

POLICY ISSUE (Information)

September 29, 2010

SECY-10-0125

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 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 including 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 to 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 26, "Congressional Budget Justification: Fiscal Year 2011," issued February 2010). The SPAR Model Program develops and improves independent risk-analysis tools and capabilities to support the use of probabilistic risk assessment (PRA) in the agency's risk-informed regulatory activities. The staff uses SPAR models to support the Significance Determination Process (SDP), the ASP Program, the Incident Investigation

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Program event assessment process, and the Generic Issue Program resolution process and to 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-09-0143, "Status of the Accident Sequence Precursor Program and the Standardized Plant Analysis Risk Models," dated September 29, 2009.

ASP Program

The staff has completed the analyses of all precursor events that were identified in fiscal year (FY) 2009 (19 precursors). Precursors are events with a conditional core damage probability (CCDP) or increase in core damage probability (Δ CDP) that is greater than or equal to 1×10^{-6} . In addition, the staff has completed the screening of FY 2010 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 either FY 2009 or FY 2010, and the staff continues to complete the review, analysis, and documentation of all potential precursors. The last *significant* precursor identified was the Davis-Besse event in FY 2002. The ASP Program provides input to the agency's safety-performance measure of zero events per year identified as a *significant* precursor of a nuclear reactor accident.

The staff evaluated precursor data during the period of FY 2001 through FY 2009 to identify statistically significant adverse trends for the Industry Trends Program (ITP). No statistically significant trend was detected for all precursors during this 9-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 other 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). Statistically significant decreasing trends were detected for two subgroups of precursors—precursors corresponding to high safety significance (i.e., CCDP or Δ CDP greater than or equal to 1×10^{-4}) and precursors that occurred at PWRs. No trends were observed in other precursor subgroups. Enclosure 1 provides additional details on results and trends of the ASP Program.

SPAR Model Program

During FY 2010, the staff completed enhancements to Systems Analysis Program for Hands-On Integrated Reliability Evaluations (SAPHIRE) software. The SAPHIRE computer code allows users to develop PRA models and is used to analyze the SPAR models. SAPHIRE Version 8 was released in April 2010. This new version includes features and capabilities that are new or improved over Version 7 to address new requirements for risk-informed programs. User interfaces were developed for performing:

- SDP Phase 2 analyses using the SPAR models.
- Degraded condition assessments for SDP Phase 3 and ASP analyses, and Management Directive (MD) 8.3 evaluations.
- Initiating event assessments for ASP analyses and MD 8.3 evaluations.
- PRA analyses requiring more significant modeling or data revisions.

The 77 SPAR models representing the 104 operating commercial NPPs were revised and augmented to take advantage of the new features and capabilities of SAPHIRE Version 8. In addition to the above model enhancements, the staff completed an evaluation of the potential core damage risk reduction associated with the extensive damage mitigation strategies and guidance required by 10 CFR 50.54(hh) for about two-thirds of the SPAR models. The evaluations of the remaining SPAR models are scheduled to be completed by October 2010.

The staff, with the cooperation of industry experts, completed a peer review of a representative BWR SPAR model and PWR SPAR model in accordance with ASME/ANS RA-S-2002, "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 are an appropriate tool to provide an independent check on utility PRAs. The peer review teams also provided additional findings and observations to enhance the SPAR models.

The staff continued to expand the SPAR model capability beyond internal events at full-power operation. The staff previously completed a total of 15 SPAR external event (EE) models (e.g., fires, floods, and seismic events). Three SPAR models which include both internal and external hazards were used in identifying and evaluating severe accident sequences for the consequential steam generator tube rupture (SGTR) project in support of the Steam Generator Action Plan. Consequential SGTR events are potentially risk significant due to the possibility of a severe core damage event (caused by either internal or external initiating events) in leading to failure of the steam generator tubes and bypass of the containment building. The SPAR-EE models were also recently used to provide background information to the Office of Nuclear Reactor Regulation (NRR) on the impact of assessing external hazard risk in 10 CFR 50.65 maintenance risk assessments. In addition, the staff plans to incorporate internal fire scenarios from the National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light-Water Reactor Electric Generating Plants," pilot applications into two SPAR models. The Office of Nuclear Regulatory Research staff continues to work with NRR and NRO to identify future enhancements to the SPAR-EE models.

The staff has continued the development and enhancement of the shutdown template models, resulting in a total of seven shutdown SPAR models that have become available to support the Reactor Oversight Process evaluations of shutdown events and degraded conditions.

The staff also developed new SPAR models for the Advanced Boiling Water Reactor (ABWR) and the AP1000. These models will allow confirmation of PRA results presented in licensing submittals and evaluation of risk-informed applications prior to new plant operation, and

assessment of operational findings and events once operation commences. The SPAR model for the AP1000 design was completed in February 2010 and quality assurance activities are being completed for the ABWR model. Enclosure 2 provides a detailed status of SPAR models.

UPCOMING ACTIVITIES

The following upcoming activities continue to be responsive to agency programs:

- The staff will continue the screening, review, and analysis (preliminary and final) of potential precursors for FY 2010 and FY 2011 events to support the agency's safety measures.
- In accordance with existing user need requests, the staff will continue to implement enhancements to the SPAR models for full-power operations. Anticipated enhancements include incorporating new models for support-system initiators and revised success criteria based on insights from thermal-hydraulic analyses. Furthermore, the staff is working with industry representatives to resolve other PRA technical issues common to both licensee PRAs and NRC SPAR models. In support of this effort, the memorandum of understanding addendum on PRA with the Electric Power Research Institute has been extended through 2016.
- The staff will continue to evaluate the need for additional SPAR model capability (beyond full-power, internal initiators) based on experience gained from SDP, ASP, and MD 8.3 event assessments and respond to any new user need requests.
- The staff has reviewed the SPAR model peer review comments. A project plan is being developed to address peer review comments, where appropriate, and is planned to be completed in 2013. The main objective of this effort is to ensure the SPAR models continue to be of sufficient quality for performing SDP Phase 3, 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 National Fire Protection Association Standards 805 pilot application process to create two new SPAR fire models with updated fire scenarios.
- 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 new plant operation, and assessment of operational findings and events once operation commences. The next new reactor SPAR model planned to be developed is for the U.S. Advanced Pressurized-Water Reactor.

SUMMARY

The ASP Program continues to evaluate the safety significance of operating events at NPPs and to provide insights to NRC's risk-informed and performance-based regulatory programs. The staff identified no *significant* precursors in FY 2010. No statistically significant trend was detected for all precursors during the FY 2001 through FY 2009 period. The SPAR Model

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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/

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Enclosures:

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

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