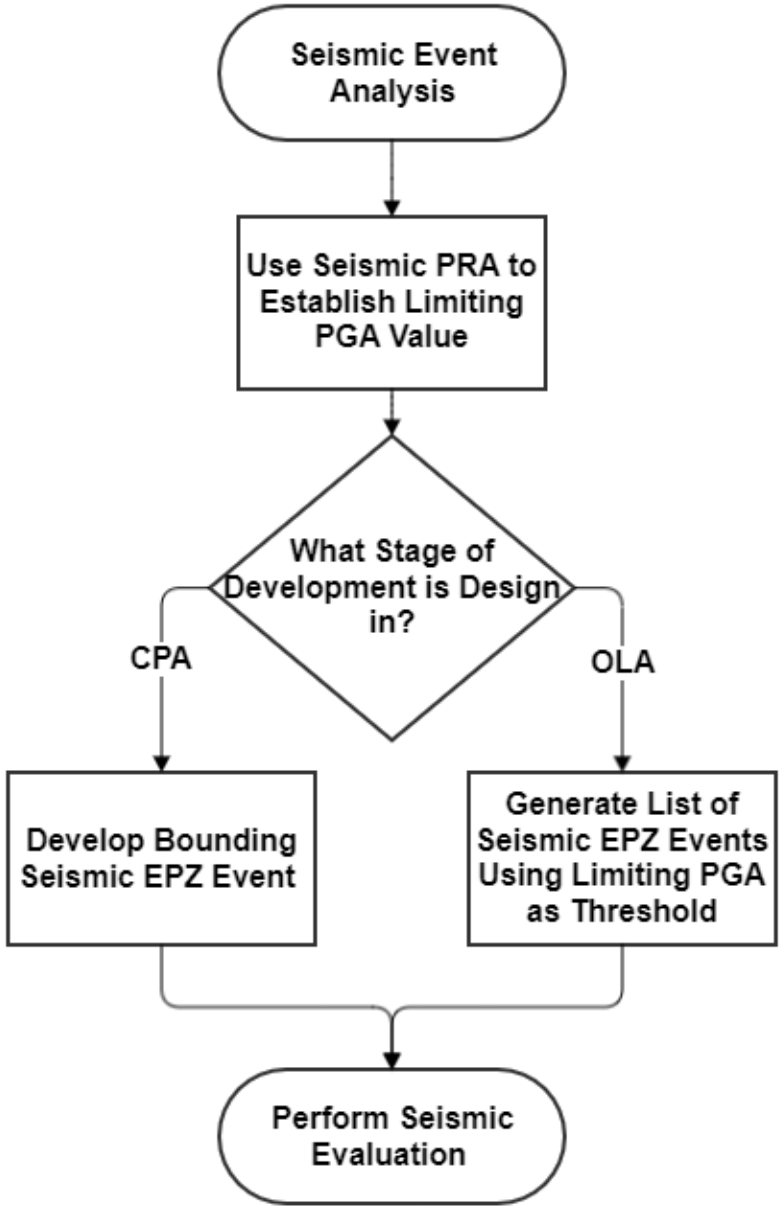
Seismic Event Selection

- Developed a bounding seismic event for the CPA
- Will generate a list of seismic EPZ events using a limiting PGA as threshold



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Development of Limiting PGA

- Limiting PGA is ***LOWER*** of the two:
  - 2x(GMRS) **OR** 1.0g
- Ensures that range of seismic hazard within credible range of ground motions
- Acknowledges limitations of the SPRA
- Acknowledges uncertainties in the emergency response infrastructure

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Criteria for PEP EPZ Sizing

- Criterion A: Projected doses from the DBAs would not exceed 1 rem mean 4-day TEDE and 5 rem 95th percentile 4-day TEDE.
- Criterion B: Projected doses from most radiological release sequences would not exceed 1 rem mean 4-day TEDE and 5 rem 95th percentile 4-day TEDE.
- Criterion C: Immediate life-threatening doses from the worst-case radiological release sequences would not exceed 24-hour, 200 rem red marrow acute effective dose.

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Red Bone Marrow Use

- Supported by guidance
  - NUREG-0396 – Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants
  - NUREG-7009 and NUREG-7161 – MACCS best practices and technical basis in the SOARCA
  - NUREG-4214 – Health Effects Models for Nuclear Power Plant Accident Consequence Analysis
- Identified as most limiting and confirmed by sensitivity analysis
- Available for quantification within MACCS

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Conclusion

- EPZ size is set based on smallest distance criteria are met.
- If the criteria are NOT met at the desired EPZ size, determination is made if design changes or refinements can be made to reduce EPZ size. Otherwise EPZ is expanded to meet the criteria.

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Acronym List

CPA – Construction Permit Application
DBA – Design Basis Accident
EPZ – Emergency Planning Zone
GMRS – Ground Motion Response Spectra
MACCS - MELCOR Accident Consequence Code System
PEP – Plume Exposure Pathway
PGA – Peak Ground Acceleration
PRA – Probabilistic Risk Assessment
SOARCA – State-of-the-Art Reactor Consequence Analysis
SPRA – Seismic Probabilistic Risk Assessment
TEDE – Total Effective Dose Equivalent