Full-Scope Site Level 3 PRA Project Status Briefing

Public Meeting

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Background (1 of 3)

- Commission paper (SECY-11-0089), dated 7/7/11, provided options for undertaking Level 3 probabilistic risk assessment (PRA) activities
- In a staff requirements memorandum (SRM) dated 9/21/2011 the Commission directed the staff to conduct a full-scope, comprehensive site Level-3 PRA
- SRM-SECY-11-0089 also requested Staff's plans for applying project results to the NRC's regulatory framework (SECY-12-0123)
- SRM-SECY-11-0172 directed staff to pilot draft expert elicitation guidance as part of the Level 3 PRA project

Background (2 of 3)

- 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.

Background (3 of 3)

- Project scope
 - Reactor cores, spent fuel pools, dry cask storage
 - All internal and external hazards
 - All reactor modes of operation
 - Integrated site risk
- Volunteer site
 - Southern Nuclear Operating Company's (SNC's) Vogtle Electric Generating Plant, Units 1 and 2
 - Westinghouse 4-loop PWRs with large, dry containments
 - Peer-reviewed internal event, internal flood, and internal fire PRAs
 - Seismic PRA nearing completion (including peer review)

Quality Activities

- Documentation
 - Assumptions, technical bases, sources of uncertainty, meeting summaries, decisions
 - Four tiers based on level of detail and control of information
- Internal reviews
 - Self-assessment
 - Independent technical reviewer
 - Level 3 PRA Project management reviewer
 - Technical Advisory Group (TAG)
- ASME/ANS PRA Standard based peer reviews
- Advisory Committee on Reactor Safeguards reviews
- General peer reviews on publicly available documents

PRA Enhancements

- Builds off of lessons-learned from the State-ofthe-Art Reactor Consequence Analysis (SOARCA) project
 - "Best practices" for MELCOR input deck development
 - Enhanced Emergency Planning (EP) modeling
- Direct integration of Level 1 and Level 2 PRA models
- Modeling of integrated site risk
- Human reliability analysis approaches for postcore-damage, area-wide events, and integrated site risk

Outline

- Reactor, at-power, Level 1
 - Internal events and floods
 - Internal fires
 - Seismic events
 - High winds, external flooding, and other hazards
- Reactor, at-power, Level 2, internal events and floods
- Reactor, at-power, Level 3, internal events and floods
- Reactor, low power and shutdown, Level 1, all hazards
- Spent fuel pool (SFP)
- Dry cask storage (DCS)
- Integrated site risk
- ASME/ANS PRA standard-based peer reviews

Reactor, At-Power, Level 1, Internal Events and Floods (1 of 2)

- Completed internal event and internal flooding models
 - Based on SNC's PRA models for Vogtle Units 1 and 2
 - SNC provided extensive Vogtle-specific information to support this effort, and hosted and facilitated a site visit to confirm assumptions for the internal flooding model
 - Some modifications made to SNC's models (e.g., SPAR modeling for loss of offsite power, support system initiating events, and ATWS; updated flood frequencies)
- PWR Owners Group (PWROG) led peer review completed the week of July 21-25, 2014

Reactor, At-Power, Level 1, Internal Events and Floods (2 of 2)

Major Challenges

- Interfacing systems LOCA (ISLOCA) common cause valve leakage rates
 - Additional work needed to refine frequency estimates of large leak rates

- Revise model and documentation to address peer review and other internal comments
- Pilot expert elicitation guidance for ISLOCA frequency estimates (SRM-SECY-11-0172)

Reactor, At-Power, Level 1, Internal Fires (1 of 2)

- Internal fire PRA (FPRA) model development is underway
 - Over 120 event trees have been added to the model for Unit 1
- FPRA model being created using available information from SNC's Vogtle FPRA
- Revising Level 1 internal event model to include additional basic events needed for FPRA model
- RES commissioned a review of licensee's FPRA by subject matter experts (Sandia National Laboratories)

Reactor, At-Power, Level 1, Internal Fires (2 of 2)

Major Challenges

- Mapping SNC's FPRA model to Level 3 PRA project FPRA model
- Review and acceptance of key FPRA inputs (e.g., fire scenario parameters and fire analysis)

Planned Activities

 Construct and document initial FPRA model by end of CY 2014 Reactor, At-Power, Level 1, Seismic Events (1 of 2)

- Initial seismic PRA (SPRA) model and documentation completed
- SPRA draft report undergoing internal review
- Current SPRA model based on 2012 hazard curves and preliminary plant-specific fragilities provided by SNC
 - Will update model once revised fragilities provided by SNC are reviewed
 - Updated model will also incorporate 2014 hazard curves
- Plant walkdowns performed in March 2013 and July 2014 to support this effort

Reactor, At-Power, Level 1, Seismic Events (2 of 2)

Major Challenges

- Review and acceptance of key SPRA inputs (e.g., plantspecific fragilities)
- Staff availability

- Internally review SPRA model and perform self-assessment
- Prepare for, and support, industry-led peer review (2015)

Reactor, At-Power, Level 1, High Winds, External Flooding, and Other Hazards (1 of 2)

- Level 1, at-power, high wind PRA model and selfassessment completed and documented
- "Other hazards" evaluation and self-assessment completed and documented
 - Includes external flooding
- PWROG-led peer review completed November 12-14, 2014

Reactor, At-Power, Level 1, High Winds, External Flooding, and Other Hazards (2 of 2)

Major Challenges

None currently identified

Planned Activities

 Revise model and documentation to address peer review and other internal comments

Reactor, At-Power, Level 2, Internal Events and Floods (1 of 2)

- Completed reactor, at-power Level 2 PRA model for internal events and internal floods
 - Completed release category development, model quantification, and draft documentation
 - Directly linked Level 1 and Level 2 PRA models
 - Developed and implemented a human reliability analysis approach for post-core-damage response
- Level 2 PRA team visited the site in March 2013 and July 2014, to support this effort
- PWROG-led peer review completed the week of December 8-12, 2014

Reactor, At-Power, Level 2, Internal Events and Floods (2 of 2)

Major Challenges

- Specific detailed plant characterization items (e.g., auxiliary building performance)
- Computational challenges associated with Level 2 modeling
- Human reliability analysis for onsite accident management; treatment of offsite resources

Planned Activities

 Will revise model and documentation to address peer review and other internal comments

Reactor, At-Power, Level 3, Internal Events and Floods (1 of 2)

- Completed MACCS development work necessary to support Level 3 PRA Reactor At-Power source terms
- Developed initial draft of technical basis for MACCS input parameters and datasets and initial draft of MACCS input files
- MACCS input files are undergoing internal QA review in parallel with initial MACCS analyses

Reactor, At-Power, Level 3, Internal Events and Floods (2 of 2)

Major Challenges

Definition of output measures (risk metrics)

- Complete consequence analysis for reactor, at-power, internal events and floods, and identify and document parameter changes necessary to extend to other scope pieces
- Complete initial documentation of model and results
- Prepare for, and support, industry-led peer review (2015)

Reactor, Low Power and Shutdown, Level 1, All Hazards (1 of 2)

- Gathered and reviewed Vogtle low power and shutdown (LPSD) operating experience and documents
- Observed Unit 2 refueling outage (September 2014)
- Developed LPSD outage type and plant operating state definitions, frequencies, and durations
- Currently performing initiating event analysis and initiating event frequency quantification
- Initiated development of event tree models
 - Completed event tree model for cold shutdown with loss of residual heat removal
- Drafted report sections on plant operating states, initiating events, and event trees

Reactor, Low Power and Shutdown, Level 1, All Hazards (2 of 2)

Major Challenges

- Applying practical scope limitations to the number of LPSD evolutions, plant operating states, and accident scenarios
- Analyzing internal fire and external hazards for unique LPSD operating conditions and plant configurations
- Applying HRA tools and methods to LPSD operations within existing resources

- Continue on-going effort to develop event trees
- Continue model development by addressing technical elements:
 - Systems analysis, Data analysis, HRA, and model quantification
- Continue developing model documentation

Spent Fuel Pool PRA (1 of 2)

- Performed site characterization and limited walkdowns
 - Both SFPs are included in a single model, due to operational considerations
- Developed site operating phases to encompass major SFP configurations
- Identified initial list of hazards
- Performed numerous pre-fuel damage sequence timing calculations to prioritize probabilistic model build-out
- Developing initial Level 1 accident sequences

Spent Fuel Pool PRA (2 of 2)

Major Challenges

- Staff availability
- Scope (i.e., the multitude of configuration, decay heat, and hazard combinations)
- Detailed plant characterization issues (e.g., structural response)

- Structural performance characterization
- Probabilistic modeling for highest priority event/hazard combinations
- Development of detailed MELCOR model
- Development of human reliability analysis approach

Dry Cask Storage PRA (1 of 2)

- Extensive interactions with SNC staff regarding dry cask storage (DCS) design and operation
- Observed cask loading campaign in November 2013
- Work progressing on:
 - Initiating event analysis
 - Structural analysis of fuel performance and multipurpose canister
 - Accident scenario development
 - Release fraction frequency estimation and characterization

Dry Cask Storage PRA (2 of 2)

Major Challenges

Development of peer review criteria

- Complete Level 1/Level 2 PRA (i.e., frequency estimation and characterization of source terms) by early 2015
- Prepare for, and support, peer review of DCS Level 1/ Level 2 PRA (mid-2015)

Integrated Site Risk (1 of 2)

- Developed Technical Analysis Approach Plan section
- Conducted SAPHIRE quantification experiments
- Identifying dependencies within and across risk sources
- Addressing cross-unit common-cause failure modeling and data
- Developing simplified model based on prioritization and dependency analysis
- Awaiting completion of single-source PRA models and their results

Integrated Site Risk (2 of 2)

Major Challenges

- Staff availability
- Applying practical scope and size limitations to the integrated risk model

- Develop and quantify simplified logic models (anticipated order):
 - Reactor, at-power, Level 1, internal events and floods
 - Reactor, at-power, Level 1, high winds, external flooding, and other hazards
 - Reactor, at-power, Level 1, seismic events

ASME/ANS PRA Standard-Based Peer Reviews (1 of 2)

- PWROG agreed to support four peer reviews in CY 2014
- Peer reviews completed for:
 - Reactor, Level 1, at-power, internal event and internal flood models (July 21-25, 2014)
 - Reactor, Level 1, at-power, high wind model and other hazards evaluation (November 12-14, 2014)
 - Reactor, Level 2, at-power, internal event and internal flood models (December 8-12, 2014)
- Fourth review will focus on developing review criteria for areas without current (approved or draft) PRA standards

ASME/ANS PRA Standard-Based Peer Reviews (2 of 2)

Major Challenges

- Peer review of scope items with no relevant PRA standard (e.g., spent fuel pool and dry cask storage PRAs)
- Total number of peer reviews required

- Hold public workshop with PWROG to develop peer review criteria for spent fuel pool and dry cask storage
- Work with PWROG to plan additional peer reviews in CY 2015

Concluding Remarks

- Robust infrastructure established
- Staff's PRA capability enhanced
- Progress being made in all technical areas of the study
- Substantial challenges remain, especially administrative (i.e., funding availability and staff diversion), as well as licensee resource challenges in responding to requests for information
 - Project schedule has slipped approximately 16 months
- Advancements made in some challenging areas (e.g., integration of Level 1 and Level 2 PRA models and Level 2 PRA HRA)