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# Full-Scope Site Level 3 PRA Project Briefing

Advisory Committee on Reactor Safeguards

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# Outline

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# Background

- Commission paper (SECY-11-0089), dated 7/7/11, provided three options for undertaking Level 3 probabilistic risk assessment (PRA) activities
  - 1) Maintain status quo
  - 2) Focused research to address gaps before proceeding
  - 3) Conduct a full-scope, comprehensive site Level-3 PRA
- In a staff requirements memorandum (SRM) dated 9/21/2011 the Commission approved a modified version of Option 3
- SRM-SECY-11-0089 also requested Staff's plans for applying project results to the NRC's regulatory framework (SECY-12-0123)

# Project Objectives

- Develop a Level 3 PRA, generally based on current state-of-practice methods, tools, and data,\* that (1) reflects technical advances since completion of the NUREG-1150 studies, and (2) addresses scope considerations that were not previously considered (e.g., multi-unit risk)
- Extract new insights to enhance regulatory decisionmaking and to help focus limited agency resources on issues most directly related to the agency's mission to protect public health and safety
- Enhance NRC staff's PRA capability and expertise and improve documentation practices to make PRA information more accessible, retrievable, and understandable
- Obtain insight into the technical feasibility and cost of developing new Level 3 PRAs

\* "State-of-practice" methods, tools, and data are those that are routinely used by the NRC and licensees or have acceptance in the PRA technical community.

# Project Scope

- Full-Scope Site Level 3 PRA – Includes all major site radiological sources (i.e., all reactor cores, spent fuel pools, and dry storage casks on site), all internal and external hazards, and all modes of reactor operation
- Incorporates improvements in PRA technology and changes in plant operational performance and safety since completion of NUREG-1150
- Study will be for a single multi-unit site; therefore, applicability to a range of sites and technical issues will be limited

# Potential Regulatory Uses

- Potential regulatory uses of the Level 3 PRA can be categorized as follows:
  - Enhancing the technical basis for the use of risk information
  - Improving the PRA state-of-practice
  - Identifying safety and regulatory improvements
  - Supporting knowledge management
- Lists of potential regulatory uses in each of these categories are provided in SECY-12-0123

Activity

CY 2011

CY 2012

CY 2013-2016

Project Infrastructure



# Previous ACRS Reliability and PRA Subcommittee Interactions

- March 2012 – Initial project plan
- December 2012 – Technical Analysis Approach Plan (TAAP) for reactor PRA
- May 2013 – TAAP for spent fuel pool and dry cask storage PRAs
- July 2013 – Integrated site risk and HRA (open); initial Level-1 internal event model results (closed)
- February 2014 – Project status, with focus on Level 2 PRA and Level 3 PRA (open); technical discussions on preliminary internal event Level 1 and Level 2 PRA (closed)
- Several informal meetings (Feb'12, Jul'13, Jan'14, Mar'14)



# Principal Project Tools

- SAPHIRE 8 – NRC’s standard software application for performing PRAs; has increased capability for handling large, complex models
- MELCOR – Used for performing thermal-hydraulic analysis to determine system success criteria and accident sequence timing, and for modeling severe accident progression for reactors, spent fuel pools, and dry storage casks
- MACCS2 – Used to evaluate public consequences of severe accidents at diverse reactor and non-reactor facilities

# Technical Analysis Approach

- Leveraging licensee's peer-reviewed internal event, flood, and fire PRA models, and information from on-going licensee seismic PRA
- Using state-of-practice for reactor Level 2, Level 3, and LPSD models, consistent with draft PRA standards
- Spent fuel pool and dry cask storage PRAs largely based on previous studies
- Integrated risk model approach involves developing simplified model and modifying based on insights from individual risk models
- Simplified HRA approach developed for beyond internal event, internal flood and internal fire; e.g., Level 2, LPSD, integrated risk, dry cask storage
- Project management approach structured to enhance integration of individual scope elements

# Technical Analysis Approach Plan (1 of 2)

- Provides guidance for developing the Level 3 PRA
  - Enhances consistency in the development of PRA models across technical areas
  - Provides traceability of how the PRA models were constructed
  - Shows how the technical elements interface with each other
  - Supports development of review criteria for assessing the technical acceptability of the PRA models
- Draft (“work in progress”) version (Rev. 0a) provided to Technical Advisory Group and ACRS for comment, and released publicly
- Subsequent draft (Rev. 0b) has also been released publicly (ADAMS Accession No. ML13296A064)
- Ultimately, TAAP will be updated to reflect actual approach taken

# Technical Analysis Approach Plan (2 of 2)

- Overall technical approach
- Success criteria
- Systems analysis
- Data analysis
- Human reliability analysis
- Structural analysis
- Fragility analysis
- Hazard analysis
- Uncertainty analysis
- Reactor, at-power, internal hazard PRA (Levels 1-3)
- Reactor, at-power, external and other hazard PRA (Levels 1-3)
- Reactor, low power and shutdown, all hazard PRA (Levels 1-3)
- Spent fuel pool PRA
- Dry cask storage PRA
- Integrated site PRA
- Quality assurance

# Vogtle Site/Plant Information

- Principal radiological sources on site:
  - Two Westinghouse 4-loop PWRs with large, dry containments (Units 3 and 4 are not within scope)
  - Two spent fuel pools (almost always hydraulically connected through the cask pit)
  - Two Independent Spent Fuel Storage Installations (ISFSIs)
- Atypical emergency planning zone
- Recent probabilistic seismic hazard models indicate higher seismic hazard
- Plant elevation greatly minimizes risk from external flooding
- Limited shared systems

# Project Status (1 of 4)

## ***Reactor Risk Assessment --***

- Level 1, at-power, internal event and flood model – R01 model complete
  - Several modifications had to be made to SAPHIRE
  - Further investigation of licensee model identified additional areas for modification
- Level 2, at-power, internal events model – substantial progress
  - Completed MELCOR model for Unit 1 reactor and containment
  - Quantified plant damage states and performed numerous representative scenario analyses
  - Developed preliminary probabilistic logic model and release category framework
  - Finalizing all pieces (e.g., HRA) and will be starting quantification soon

# Project Status (2 of 4)

## ***Reactor Risk Assessment (Continued) --***

- Level 3 (consequence analysis) – work progressing
  - Obtained all major input data needed for development of MACCS2 input decks
  - Documenting technical basis for MACCS2 input parameters and datasets
  - Performing MACCS2 development work in parallel with initial analyses
- Level 1, at-power, fire, seismic, and other external hazards – work underway
  - Completed high wind PRA model
  - Completed initial seismic PRA model (based on most recent hazard curves and preliminary plant-specific fragilities provided by the licensee)
  - Internal fire PRA modeling is in progress
  - Preliminarily screened out all “other hazards,” including external flooding
- Level 1, low power and shutdown modeling – just beginning

# Project Status (3 of 4)

## ***Spent Fuel Pool Risk Assessment --***

- Completed SCALE analysis
- Developed simplified MELCOR model
- Completed preliminary sequence timing analysis
- Initiated accident sequence modeling

## ***Dry Cask Storage Risk Assessment --***

- Gathered and reviewed information from NRC and Vogtle
- Monitored cask loading campaign in November 2013
- Work progressing on initiating event analysis
- Just beginning structural analysis on fuel and cask drops



# Project Status (4 of 4)

## ***Integrated Site Risk Assessment --***

- Developed Technical Analysis Approach Plan section
- Identifying dependencies within and across risk sources
- Developing a simplified model based on prioritization and dependency analysis

## ***ASME/ANS PRA Standard-Based Peer Reviews --***

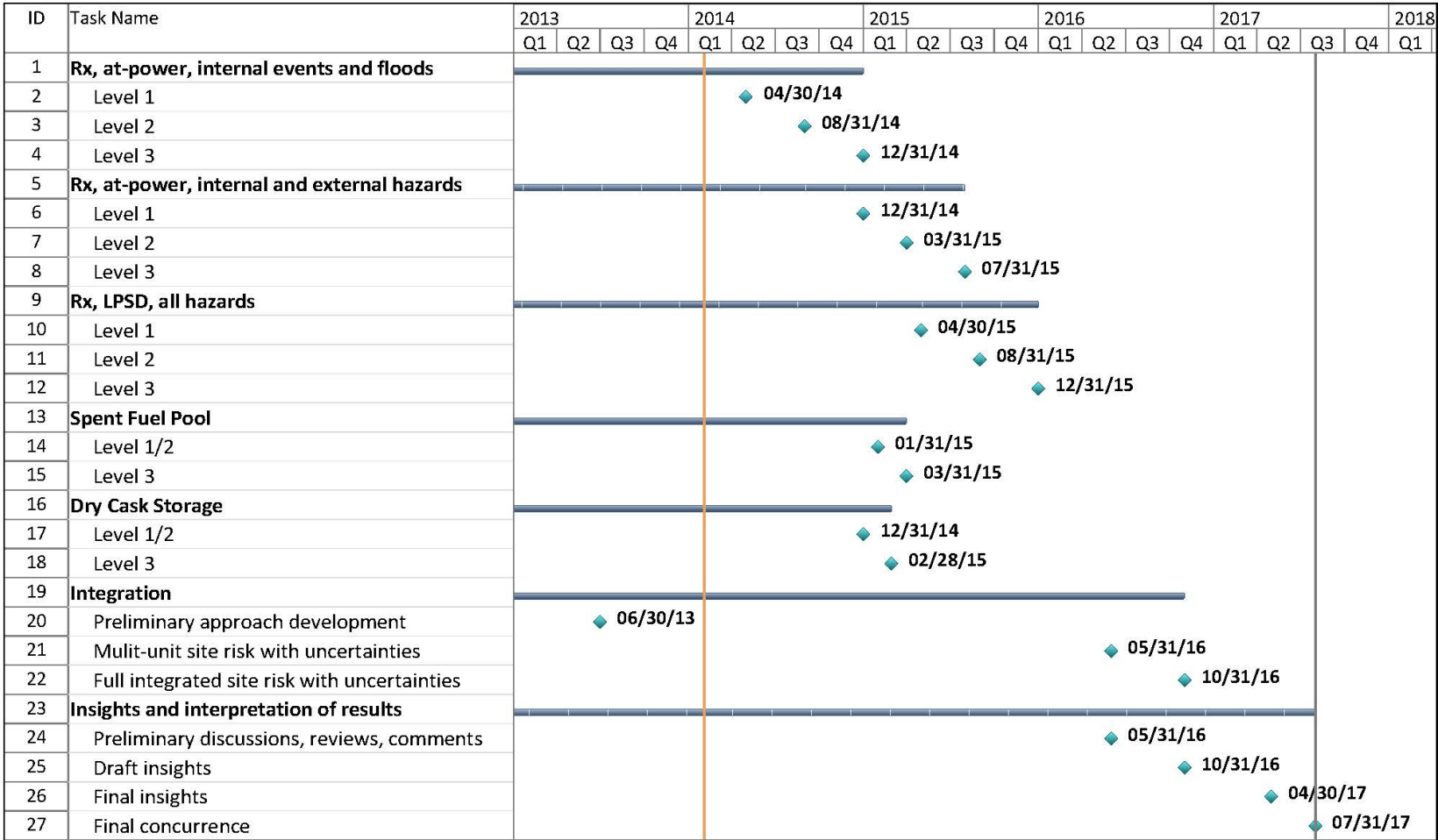
- PWR Owner's Group (PWROG) agreed to support four peer reviews in CY 2014
- Three reviews will focus on different L3PRA models; fourth review will focus on developing review criteria for areas without current (approved or draft) PRA standards

# Schedule Challenges (1 of 2)

- Administrative challenges
  - Funding availability
    - Reductions in FY2013 budget and delays in FY2013 funding
    - FY2014 budget has been restored to initial planning level (i.e., ~\$2M), but delays in sequestration decisions already impacted Level 3 PRA contracts for 1<sup>st</sup> quarter of FY2014
  - Staff diversion
    - Spent fuel pool study and COMSECY paper
    - Waste confidence decision
    - NFPA 805 implementation
    - Near-Term Task Force (NTTF) Recommendations 1, 2.1, 2.3, 3, and 5
    - Risk Management Regulatory Framework (RMRF)
  - Licensee resource challenges in responding to requests for information

# Schedule Challenges (2 of 2)

- Technical challenges
  - Greater than expected effort to develop project infrastructure, especially for technical approach plans, information exchange protocols, project documentation and quality assurance, and contracting actions
  - Complications in converting licensee model from industry software to NRC software (SAPHIRE) and in enhancing SAPHIRE to integrate Level 1 and Level 2 PRA
  - Additional effort to modify licensee's Level 1 internal event and flood PRA model, as part of taking "ownership" of the model



Project: Timeline\_L3PRA\_taskList  
Date: Mon 02/03/14

Manual Milestone Manual Summary Rollup

# Key Milestones – CY 2014

- Completion of initial reactor, Level 1, seismic event PRA (Summer 2014)
- Industry-led peer review of reactor, Level 1, internal event and flood PRA (July 2014)
- Industry-led peer review of reactor, Level 1, high wind and other hazards PRA (November 2014)
- Industry-led peer review of reactor, Level 2, internal event and flood PRA (November 2014)
- Completion of reactor, Level 3, internal event and flood PRA (Winter 2014/2015)
- Completion of dry cask storage, Level 1 and Level 2, PRA (Winter 2014/2015)
- Meetings and briefings:
  - Commissioner assistants briefing on project status and preliminary results (September 2014)
  - ACRS Reliability and PRA Subcommittee meeting on project status , and closed session primarily on Level 2 PRA (October 2014)
  - Public meeting on project status and preliminary results (Fall 2014)

# Concluding Remarks

- Project schedule has slipped approximately 16 months
  - Further reductions in project funding or diversion of key personnel to higher priority work in FY2014 and beyond will further delay the schedule
- Robust infrastructure established
- Good collaboration with licensee
- Very successful inter-organizational collaboration and significant use of mid-career and junior staff, led by senior staff
- Progress is being made in all technical areas of the study
- Substantial challenges remain, especially administrative (i.e., staff diversion, funding availability, and access to plant information)