

POLICY ISSUE INFORMATION

October 4, 2012

SECY-12-0133

FOR: The Commissioners

FROM: Brian W. Sheron, Director
Office of Nuclear Regulatory Research

SUBJECT: STATUS OF THE ACCIDENT SEQUENCE PRECURSOR PROGRAM
AND THE STANDARDIZED PLANT ANALYSIS RISK MODELS

PURPOSE:

To inform the Commission of the status of the Accident Sequence Precursor (ASP) Program, provide the annual quantitative ASP results, and communicate the status of the development and maintenance of the standardized plant analysis risk (SPAR) models. This paper does not address any new commitments or resource implications.

BACKGROUND:

In a memorandum to the Chairman dated April 24, 1992, the staff of the U.S. Nuclear Regulatory Commission (NRC) committed to report periodically to the Commission on the status of the ASP Program. In SECY-02-0041, "Status of Accident Sequence Precursor and SPAR Model Development Programs," the staff expanded the annual ASP SECY paper to include: (1) the evaluation of precursor data trends and (2) the development of associated risk models (e.g., SPAR models). The ASP Program systematically evaluates U.S. nuclear power plant (NPP) operating experience to identify, document, and rank the operating events most likely to lead to inadequate core cooling and severe core damage (precursors). The ASP Program provides insights into the NRC's risk-informed and performance-based regulatory programs and monitors performance against safety measures established in the agency's Congressional Budget Justification (see NUREG-1100, Volume 28, "Congressional Budget Justification: Fiscal Year 2013," issued February 2012). The SPAR Model Program develops and maintains independent risk-analysis tools and capabilities to support the use of probabilistic risk assessment (PRA) across a broad range of the agency's risk-informed regulatory activities.

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The staff uses SPAR models to support the Reactor Oversight Program's Significance Determination Process (SDP), the ASP Program, Management Directive (MD) 8.3, "NRC Incident Investigation Program," event assessment process, and MD 6.4, "Generic Issues Program," resolution process. In addition, the staff uses SPAR models to risk inform licensing and inspection activities.

DISCUSSION:

This section summarizes the status, accomplishments, and results of the ASP Program and SPAR Model Program since the previous status report, SECY-11-0138, "Status of the Accident Sequence Precursor Program and the Standardized Plant Analysis Risk Models," dated September 30, 2011.

ASP Program

The staff continues to review plant events from licensee event reports and inspection reports. Each event analyzed by the ASP Program is thoroughly inspected by regional and, if necessary, headquarters staff to ensure it is understood and that appropriate corrective action is taken by licensees. The staff has completed the analyses of all precursor events that were identified in fiscal year (FY) 2011 (22 precursors). Precursors are events with a conditional core damage probability (CCDP) for initiating event analyses or an increase in core damage probability (Δ CDP) for equipment deemed unavailable or degraded that is greater than or equal to 1×10^{-6} . In addition, the staff has completed the screening of FY 2012 events for *significant* precursors. *Significant* precursors have a CCDP or Δ CDP greater than or equal to 1×10^{-3} . No *significant* precursors were identified in FY 2011, and no *significant* precursors have been identified in FY 2012, to date. However, the staff has identified a potential *significant* precursor involving the loss of offsite power and subsequent station blackout that occurred at Byron Station, Unit 2, on January 30, 2012. The staff will continue to evaluate this event and other ongoing analyses and inform the Commission if *significant* precursors are identified.

The staff evaluated precursor data during the period of FY 2002 through FY 2011 to identify statistically significant adverse trends for the Industry Trends Program (ITP). The staff detected no statistically significant trend for all precursors during this 10-year period. The ASP Program results are trended in the ITP to provide an input to the agency's safety performance measure of no significant adverse trend in industry safety performance.

In addition to the trend analysis of all precursors, the staff performs trend analyses on precursor subgroups. These subgroups include precursors with a high safety significance (i.e., CCDP or Δ CDP greater than or equal to 1×10^{-4}), initiating events, degraded conditions, loss of offsite power initiating events, precursors at boiling-water reactors (BWRs), and precursors at pressurized-water reactors (PWRs). The staff observed no statistically significant trends in these precursor subgroups. Enclosure 1 provides additional details on results and trends of the ASP Program.

SPAR Model Program

The staff continued to maintain and update the 79 SPAR models representing the 104 operating commercial nuclear power reactors during FY 2012. The staff completed the development of new Plant Risk Information e-Books for all SPAR models. These reports provide summary information about systems and components important to nuclear plant risk and will support use

of the Systems Analysis Program for Hands-On Integrated Reliability Evaluations (SAPHIRE) computer code platform¹ by a wider range of Regional inspection staff. In addition, the staff continued to expand the SPAR model capability beyond internal events at full-power operation. Currently, a total of 18 SPAR all-hazard models exist (these models include hazards such as fires, floods, and seismic events). The staff also incorporated internal fire scenarios from the National Fire Protection Association (NFPA) 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," for the Shearon Harris Nuclear Power Plant pilot application. The Office of Nuclear Regulatory Research staff continues to work with the Office of Nuclear Reactor Regulation and the Office of New Reactors to identify future enhancements to the SPAR all-hazard models.

The staff has completed the development and enhancement of the shutdown template models, resulting in a total of eight shutdown SPAR models available to support the Reactor Oversight Process evaluations of shutdown events and degraded conditions during shutdown conditions. The staff also developed new reactor SPAR models for the AP1000, Advanced BWR (for both the Toshiba and General Electric designs), and the U.S. Advanced PWR. In addition, the staff initiated the development of a SPAR model for the U.S. Evolutionary Power Reactor. The staff continues to expand the capability of some of these models to include seismic hazards and shutdown conditions. These new reactor SPAR models allow confirmation of PRA results presented in licensing submittals, evaluation of risk-informed license applications prior to plant operation, and assessment of operational findings and events once operation commences. In addition, the SPAR models for the AP1000 and Advanced BWR were used extensively to support staff recommendations in SECY-12-0081, "Risk-Informed Regulatory Framework for New Reactors," dated June 6, 2012.

In FY 2010, the staff, with the cooperation of industry experts, completed peer reviews of a representative BWR SPAR model and PWR SPAR model, in accordance with American Society of Mechanical Engineers (ASME) RA-S-2008, "Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications," and Regulatory Guide 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities." The peer review teams concluded that, within the constraints of the program, the SPAR models provide an appropriate tool to conduct an independent check on the technical adequacy of utility PRAs. The teams also made a number of observations regarding improvements that could be made to the SPAR Models and supporting documentation. The staff has reviewed the peer review comments and has initiated projects to address these comments, where appropriate. Major activities undertaken to address these peer review items in FY 2012 include the following:

- Structuring the SPAR model documentation to more closely align with the structure of PRA standard.
- Incorporating improved loss of offsite power modeling.
- Addressing the high priority items for the BWR SPAR models.

¹ SAPHIRE is the Agency's primary tool for conducting Probabilistic Risk Assessments. SAPHIRE uses logical event and fault tree models to quantify the frequencies and probabilities associated with events of interest, such as core damage. SAPHIRE is also capable of performing uncertainty calculations and risk importance measures.

These activities have been delayed approximately 1 year because of higher priority Reactor Oversight Process support and activities related to the events at Fukushima Dai-ichi, in Japan. The staff plans to complete these efforts in 2014.

The staff continues to maintain and improve the SAPHIRE software to support the SPAR Model Program. SAPHIRE is a personal computer-based software application used to develop PRA models and to perform analyses with SPAR Models. During FY 2012, the new features, capabilities, and user support activities that have been implemented for SAPHIRE include:

- An improved common-cause failure calculation module.
- Oversight of the SAPHIRE software quality assurance program, including an audit of software quality assurance activities, tools, and documents.
- An update to the SAPHIRE Web site design and user support features, including an automatic password retrieval system to assist active users in maintaining access to the secure site.
- Research on advanced quantification methods to overcome limitations of the approximation methods that are typically used in PRA software.

Enclosure 2 provides a detailed status of SPAR models and related activities.

Planned Activities

- The staff will continue the screening, review, and analysis (preliminary and final) of potential precursors for FY 2012 and FY 2013 events to support the agency's safety measures.
- The staff will continue to implement enhancements to the internal event SPAR models for full-power operations. Enhancements include incorporating new models for support-system initiators and revised success criteria based on insights from thermal-hydraulic analyses. The staff also is working with industry representatives through a memorandum of understanding with the Electric Power Research Institute (EPRI) to resolve other PRA technical issues common to both licensee PRAs and NRC SPAR models. The memorandum of understanding addendum on PRA with EPRI extends through 2016.
- The staff has reviewed the SPAR model peer review comments and developed a project plan to address them, where appropriate. These activities have been delayed approximately 1 year because of higher priority Reactor Oversight Process support and activities related to Fukushima Dai-ichi. The staff is planning to complete this effort in FY 2014. The effort's main objective is to ensure the SPAR models continue to be of sufficient quality for performing SDP, ASP, and MD 8.3 event assessments in support of the staff's risk-informed activities.

- The staff will use information obtained as part of the NFPA 805 application process to create new SPAR fire models with updated fire scenarios.
- The staff will continue to evaluate the need for additional SPAR model capability (beyond full-power internal events) based on experience gained from SDP, ASP, and MD 8.3 event assessments, and Safety Risk Assessments conducted for the Generic Issues Program under MD 6.4.
- The staff will continue the development of SPAR models for new reactors to allow confirmation of PRA results presented in licensing submittals, evaluation of risk-informed applications prior to plant operation, and assessment of operational findings and events once operation commences.
- The staff will develop approximately one new all-hazards model per year, and plans to perform validation activities for existing all-hazards models.
- The staff will continue to maintain and improve the SAPHIRE software to support the SPAR Model Program.
- The staff will use SAPHIRE and the Units 1 and 2 Vogtle SPAR model as primary tools for developing the Level 1 and Level 2 portions of the full-scope site Level 3 PRA project, which is being conducted per the staff requirements memorandum to SECY-11-0089, "Options for Proceeding with Future Level 3 Probabilistic Risk Assessment Activities."
- As noted in SECY 11-0137, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," the staff acknowledged that additional SPAR model updates could be identified as a result of Tier 1 related inspection activities. The RES staff will continue to monitor the status of these Fukushima follow-up activities and will perform additional SPAR model update activities, as appropriate.

SUMMARY:

The ASP Program continues to evaluate the safety significance of operating events at NPPs and to provide insights into the NRC's risk-informed and performance-based regulatory programs. The staff identified no *significant* precursors in FY 2012; however, a potentially *significant* precursor has been identified for an operational event that occurred at Byron Station, Unit 2. The analysis of the event is ongoing. No statistically significant trend was detected for all precursors during the FY 2002 through FY 2011 period. The SPAR Model Program is continuing to develop and improve independent risk analysis tools and capabilities to support the use of PRA in the agency's risk-informed regulatory activities.

The Commissioners

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COORDINATION:

The Office of the General Counsel reviewed this Commission paper and has no legal objection.

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Brian W. Sheron, Director
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Enclosures:

1. Results, Trends, and Insights
of the ASP Program
2. Status of the SPAR Models

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