

# ***INL Seismic Risk Assessment Project: Implementation of Proposed Methodology at INL and Associated Risk Studies***

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## ***Presentation Goals***

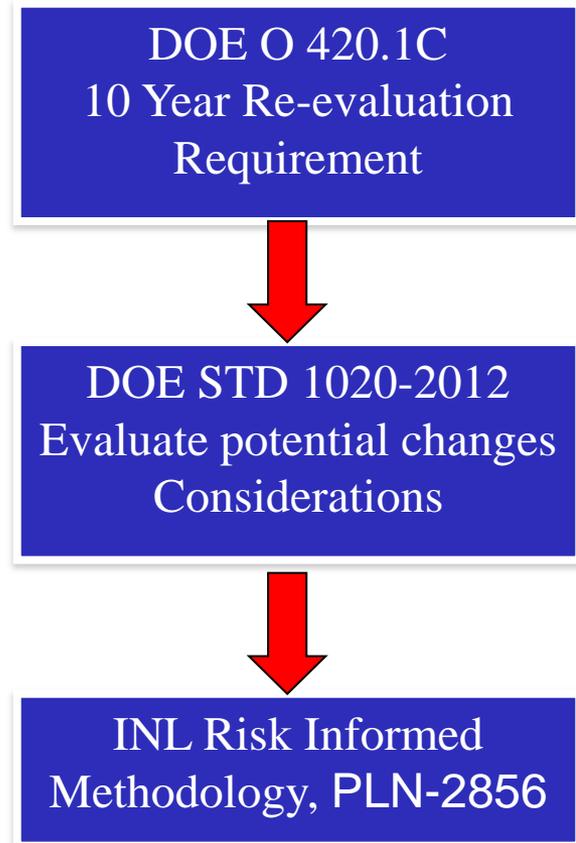
- Discuss how risk-informed methodology ensures nuclear facility safety
- Discuss how risk methodology meets intent of DOE Order 420.1C and STD 1020
- Demonstrate how INL is performing the risk-informed methodology, for existing facilities, to determine if the seismic risk has changed significantly (or is below target).
  - Is there a significant change in nuclear facility safety?

# ***Nuclear Facility Safety***

- Confinement/Containment of hazardous materials
- Protection of occupants, co-located workers, and the public
- Continued operation of essential facilities and equipment
- Safe shutdown of hazardous facilities and equipment
- Maintaining personnel access responding to accidents during NPH events

# Nuclear Facility NPH (Seismic) Decisions

- For existing nuclear facilities DOE-O-420.1 requires 10-year Natural Phenomena Hazard review
  - Any **significant** changes in data, criteria, and assessment methods
- Consistent with DOE 420.1C, a preliminary estimate of whether changes to data, models, or methods are “significant” and warrant updating the assessments should be performed and consider the following criteria:
  - Are the changes to data, models, or methods likely to cause a change in the estimates of the major inputs to hazard calculations?
  - Given potential changes to the hazard inputs, by what magnitude might the calculated hazard results change, and how might the results impact current site design standards?



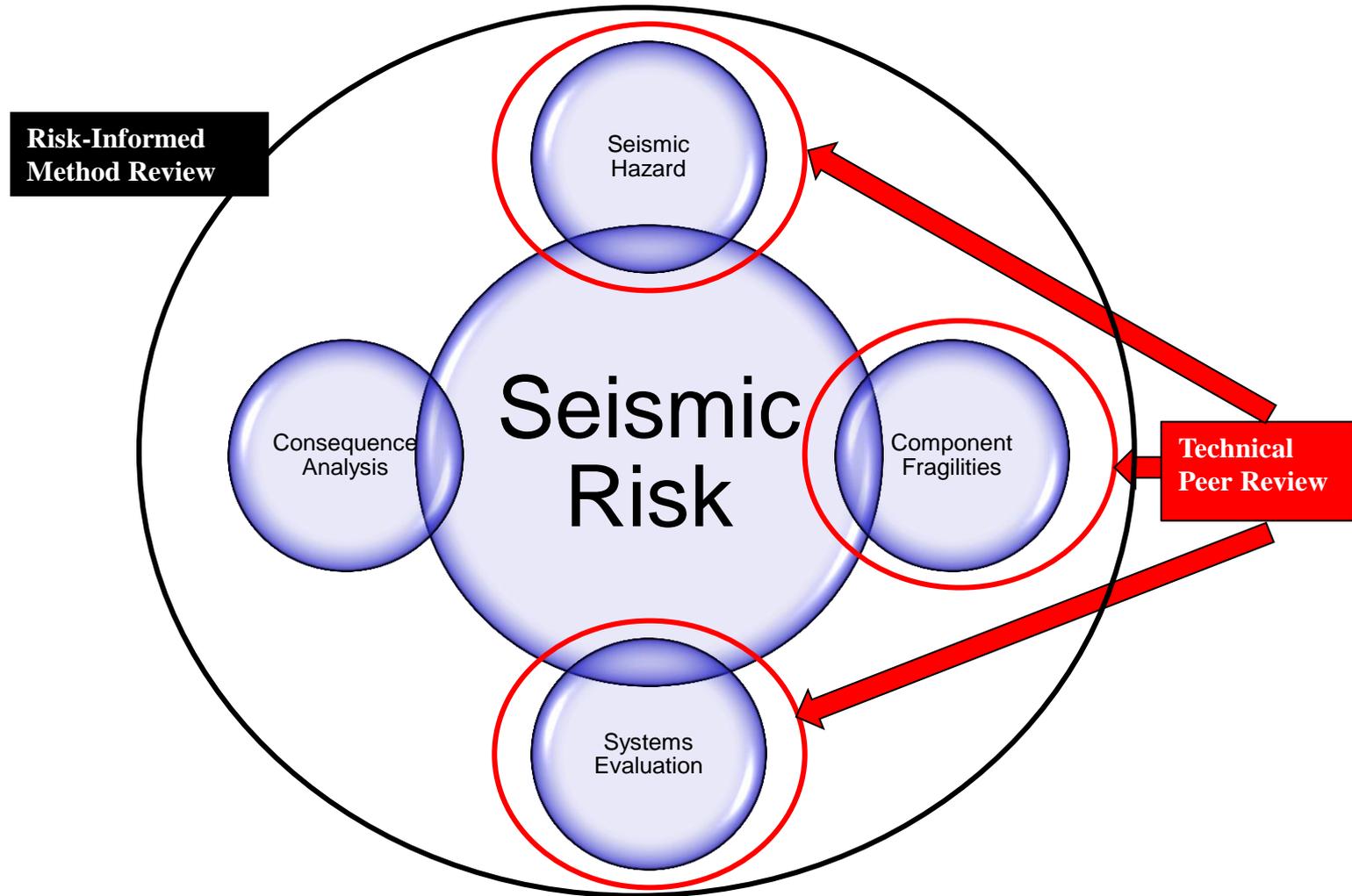
## ***Additional DOE STD 1020 Considerations***

- A decision on updating an NPH assessment should consider the intended application of the assessment results. Such considerations include:
  - The number of facilities affected by the NPH assessment, and the hazards posed by the facilities;
  - The life-cycle stages of the facilities affected by the NPH assessment;
  - Whether the assessment results will be used as design input for any future facilities;
  - NUREG-2117, Chapter 6; and
  - NUREG-CR 6372, Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on Uncertainty and use of Experts, Appendices Vol. 2, Appendix G.

## ***Need for Risk Informed Methodology***

- DOE O 420.1C and DOE STD 1020 imply risk
  - Without sufficient (SDC-3 or greater) Material at Risk (MAR) no need for the 10-year requirement
- Risk-Informed methodology is focused on timely assurance of continued nuclear facility operations
  - Using a defensible estimate of the seismic hazard (based on new data, models, methods) determine if nuclear facility risk has changed significantly
    - Rather than years from now

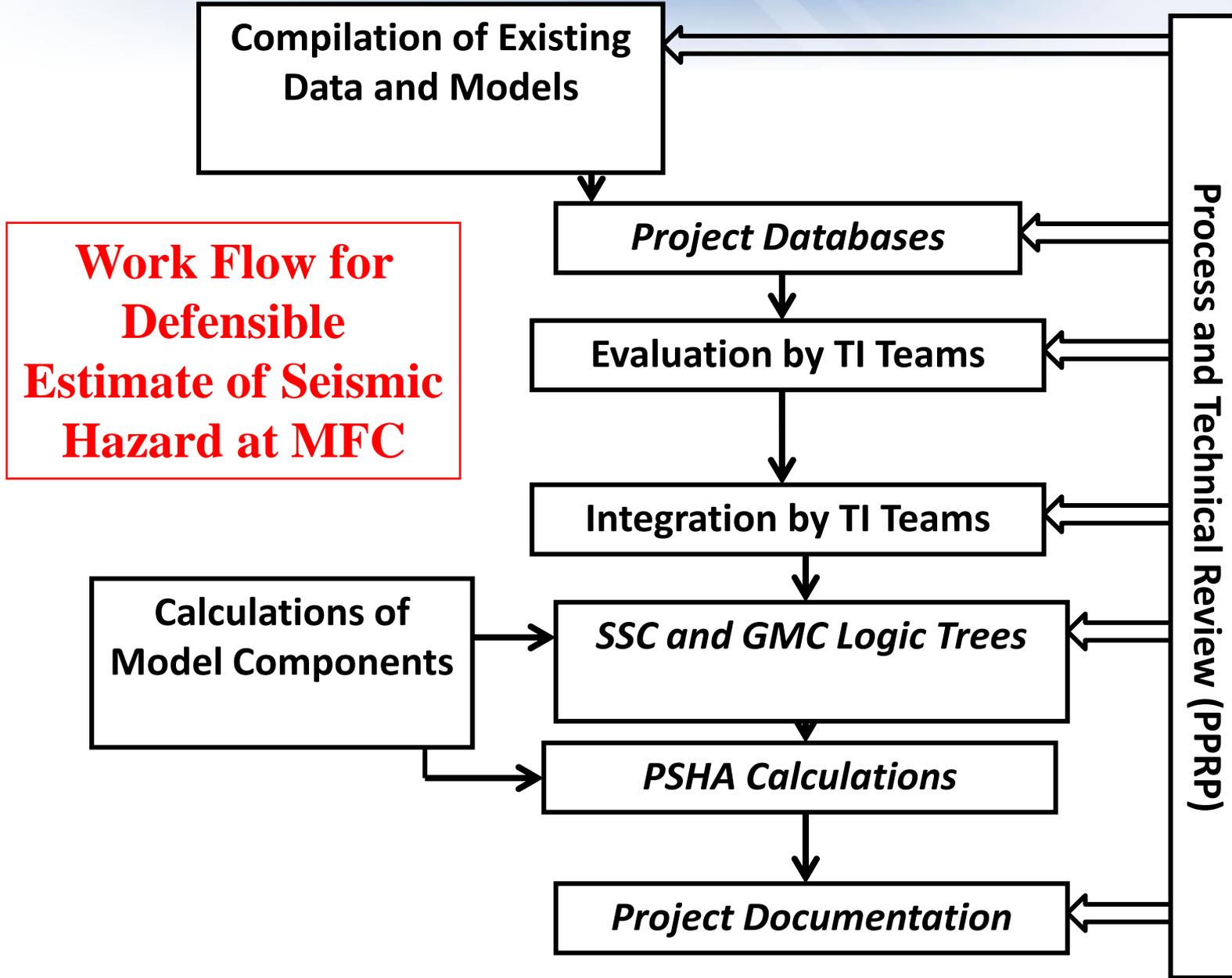
# Nuclear Facility Seismic Risk Quantification



# *INL Risk-Informed Methodology to Quantify “Existing” Nuclear Facility Risk*

- FY 2015 focus on FMF
- Project Execution Plan includes quantification of significant change in nuclear facility risk and/or target performance goal by:
  - Defensible estimate of seismic hazard at MFC
  - Evaluate nuclear facility structure, system, and component fragilities
  - Quantify facility risk
  - Perform independent peer review

# INL Seismic Risk Methodology: Defensible Estimate of Seismic Hazard



# ***INL Seismic Risk Methodology: SSCs and Fragility Calculations***

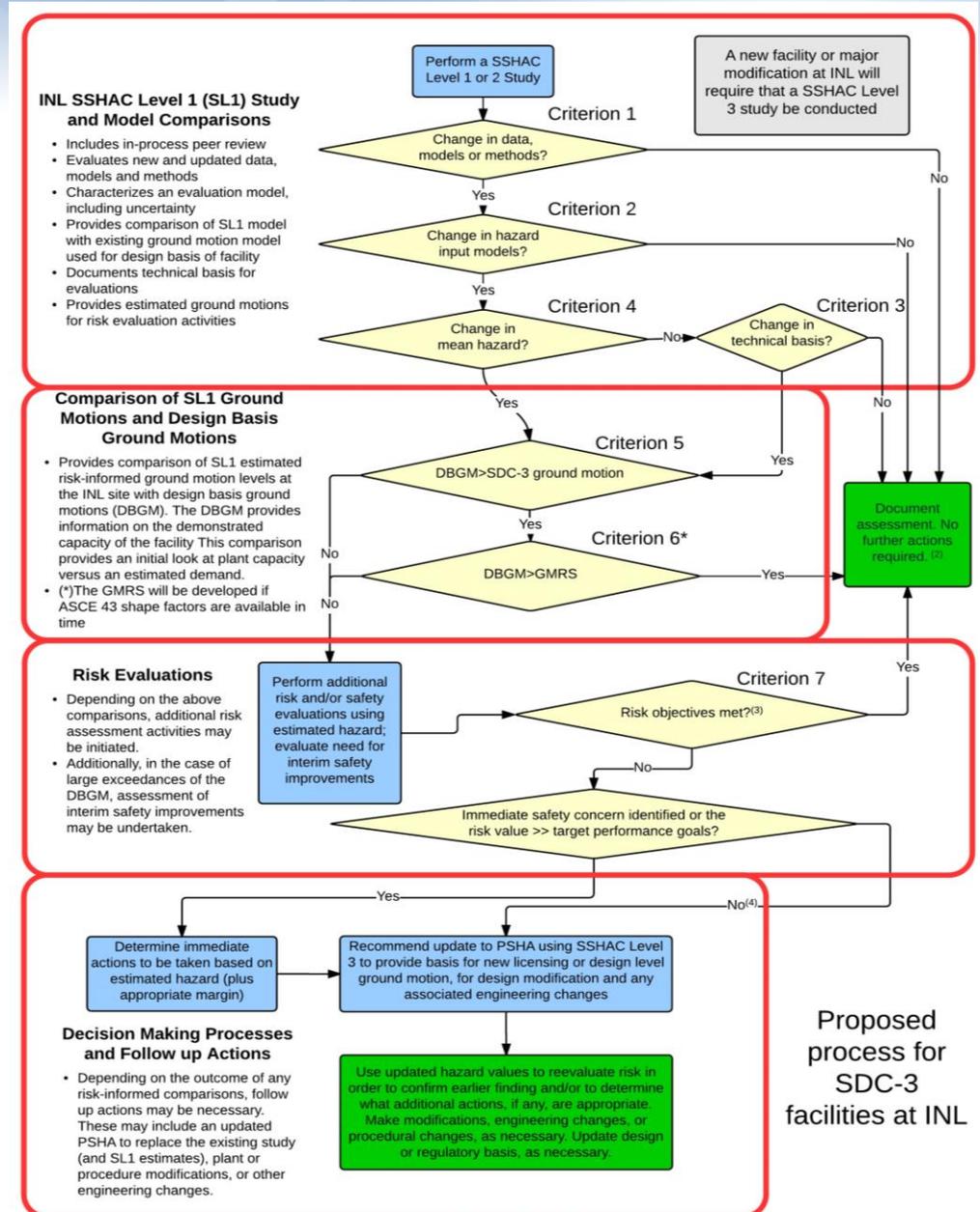
- FMF has a limited suite of PC-3 SSCs
  - Simple reinforced concrete shear wall structure (a “box”) founded on 5 – 15 feet of soil over bedrock, but embedded in a soil backfill
  - Storage racks
- FMF has fragilities developed to support risk calculations based on a defensible estimate of the seismic hazard
- Fragilities and risk calculations performed by the same people who completed ATR work.

# *INL Seismic Risk Methodology: Systems analysis and Risk Quantification*

- Have simple facility that houses an inventory of hazardous material (MAR),
  - Facility has one or more features for confining the MAR during the mission of the facility.
- One to several structural elements of the building (SSC) may be included where necessary for successful confinement.
- Analysis contains logic that assesses each SSC that can affect the confinement function.
- Analysis determines the probability of failure of each identified SSC across a range of seismic intensities.
- Loss of confinement leads to building damage and potential release of MAR to the environment.
- The probability that an earthquake will fail the confinement function for each hazard bin is combined with the frequency of occurrence of seismic events in each bin to determine the overall release frequency due to seismic events.
- Seismic risk = Severity of release \* frequency of occurrence of seismic event

# Risk Informed Methodology

- Draft from Peer Review White Paper



## Conclusion

- INL ensuring continued nuclear facility safety by:
  - Using a defensible estimate of the seismic hazard to determine if nuclear facility risk has changed significantly
    - As opposed to years from now
    - Also incorporate any engineered improvements in fragility calculations
- The INL Risk Methodology Meets Intent of DOE Order 420.1C and STD 1020
- INL is performing a risk-informed methodology, for existing facilities, to determine if the seismic risk has changed significantly (or is below some target).

# Questions

## **DOE O 420.1C IV**

- Existing facility or site NPH assessments must be reviewed at least every 10 years for any significant changes in data, criteria, and assessment methods that would warrant updating the assessments. Sections 9.0 and 9.2 of DOE-STD-1020-2012 contain criteria and guidance for performing these reviews. The review results, along with any recommended update actions, must be submitted to the head of the field element for approval. If no update is necessary, this result must be documented following the review.

# DOE STD 1020 2012

- 9.2. Periodic Review and Update of NPH Assessments
- 9.2.1 At a frequency not to exceed ten years, the following aspects of NPH assessments shall be reviewed for changes that would warrant updating the assessments:
  - NPH data and data collection methods;
  - NPH modeling techniques, either generic or specific to the region of interest;
  - and
  - NPH assessment methods.
- 9.2.2 Consistent with DOE 420.1C, a preliminary estimate of whether changes to data, models, or methods are “significant” and warrant updating the assessments should be performed and consider the following criteria:
  - Are the changes to data, models, or methods likely to cause a change in the estimates of the major inputs to hazard calculations?
  - Given potential changes to the hazard inputs, by what magnitude might the calculated hazard results change, and how might the results impact current site design standards?
- 9.2.3 The preliminary estimate of how hazard results might change from new inputs will likely be imprecise. An expected significant increase in the hazard results would clearly favor completion of a new assessment. However, even if hazard results are not expected to change significantly, large changes to the input parameters may warrant a new assessment to ensure the NPH assessment continues to have a viable technical basis.
- 9.2.4 In the case of seismic hazard assessments, a determination of whether an existing assessment remains adequate for future use should consider the criteria in Section 4.1 of ANSI/ANS-2.29-2008 for the suitability of existing studies. Additional guidance on the bases for updating existing seismic assessments can be obtained from NUREG-2117, Practical Implementation Guidelines for SSHAC Level 3 and 4 Hazard Studies.
- 9.2.5 A decision on updating an NPH assessment should consider the intended application of the assessment results. Such considerations include:
  - The number of facilities affected by the NPH assessment, and the hazards posed by the facilities;
  - The life-cycle stages of the facilities affected by the NPH assessment;
  - Whether the assessment results will be used as design input for any future facilities;
  - NUREG-2117, Chapter 6; and
  - NUREG-CR 6372, Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on Uncertainty and use of Experts, Appendices Vol. 2, Appendix G.
- 9.2.6 If the review and evaluation of the changes warrants an update, the updated assessment shall be performed following the

## General Seismic Risk Calculation Process

- FMF seismic risk calculations started by developing logic for specific building and system responses to potential seismic events.
- Seismic failure events are created for facility structural elements (SSC) determined to be susceptible and added to the model.
- Susceptible SSC failure events are quantified using data from the seismic engineering community:
  - Local seismic hazard data
  - Fragility values for susceptible SSCs
- Seismic initiating events are quantified using the provided site hazard data, which is binned according to peak ground acceleration and probability of occurrence per year (frequency of occurrence).
- Each susceptible SSC is given an array of failure rates that depend on its fragility and the magnitude of the seismic event for each bin.
- The model is analyzed using SAPHIRE software, with the frequency of occurrence of the applicable plant damage state determined for each seismic bin and for the aggregate of all postulated seismic events.

## *Path Forward*

- Execute work scope in PLN-2856
  - By end of FY-15, update project execution plan to consider all factors defined by DOE STD-1020-2012
  - Possible outcomes:
    - Take action on identified facilities to mitigate seismic risk.
- AND
- Probabilistic Seismic Hazard Assessment update not necessary for existing facilities.
- OR
- Continue work on Probabilistic Seismic Hazard Assessment

**IMPROVED, EARLY UNDERSTANDING OF RISK**