MUPRA Overview & Needs for More Research

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Panel on Multi-Unit PRA Advances, Issues, Impediments and Promise

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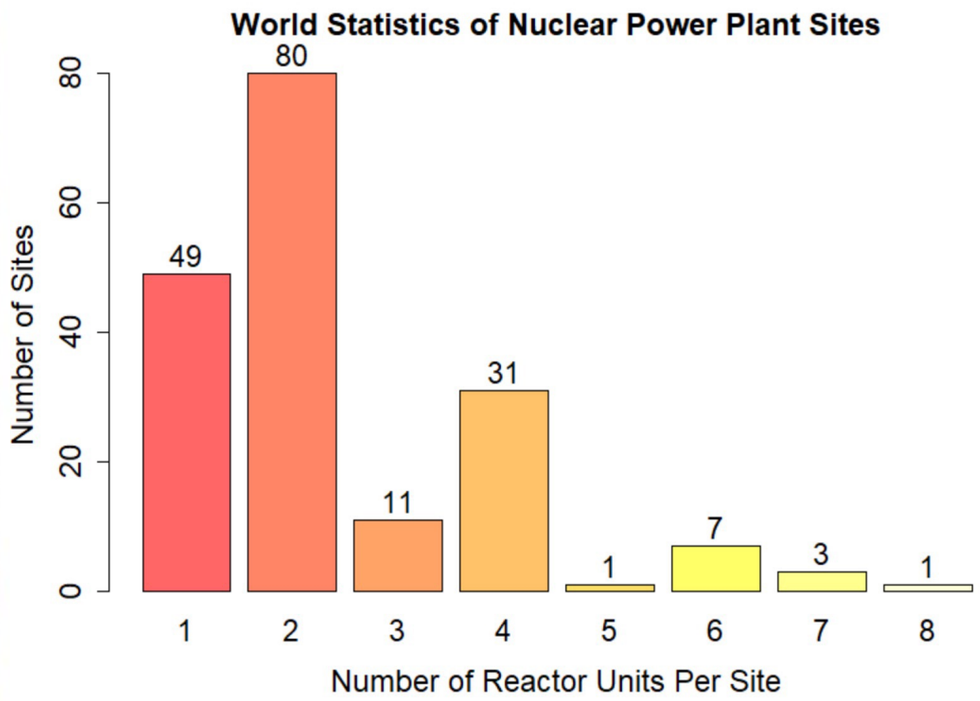
Critical Characteristics of MUPRA

- SUPRA vs. MUPRA
- Intra- vs. Inter-dependencies
- Site vs. Multi unit
- Examples of Site-level Decencies:
  - Proximity
  - Shared SSCs (e.g., shared batteries and diesel generators)
  - Common operation practices and shared control room
  - Procedural and other organizational similarities
- Current Major MUPTRA Activities: IAEA, U.S. EPRI, South Korea, Japan, Canada and France
- Significant progress in MUPRA since the Fukushima Daiichi accident

Why MUPRA is Important?

- 88.9% of the operating reactors are located on multi-unit sites
- Countries most affected: China, Canada, South Korea and Japan
- There are regional dependencies too: For example: Hope Creek & Salem; FitztPatrick and Nine Mile Point



- Early considerations of MUPRA in U.S.:
  1. Indian Point & Seabrook PRAs (CCDP of 2nd Unit CD was 14%)
  2. Internal and Flood PRAs in Byron/Brainwood in 1990s showed 67% CCDPs
  3. SBO PRAs and some Seismic PRAs
- OECD/NEA CCF data Exchange: out of 192 CCFs, 87 involved multi-units (mostly attributed to design)
- External events: Seismic and Flood are critical contributors
- SMRs have harder multi-module dependencies than multiple Gen II/III units on a sites

Current U.S. NRC Multi-Unit Related Regulatory Requirement and Positions

- **10 CFR Part 50, Appendix A, General Design Criterion 5 states:**

Structures, systems, and components important to safety shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impact their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.

- **10 CFR 100.11(b), Requirements for determining the exclusion area:**

Subsection (b)(1): If the reactors are independent to the extent that an accident in one reactor would not initiate an accident in another, the size of the exclusion area, low population zone and population center distance shall be fulfilled with respect to each reactor individually.

Subsection (b)(2): If the reactors are interconnected to the extent that an accident in one reactor could affect the safety of operation of any other, the size of the exclusion area, low population zone and population center distance shall be based on the assumption that all interconnected reactors emit their postulated fission product releases simultaneously.

- **NUREG-0880 summarizes comments made by the public as the Safety Goals**

Some commenters objected to the originally proposed individual and societal numerical guidelines because they were to be applied on a per-site basis. This would have resulted in tighter requirements being imposed on plants at multiunit sites than at single-unit sites. The Commission decided not to impose a regulatory bias against multiunit sites. Therefore, the quantitative design objectives were changed from risks per site to risk per plant.

More Research Still Needed in MUPRA

- No universally acceptable treatment of internal, external, human, and organizational events exit
- Level-2 and Level-3 MUPRAs could play an important role in enhancing Defense in Depth implementation, but only limited work has been done
- Defining the three PRA levels in the context of MUPRA
- Modeling of human and organizational contributors including:
  - FLEX equipment
  - Site accessibility
  - HRA Dependencies
  - Emergency response measures
  - SAMGs in the context of multi-unit accidents
- Understanding cascading dependencies among heterogenous SSCs
- Site-based risk metrics are maturing but are not universally accepted
- Aggregation methods for site-level risks not well developed and understood
- More efficient tools to handle very large-scale models
- Dependent hazard frequency and SSC dependencies in external events particularly seismic and Flood
- SMR site risk models are primitive