

## SPAR Model Development Program

RES/DRA

RES has developed risk assessment models known as Standardized Plant Analysis Risk (SPAR) models. SPAR models are plant-specific probabilistic risk assessment (PRA) models that model accident sequence progression, plant systems and components, and plant operator actions. The standardized models represent the as-built, as-operated plant. The SPAR models permit the NRC staff to perform risk-informed regulatory activities by independently assessing the risk of events or degraded conditions at operating nuclear power plants. SPAR models for internal initiating events during full-power operation are available for all 104 operating commercial nuclear power plants in the United States. Fifteen of the 77 internal events models have been expanded to include external initiating events (fires, floods, seismic events, high winds, etc.). Five models for internal initiating events during low-power and shutdown (LP/SD) operations have been developed and are available for trial use. Four models have been extended to include containment systems and plant damage states to support large early release frequency (LERF)/Level II analysis. Three Level2/LERF containment event tree models have been developed to model the impact of phenomenological uncertainties on containment accident progression. Additional integration of external events models, low-power shutdown models and LERF/Level II models is scheduled and coordinated with NRR.

Enhancements to the internal events (Level 1), Revision 3 SPAR models continue to be implemented. This is being accomplished through two separate efforts. The first effort involves incorporating the resolution of modeling issues that have been identified from, the results of onsite quality assurance reviews of the Revision 3 SPAR models, the results of the comparison exercise conducted with the pilot plants in the Mitigating Systems Performance Index (MSPI) Development Program, and feedback from model users. The second effort involves performing a cut-set level review of Revision 3 SPAR models against the respective plant's probabilistic risk assessment (PRA), in a manner similar to the review performed during the comparison exercise conducted with the pilot plants in the MSPI Development Program. Although initial reviews have been completed, subsequent reviews are being performed to include physical changes to a plant or significant changes to a licensee's model. The SPAR models will be modified in FY 2010 to take advantage of the new features incorporated in SAPHIRE version 8.

RES has executed an addendum to the memorandum of understanding with the Electric Power Research Institute to conduct cooperative nuclear safety research for PRA. Several of the initiatives included in the addendum are intended to help resolve key technical issues that affect both the NRC SPAR models and licensee PRAs. The objective of this effort is to work with the broader PRA community to resolve PRA issues and develop PRA methods, tools, data, and technical information useful to both the NRC and industry. Cooperative research activities have commenced on two of the key technical issues, Support System Initiators and Loss of Offsite Power. The agency has established working groups that include support from NRR, the Office of New Reactors, and the regional offices.

The staff is in the process of enhancing the SPAR models and evaluating the risk benefit, if any, based on insights gained as a result of licensee response to the Section B.5.b requirements. These model improvements include plant safety enhancements resulting from Phases 1, 2 and 3 of the Section B.5.b assessments. The engineering and risk information used for these enhancements was been obtained from licensee submittals, staff safety evaluations and special inspection reports. Approximately one third of the SPAR models have been evaluated to date.

The staff has completed thermal hydraulic analysis on two plants in an effort to improve the success criteria used in the SPAR models. These studies provide a better understanding of the timing sequences associated with a given accident scenario, as well as, identify the minimum set of plant components required to mitigate the accident scenario. In FY10, the staff plans to use the results of the thermal hydraulic (TH) analysis to modify the success criteria for SPAR models that correspond to the design configuration portrayed in the TH analysis. Additional TH analysis to support the other design configurations is being pursued by staff.

SPAR models are used to:(1) evaluate the risk significance of inspection findings in SDP Phase 3 analyses; (2) evaluate risk associated with operational events and degraded conditions in the ASP Program; (3) identify modeling issues that are risk-significant, and rank and prioritize these issues as part of the PRA quality efforts (e.g., as part of RG 1.200); (4) support generic safety issue resolution (e.g., GSI-189 and GSI-191) by screening (or prioritizing), performing detailed analysis to determine if licensees should be required to make changes to their plants, assessing whether NRC should modify or eliminate an existing regulatory requirement, and doing flexible and quick analyses using minimum resources to perform generic studies; (5) perform analyses in support of the staff's risk-informed review of license amendments (e.g., tech spec changes, Notice of Enforcement Discretion (NOED), fire protection requirements); and (6) independently verify the Mitigating Systems Performance Index (MSPI).

The Sandia PRA study to support the Consequential Steam Generator Tube Rupture (SGTR) Risk Assessment Task (Task 3.5 of Steam Generator Action Plan (SGAP)) resulted in a report delivered to RES in the first half of 2008. Using this report, SPAR internal and external event models, and other reports related to this subject, a RES report has been prepared and sent to NRR for comments. The objective is to bring closure to Task 3.5 of the SGAP, and seek an ACRS presentation in the near future as a part of this objective.

The Risk Assessment of Operating Events Handbook, commonly referred to as the RASP Handbook (Risk Assessment Standardization Project), has been revised and updated. The RASP Handbook provides for standard methods and guidelines for evaluating operational events and degraded conditions using the SPAR models. The Handbook also provides guidance on consensus review for major decisions and high-risk events. The review verifies that both the licensee and the NRC are using state-of-the-art approaches and complete plant information, demonstrating that risk-informed regulatory decisions are based on the as-built and as-operated plant. RASP Handbook - Vol. 1, Part 1, Internal Events Analysis, Vol. 2, External Events Analysis, Vol. 3, SPAR Model Reviews (checklists) are completed and publicly available. RASP Tool Box Web Page is operational. This provides Web links to tools and access to references for SRAs and analysts. RASP Program roles and responsibilities have been established. NRR/DRA/APOB is the owner (technical interpretation & reviews), while RES/DRA/OEGIB supports NRR via handbook maintenance.

### New Reactor SPAR Models

The staff has begun the development of new reactor SPAR models in response to a recent user need from the Office of New Reactors (NRO). This project is in support of NRO User Need "Development of Standardized Plant Analysis Risk Models for New Reactors", dated March 25, 2008. Prior to new plant operation, the NRC staff may need to perform risk assessments to confirm PRA results provided in combined operating license (COL) submittals or to evaluate risk-informed applications after COL issuance.

The Project consists of developing a single SPAR model for the AP1000 design new reactors; i.e., a proof-of-concept, to show that the state-of-the art of SPAR model development is

sufficient to develop a SPAR model for the new reactor designs. This is important since some of the new reactor designs rely on passive systems and components to mitigate accident scenarios. Although vendors have provided a detailed document describing the PRA of their specific design, certain challenges have been recognized concerning the conversion of this information into a standardized PRA model that satisfies the requirements of the User Need. These include a new understanding of success criteria, a more detailed understanding of the thermal/hydraulic analysis, development of new basic event data (e.g., passive system and component failure data, human reliability data, common cause data, etc.) and a systematic expansion of the current standardization approach used in the SPAR models. Since design standardization is a key aspect of the new plants, it will only be necessary to develop one SPAR model for each of the new designs.

The methodology, quality, and philosophy used to develop the current set of SPAR models for the 104 operating commercial nuclear power plants, shall be used to develop the SPAR models for the new reactor designs to the extent practicable.

Since some of the new reactor designs rely on passive systems and components to mitigate accident scenarios, the first model was a proof-of-concept to ensure that the necessary resources are in fact available and the state-of-the art of the SPAR models is sufficient to complete the models. The initial development of the AP1000 design internal events SPAR model is complete. The model is planned to be transitioned to SAPHIRE version 8 in FY 2010, along with the other SPAR models. With the successful development of the AP1000 design SPAR model, NRO has requested RES to develop an Advanced Boiling Water Reactor (ABWR) SPAR Model. The ABWR SPAR model is planned to be completed in FY11.

#### **Project accomplishments over the past 6 months**

- Cut-set levels reviews completed on ALL SPAR models
- Initiated revised Level 2/LERF model development
- Cooperative research activities continue under the RES/EPRI MOU Addendum to address resolution of key technical issues with industry
- Initial evaluation of strategies to mitigate severe accidents completed for first third of licensees
- Peer review of SPAR models in accordance with the ASME Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications is planned in August and October of 2009. Industry and Senior Reactor Analyst from the regions have agreed to participate.
- Thermal Hydraulic studies have been completed by the staff to improve the success criteria of the SPAR models.

<b>Noteworthy Completed &amp; Planned Activities</b>	
<b>SPAR Milestones</b>	<b>Target Completion Date</b>
Resolve key technical issues (FY08 & FY11) Complete Industry/NRC Guidance Document on Support System Initiators Draft report issued January 2009	FY 2011
Resolve key technical issues (FY09 & FY10) Complete Industry/NRC Guidance Document on Loss of Off-Site Power	12/2009
Extend Level 1 SPAR Models to incorporate containment systems for selected plant classes (3 models)	01/2009
Complete independent Peer Review of one PWR SPAR Model and one BWR SPAR model	10/2009
Complete SPAR Level 2/LERF CET models for selected plant classes for trial use	Complete
Complete one new next generation SD model	10/2009
AP-1000 SPAR Model	Complete
ABWR SPAR Model	FY11