POLICY ISSUE
INFORMATION

October 4, 2013 SECY-13-0107

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, including 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 that have a conditional core damage probability (CCDP) or an increase in core damage probability (ΔCDP) greater than or equal to 1×10^{-6}. 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 29, "Congressional Budget Justification: Fiscal Year 2014," issued April 2013).

CONTACT: Keith M. Tetter, RES/DRA
301-251-7605

Under the SPAR Model Program, the staff develops and maintains independent risk-analysis tools and capabilities to support NPP-related risk-informed regulatory activities. The staff uses SPAR models to support the Reactor Oversight Process (ROP) Significance Determination Process (SDP); the ASP Program; the Management Directive (MD) 8.3, "NRC Incident Investigation Program," event assessment process; and the MD 6.4, "Generic Issues Program," resolution process. In addition, the staff uses SPAR models to risk-inform 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-12-0133, "Status of the Accident Sequence Precursor Program and the Standardized Plant Analysis Risk Models," dated October 4, 2012.

ASP Program

The staff continues to review plant events from licensee event reports and inspection reports to identify potential precursors. Precursors are events with a CCDP for initiating event analyses or a ΔCDP that are greater than or equal to 1×10^{-6} for equipment deemed unavailable or degraded. *Significant* precursors have a CCDP or ΔCDP greater than or equal to 1×10^{-3}. The staff has identified eight precursor events for fiscal year (FY) 2012. The staff did not identify any *significant* precursors for FY 2012, and has not identified any potentially *significant* precursors for FY 2013, to date, although evaluation of some FY2013 events is still in progress.

The ASP Program evaluates the trend for all precursors (i.e. those greater than 1×10^{-6}) as an input to the Industry Trends Program (ITP), which provides an input to the agency's safety performance measure of no significant adverse trend in industry safety performance. For the period of FY 2003 through FY 2012, the staff found no statistically significant trend when looking at the total population of all precursors.

In addition to the trend analysis of all precursors required for the ITP, the staff performs trend analyses on precursor subgroups for additional insights. These subgroups include important precursors with high safety significance (i.e., CCDP or ΔCDP greater than or equal to 1×10^{-4}). The staff found a statistically significant increasing trend in the subgroup of precursors with a CCDP or ΔCDP greater than or equal to 1×10^{-4}. This increasing trend is due to occurrence of seven precursors in this subgroup in the past three years after no events were identified in the previous six years. The staff reviewed these events for risk-informed insights, looking at the systems causing the events, the dominant risk sequences, and the plant types affected by the events. The most common similarity was that six of the seven events were caused by multiple electrical-related failures. These electrical failures varied from electrical equipment such as circuit breakers failing to losses of offsite power. Regulatory actions taken as a result of these events include plant-specific SDP evaluations of the risk significance of the performance deficiencies associated with the events, information notices, and a bulletin.

Enclosure 1, "Results, Trends, and Insights of the Accident Sequence Precursor Program," provides additional details on results and trends of the ASP Program.

SPAR Model Program

The staff continued to maintain and update the 80 SPAR models representing 104 commercial nuclear power reactors. Additionally, the staff has also developed new reactor SPAR models for the AP1000, Advanced Boiling Water Reactor (BWR) (for both the Toshiba and General Electric-Hitachi designs), U.S. Advanced Pressurized Water Reactor (PWR), and the U.S. Evolutionary Power Reactor. The scope of every SPAR model includes internal events, at-power, through core damage (i.e., Level 1 model). In addition, the staff continued to expand SPAR model capability beyond internal events at full-power operation. Currently, a total of 19 operating reactor SPAR All-HaZard (SPAR-AHZ) models include hazards such as fires, floods, and seismic events based on the results from the Generic Letter 88-20, Supplement 5, "Individual Plant Examination of External Events for Severe Accident Vulnerabilities," assessments and other readily available information. The staff has completed incorporation of internal fire scenarios from the National Fire Protection Association (NFPA) 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," fire probabilistic risk assessments (PRAs) for the Shearon Harris Nuclear Power Plant and the Donald C. Cook Nuclear Power Plant. The staff is also leveraging the ongoing Level 3 PRA project for the Vogtle Electric Generating Plant, Units 1 and 2, to develop improved external hazard and fire modeling for the Vogtle SPAR model. In addition, the staff is expanding the capability of the AP1000 SPAR models to include hazards such as seismic, fire, and flooding events. The Office of Nuclear Regulatory Research staff continues to work with the Office of Nuclear Reactor Regulation (NRR) and the Office of New Reactors to identify future enhancements to the SPAR-AHZ models, including accelerating the development of new all-hazard SPAR models.

In FY 2010, the staff completed peer [1]reviews of a representative BWR SPAR model and PWR SPAR model. These peer reviews were performed in accordance with American Society of Mechanical Engineers (ASME)/ American Nuclear Society (ANS) RA-S-2008, "Standard for Level 1/Large Early Release Frequency 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 identified a number of facts and observations (F&Os) related to areas where enhancements could be implemented on the SPAR models and supporting documentation. The staff has reviewed the peer review comments and has prioritized them into high, medium, and low bins.

[1] In this context, the term "peer review" refers to a formal review done in accordance with Regulatory Guide 1.200, "An Approach For Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," intended to determine the technical adequacy of a PRA. When implemented in accordance with RG 1.200, this peer review process obviates the need for the NRC staff to conduct in-depth reviews of a base PRA in order to allow the staff to focus on key assumptions and areas identified by peer reviewers as being of most concern and relevant to the application under consideration. Normally, peer reviews of licensee developed PRAs are conducted by a team of utility and contractor personal who are independent of the PRA being reviewed and, collectively, are experts in all phases of PRA and experienced in performance of PRAs. In order for the SPAR model peer reviews to be conducted in the same manner as industry peer reviews, the staff used review teams composed of a combination of industry and NRC experts that were led by experienced industry peer review leaders. This approach ensured that all SPAR peer review team members met the basic qualification requirements endorsed by RG 1.200 and that the SPAR peer review approach and conduct was consistent with what is normally done for industry peer reviews.

The staff has initiated projects to address the high-priority comments, as available resources permit. Major activities undertaken to address these peer review items in FY 2013 include the following:

- Structuring the SPAR model documentation to more closely align with the structure of ASME/ANS PRA standard.

- Incorporating improved loss of offsite power modeling and support system initiating events modeling (e.g., loss of service water or component cooling water).

- Addressing the high-priority F&Os for the BWR SPAR models.

Due to sequestration, the staff reduced the pace of work on these activities during FY 2013. However, pending the availability of sufficient resources in FY 2014, the staff plans to continue to address high-priority BWR peer review items, including documentation enhancements and model updates. The staff has deferred resolution of high-priority PWR peer review comments and all low- and medium-priority comments due to funding limitations. In addition to this effort, the staff has also completed a comprehensive update to the SPAR quality assurance program in FY 2013.

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 2013, significant SAPHIRE activities included the following:

- Oversight of the SAPHIRE software quality assurance program, including performance of an annual audit of software quality assurance activities, tools, and documents in accordance with NUREG/BR-0167, “Software Quality Assurance Program and Guidelines.”

- Transitioning legacy SAPHIRE source code to a newer programming language for the purpose of improving long-term maintenance and support.

- Continued research on advanced quantification methods to improve accuracy and calculation speeds.

Enclosure 2, “Status of the Standardized Plant Analysis Risk Models,” 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 2013 and FY 2014 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 ongoing thermal-hydraulic analyses.

- The staff will continue quality assurance activities for both the agency SPAR models and the SAPHIRE code. This will ensure that agency risk tools continue to be of sufficient quality for performing SDP, ASP, and MD 8.3 event assessments in support of the staff's risk-informed regulatory activities.

- 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 feedback from user offices.

- The staff will continue development of new SPAR-AHZ models, including incorporation of modeling derived from the NFPA 805 application process. The staff will continue to work to identify approaches that can accelerate the pace of external hazard model development for operating reactors.

- The staff is reviewing precursor events from the past five years to determine if there is any trend of concern. The staff will document any conclusions or recommendations resulting from this review in the FY 2013 Industry Trends annual report. In addition, the staff will evaluate the conclusions and recommendations to determine if changes to the ROP are warranted as part of the ROP Self-Assessment Process.

SUMMARY:

Under the ASP Program, the staff 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 2013 for events evaluated to date. A statistically significant increasing trend in precursors with a CCDP or ΔCDP greater than or equal to 1×10^{-4} was observed. This was largely due to an increase of precursors in this subgroup with seven events in the past three years after no events were identified in the previous six years. Six of the seven events were caused by multiple electrical-related failures which varied from electrical equipment such as circuit breakers failing to losses of offsite power. These events were evaluated within the ROP and generic communications programs and are being reviewed by NRR to determine if there is any trend of concern that the NRC will need to address. 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.

COORDINATION:

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

/RA/ K. Steven West for

Brian W. Sheron, Director
Office of Nuclear Regulatory Research

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

- The staff will continue quality assurance activities for both the agency SPAR models and the SAPHIRE code. This will ensure that agency risk tools continue to be of sufficient quality for performing SDP, ASP, and MD 8.3 event assessments in support of the staff's risk-informed regulatory activities.

- 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 feedback from user offices.

- The staff will continue development of new SPAR-AHZ models, including incorporation of modeling derived from the NFPA 805 application process. The staff will continue to work to identify approaches that can accelerate the pace of external hazard model development for operating reactors.

- The staff is reviewing precursor events from the past five years to determine if there is any trend of concern. The staff will document any conclusions or recommendations resulting from this review in the FY 2013 Industry Trends annual report. In addition, the staff will evaluate the conclusions and recommendations to determine if changes to the ROP are warranted as part of the ROP Self-Assessment Process.

SUMMARY:

Under the ASP Program, the staff 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 2013 for events evaluated to date. A statistically significant increasing trend in precursors with a CCDP or ΔCDP greater than or equal to 1×10^{-4} was observed. This was largely due to an increase of precursors in this subgroup with seven events in the past three years after no events were identified in the previous six years. Six of the seven events were caused by multiple electrical-related failures which varied from electrical equipment such as circuit breakers failing to losses of offsite power. These events were evaluated within the ROP and generic communications programs and are being reviewed by NRR to determine if there is any trend of concern that the NRC will need to address. 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.

COORDINATION:

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

/RA/ K. Steven West for

Brian W. Sheron, Director
Office of Nuclear Regulatory Research

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

ADAMS Accession No.: ML13232A062 **WITS 199200101**

OFFICE	RES/DRA/PRB	SUNSI Review	RES/DRA/PRB	RES/DRA/PRAB	Tech Editor
NAME	K. Tetter	K. Tetter	G. DeMoss	K. Coyne	J. Dougherty
DATE	8/21/13	8/21/13	8/22/13	8/23/13	9/4/13
OFFICE	RES/DRA	NRR	NRO	OGC	RES
NAME	R. Correia	E. Leeds	G. Tracy	M. Doane	B. Sheron (K. S. West for)
DATE	9/11/13	9/17/13	9/25/13	9/26/13	10/04/13

OFFICIAL RECORD COPY