UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 12, 2002

MEMORANDUM TO: Chairman Meserve
Commissioner Dicus
Commissioner Diaz
Commissioner McGaffigan

FROM: William D. Travers
Executive Director for Operations

SUBJECT: RESPONSE TO STAFF REQUIREMENTS MEMORANDUM SRM-M020319, DATED APRIL 1, 2002, BRIEFING ON OFFICE OF NUCLEAR REGULATORY RESEARCH (RES) PROGRAMS, PERFORMANCE, AND PLANS

This memorandum responds to SRM-M020319, in which the Commission requested that:

> The staff should clearly identify and communicate the differences and applicability of the various systems used to assess the risk significance of issues and events. This should include the Significance Determination Process (SDP), the Accident Sequence Precursor (ASP) Program, and the International Nuclear Event Scale (INES) Program.

Introduction

Programs in the Agency were reviewed to identify systems that are involved with the assessment of events and degraded conditions at nuclear power plants. The event response evaluation used in the NRC Incident Investigation Program was added to the above list of systems. The purposes of the four systems that are used to assess the risk significance of issues and events are summarized below.

- ***Accident Sequence Precursor Program.*** The main purpose of the ASP Program is to review and evaluate operational experience to identify precursors to potential severe core damage sequences. The ASP Program provides a comprehensive risk analysis of initiating events (e.g., reactor trip initiator) and degraded conditions (e.g., equipment or functional degradations) at nuclear power plants.

CONTACT: Don Marksberry, RES
301-415-6378

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- ***Significance Determination Process.*** The main purpose of the SDP is to determine the safety significance of inspection findings. The SDP is part of the Reactor Oversight Process and evaluates inspection findings in all seven cornerstones of safe operation—initiating events, mitigating systems, barrier integrity, emergency preparedness, public radiation safety, worker radiation safety, physical protection. The SDP uses a three-phased approach to determine the significance of inspection findings in the initiating events, mitigating systems, and barrier integrity cornerstones.

- ***International Nuclear Event Scale Program.*** The main purpose of the INES Program is to facilitate global communications and understanding between the nuclear community, the media, and the public on the safety significance of events involving nuclear material. The INES Program determines the international classification rating of events reported to the NRC Operations Center. The INES reports are provided to the International Atomic Energy Agency (IAEA) for distribution to the international community. The INES Program provides a prompt classification of any event involving reactor and fuel cycle facilities and NRC or Agreement State licensed materials. The INES process uses a simple defense-in-depth approach to the classification of events and degraded conditions at nuclear power plants.

- ***NRC Incident Investigation Program—Event Response Evaluation.*** The main purpose of the event response evaluation element of the NRC Incident Investigation Program is to determine the appropriate level of reactive inspection in response to a significant event. The event response evaluation process is part of the Reactor Oversight Process and provides a prompt evaluation of significant operational events (as defined in Management Directive 8.3, "NRC Incident Investigation Program") involving reactor and fuel cycle facilities and NRC or Agreement State licensed materials.

Summary of Similarities and Differences

The discussion below presents differences among the various systems and is focused on the part of the systems used to evaluate actual events and degraded conditions at nuclear power plants. These events and conditions correspond to three of the seven cornerstones of safe operation: initiating events, mitigating systems, and barrier integrity. Differences and similarities among the four systems are summarized in the table in the attachment.

- **INES Versus the Other Systems**

  The INES process is the least complex of the four systems. The process model is a defense-in-depth classification scheme based on the degree of degradation of safety functions, barrier integrity, and reactor fuel. Although degradation of defense-in-depth can be related to risk (the loss of redundancy or a barrier increases the risk of core damage), the INES flowchart model was not developed using risk insights.

- **Similarities Between ASP, SDP, and Event Response Processes**

  The risk models and technical methods used in ASP, SDP Phase 3, and event response assessments are generally similar. The Standardized Plant Analysis Risk (SPAR) models are typically used in all three processes, although the licensee's probabilistic risk assessment (PRA) can be used in SDP and event response assessments. Most of the methods applied in SDP Phase 3 and event response assessments are derived from the ASP Program; however, other methods, such as use of the licensee's generated PRA results and simplified hand calculations, are permitted by the procedures.

The SDP Phase 1 is a screening procedure that identifies the inspection findings to be evaluated under SDP Phase 2 or 3. The ASP and event response processes also employ screening procedures. Risk significance estimation under the SDP Phase 2 process is quite different from ASP, SDP Phase 3, and event response processes. The SDP Phase 2 process will be discussed at the end of this report.

- **Differences Between ASP, SDP Phase 3, and Event Response Processes**

Some differences are inherent in the intended function of the system. For example, the timeliness in which results are needed has a significant impact on the level of detail that goes into an analysis and the amount of event-related information available at the time the results are needed by decision makers. More available time can reduce the uncertainties in the results. Another example is the scope of the events analyzed. Not all systems evaluate all events and degraded conditions.

Some differences are highlighted below.

– ***Applicability.*** Inspection findings with a greater-than-green risk significance are most likely precursors in the ASP Program. However, not all precursors result in an inspection finding. These precursors include initiating events (actual reactor trips) or degraded conditions where no deficiency in the licensee's performance was identified. For example, an extended loss of offsite power event caused by an act of nature will be a precursor, most likely in the 10^{-4} conditional core damage probability (CCDP) range. The SDP would screen out this event if no performance deficiency was found.

  Significant events and degraded conditions that result in a reactive inspection (i.e., special inspection, augmented inspection, incident investigation) based on an event response evaluation would be analyzed in the ASP program. In the loss of offsite power example above, an augmented inspection or incident investigation would be considered based on a CCDP in the 10^{-4} range.

– ***Analyses.*** Event response assessment is expected to be performed within a day or two after the event notification. Lack of detailed information regarding the event or degraded conditions at the time of the assessment sometimes requires use of engineering judgment or simplistic assumptions. In such a case, the point estimate of the risk assessment carries a large uncertainty. However, for determining what reactive inspection may be most appropriate, based on a risk-informed as opposed to risk-based process, the emphasis is not on the specific value but on the range of the safety significance.

  The Agency's goal for SDP/enforcement timeliness is that all (i.e., 100 percent) significance determinations be completed within 120 days of the first exit meeting and within 90 days of the first official inspection report issue date. Although the SDP analysis has the benefit of information obtained from the inspection, a detailed engineering evaluation of complex degraded conditions may not be available at the time of the preliminary significance determination.

The ASP Program has time to complete an analysis of a complex issue that produces a more refined estimate of risk. Analyses schedules provide time so that NRC or licensee engineering evaluations can be made available for review. State-of-the-art methods can be developed for unique conditions or current ones refined. In addition, the SPAR model can be modified for special considerations (e.g., seismic, internal fires, flooding).

– ***Technical Reviews.*** The ASP Program employs a rigorous review process. All preliminary analyses are independently reviewed by a second PRA analyst. The typical two-day review is performed using a checklist. The analysis is then sent for peer review by the licensee and NRC technical staff (NRR, RES, Region). Changes in the analysis based on peer comments are reviewed by the second in-house PRA analyst. Technical audits by branch management are performed for preliminary and final analyses prior to issuance. Technical differences are discussed with the reviewer. The response to comments and differences are documented in the final ASP analysis report.

  The SDP analyses are reviewed by another senior reactor analyst (SRA). In addition, the SRA may solicit peer support for SDP analyses and, depending on the need, support from PRA analysts from NRR and the ASP Program (RES). All greater-than-green findings are reviewed by NRR and Region management during the *SDP and Enforcement Review Panel* (SERP). Prior to SERP, the SERP package with the SDP analysis is reviewed by a PRA analyst from NRR. The SERP provides final disposition of technical differences between staff. The SERP may determine that further information and/or analysis, or re-SERP is needed prior to officially issuing a significance determination. The preliminary significance determination of the finding is sent to the licensee for formal comment. Significant changes to the SDP analysis based on licensee's comments are reviewed by a PRA analyst and/or an SRA. The SERP reviews changes to the preliminary significance determination or substantial changes to its bases prior to issuance of the final significance determination.

  The results of an event response assessment that may warrant at least consideration of an Augmented Inspection Team response is reviewed by SRA(s) and PRA analyst(s) from NRR and RES. Optimally, NRR, RES, and the Region will reach consensus on the risk significance of an event. However, NRR staff makes the final recommendation to NRR management as to the appropriate agency response. This process is prescribed in NRR Office Instruction LIC-405, "Risk-Informed Event Response."

- **Differences Between SDP Phase 2 Notebooks and SPAR Models**

The SDP Phase 2 process uses site-specific, risk-informed inspection notebooks to assess the risk significance (i.e., color) of inspection findings. The ASP, SDP Phase 3, and event response evaluation processes primarily use SPAR models in the analysis of events and degraded conditions.

- ***SDP Phase 2 Notebooks.*** An SDP Phase 2 notebook contains a set of worksheets that process inputs from the inspection findings (e.g., degraded system, exposure time) to generate an overall color corresponding to the risk significance of a finding. The initial worksheets of major accident sequences leading to core damage were based on the licensee's updated PRA (or the individual plant examination if a PRA was not available). Additional accident initiators are included in the Revision 1 notebooks to ensure consistency across similar plant designs.

  The SDP notebook uses probability bins or "credits" to characterize the failure probabilities of mitigating systems and human actions that are used to determine the risk significance of core damage sequences. These credits (e.g., remaining mitigation capability credits, operator action credits, operator recovery credits) are typically generic among a class of plants. Notebook usage rules must be used in conjunction with the worksheets to arrive at the risk significance of an inspection finding. Generic usage rules are used to adjust worksheet parameters (e.g., initiating event likelihood factor, remaining mitigation capability credit) based on the nature of the inspection finding.

  The notebooks are designed with a higher tolerance for overestimating the risk significance of inspection findings than for underestimating the risk significance. The Revision 1 notebooks are in the process of being benchmarked against the licensees' PRA models.

- ***SPAR models.*** The Revision 3 SPAR models are a standardized, plant-specific set of PRA-based risk models that use the event tree/fault tree linking methodology. They use an NRC-developed standard set of event trees and NRC-developed standardized input data for initiating event frequencies, equipment performance and human performance. These input data can be modified to be more plant- and event-specific where needed. Although the set of initiating events (event trees) modeled in the SPAR models has been developed independently from the SDP notebooks, the scope is essentially the same as those modeled in the notebooks. The system fault trees contained in the SPAR models are not as detailed as those contained in licensees' PRA models. However, benchmarking performed with the SPAR models during the onsite quality assurance review of these models indicates that this difference is not very significant from a risk standpoint.

  Revision 3 of the SPAR models includes uncertainty analysis capability through the propagation of uncertainties at the equipment and human performance levels. Currently, sensitivity analyses are used in the ASP Program to assess the impact of uncertainties in key elements of the model and assumptions that could influence the characterization of an event as a precursor (CCDP or ΔCDP $\geq 1.0 \times 10^{-6}$), important precursor (CCDP or ΔCDP $\geq 1.0 \times 10^{-4}$), or significant precursor (CCDP or ΔCDP $\geq 1.0 \times 10^{-3}$).

  The SPAR models use results from RES-sponsored studies to provide an independent check of input parameters used in a licensee's PRA. These studies include system and component reliability studies, initiating event studies, and a human reliability analysis method.

- **Narrowing differences between ASP and SDP**

  The information presented in this memorandum provides a comprehensive review of differences and applicability of the various systems used to assess the risk significance of issues and events. Some differences are inherent in the intended function of the system; while other differences are the result of differing approaches used in the analyses and technical reviews. NRR and RES have plans to improve consistency between ASP and SDP approaches, where possible. This effort is part of NRR's SDP improvement initiative.

Contacts

The technical contact for each of the programs discussed above is included at the bottom of the table in the attachment.

Attachment: Comparison Summary of Four Systems Used To Assess the Risk Significance of Issues and Events

cc: SECY
OCA
OGC
OPA
CFO

MEMORANDUM DATED: 07/12/02

SUBJECT: RESPONSE TO STAFF REQUIREMENTS MEMORANDUM SRM-M020319, DATED APRIL 1, 2002, BRIEFING ON OFFICE OF NUCLEAR REGULATORY RESEARCH (RES) PROGRAMS, PERFORMANCE, AND PLANS

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Comparison Summary of Four Systems Used to Assess the Risk Significance of Issues and Events.

	ASP	SDP	INES	Event Response
Purpose	Identify significant precursors, adverse trends, and insights	Determine the safety significance of inspection findings	Determine the INES classification rating to facilitate global communications	Determine the appropriate level of reactive inspection
Applicability (Power reactors)	• Actual initiating events • Degraded conditions • Events and conditions independent of cause • Concurrent multiple degraded conditions (analyzed together) • At power and shutdown events and degraded conditions	• Degraded conditions • At power and shutdown degraded conditions • **Note:** Concurrent multiple conditions without common-cause implications are analyzed individually ***Exclude*:** • Conditions with no licensee performance issues • Actual initiating events occurring at-power or shutdown • Willful violations	• Actual initiating events • Degraded conditions • At power and shutdown events and degraded conditions ***Exclude*:** • Certain degraded conditions affecting redundant trains • Concurrent multiple degraded conditions	• Actual initiating events • Degraded conditions • At power and shutdown events and degraded conditions
Timeliness	About 6 to 12 months to issue final analysis	Issue final significance determination within 120 days of the first exit meeting and within 90 days of the first official inspection report issue date	Within days to issue report to IAEA	Within days to decide appropriate reactive inspection
Character-ization of results	CCDP for actual initiating events and ΔCDP for degraded conditions	• SDP outcome color scheme (Green, Yellow, White, or Red) that correlates to change in core damage frequency (ΔCDF) • Phase 2 results in color • Phase 3 results in ΔCDF and color	• INES 7-level scale • No correlation to CCDP/ΔCDP except Levels 4-7 = core damage • **Note:** Events rated at level 2 and above are reported to IAEA	• CCDP or conditional large early release frequency for actual initiating events • ΔCDP or ΔLERF for degraded conditions • Emphasis on a range of safety significance not on a specific value

	ASP	SDP	INES	Event Response
Event-related information used in assessments	• LERs, Part 21 notifications • NRC inspection reports • Root cause analyses • Assessments from NRC experts • Discussions with licensee • NRC expert elicitation	• Information collected during the inspection • Some post inspection discussions with licensee • Detailed information from root cause analysis may not be available	• Initial assessment limited information available 1-2 days after notification • Re-assessment permitted as a result of additional information	Limited information available 1-2 days after notification
Models used	• Plant-specific SPAR models for internal events • SPAR model modified for unique condition-specific considerations (e.g., fires, flooding, external events, shutdown)	• Phase 2—plant-specific notebooks • Notebooks designed for higher tolerance for overestimating risk • Phase 3—SPAR, licensee's PRA, modified notebook	Simplified flowcharts and matrix tables based on the defense-in-depth approach	• Plant-specific SPAR models • Licensee's PRA results • Hand calculations
Procedures and methods used	• ASP analysis conducted in accordance with procedures • Methods from 900+ ASP analyses • New methods developed for unique conditions • ASP human reliability analysis method	• Proceduralized methods for Phases 1 and 2 • Phase 3 guidance to be developed in near future • However, ASP methods normally applied • ASP or licensee's HRA method	• Instructions provided in Management Directive 5.12, "International Nuclear Event Scale Participation" (INES User's Manual included in MD 5.12) • Specific implementation guidance to be developed by NRR	• Conventional risk assessment methods, including ASP analysis methods, applied • Specific analysis guidance not documented
Handling of uncertainties	• Rev. 3 SPAR models include uncertainty analysis capability through the propagation of uncertainties at the equipment and human performance levels • Sensitivity analyses used to assess the impact of uncertainties in modeling and assumptions that could influence the result	• Phase 2—Notebooks designed for higher tolerance for overestimating risk • Phase 3—Rev. 3 SPAR models, if used; otherwise, sensitivity analyses used to assess the impact of uncertainties in modeling and assumptions that could influence the result	None	Implicit handling of uncertainities through a risk-informed process—emphasis on a range of safety significance not on a specific value

	ASP	SDP	INES	Event Response
Assessments performed by	• Team of PRA analysts (RES and contractor) • Assistance from NRR and regional SRA	• Phases 1 and 2 analyses by inspectors • Phase 3 analysis by SRA • Complex analysis by PRA analyst • Assistance from PRA analysts from ASP Program (RES)	Engineer with events assessment experience (NRR)	• Regional SRA • PRA analyst (NRR) • Assistance from PRA analysts from ASP Program (RES)
Technical reviews	• Independent technical reviews conducted by procedure • Detailed review by second PRA analyst • Peer reviews by licensee and cognizant NRC technical staff • Resolution of comments and differences documented in final ASP analysis report	• Phase 2 results reviewed by SRA • Phase 3 results reviewed by another SRA and may be reviewed by PRA analysts from NRR and ASP Program (RES) • All greater-than-green findings are reviewed by PRA analysts from NRR and SERP • SERP provides final deposition of technical differences between staff • Specific technical review guidance not documented	Specific technical review guidance not documented	• Consensus between PRA analyst(s) and SRA(s) • High-level review guidance documented
Program reference	"Precursors to Potential Severe Core Damage Accidents: FY 1999 - A Status Report" (ML021680163)	Inspection Manual Chapter 0609, "Significance Determination Process"	Management Directive (MD) 5.12, "International Nuclear Event Scale Participation"	• MD 8.3, "NRC Incident Investigation Program" • NRR Office Instruction LIC-405, "Risk-Informed Event Response" (ML011620541)
Program contacts	• ASP Program: **Don Marksberry**, OERAB/RES 301-415-6378 • SPAR Model Development: **Patrick O'Reilly**, OERAB/RES 301-415-6378	• SDP Program: **Douglas Coe**, IIPB/NRR 301-415-2040 • SDP Phase 2 Notebook Development: **Peter Wilson**, SPSB/NRR 301-415-1114	**Robert Stransky**, IRD/NSIR 301-415-6411	**Ian Jung**, RORP/NRR 301-415-1837