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SUBJECT: PLANS FOR INCREASING STAFF CAPABILITIES TO USE RISK INFORMATION IN DECISION-MAKING ACTIVITIES

PURPOSE:

This paper provides the U.S. Nuclear Regulatory Commission (NRC) staff's plans for increasing capabilities to use risk information in decision-making activities, in response to recent Commission direction. It also describes challenges towards further progress in risk-informed decision-making (RIDM) and measures that the staff is taking to overcome these challenges. This paper focuses on RIDM for the reactor program (i.e., operating and new reactors). This paper does not address any new commitments or resource implications.

SUMMARY:

The NRC has a regulatory framework that largely relies on specific design-basis accidents (DBAs) without explicit consideration of DBA likelihood. Although this framework has ensured protection of public health and safety for more than four decades, the NRC has recognized that additional safety enhancements may be realized and that operational flexibility may be gained when likelihood, or probability, is considered in conjunction with postulated accident scenarios and their consequences. Commission policy describes the NRC's commitment to increasing the use of probabilistic risk assessment (PRA) technology to the extent supported by the state of the art in PRA methods and data and in a manner that complements the NRC's deterministic

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approach and supports its traditional defense-in-depth philosophy.[1] The probabilistic approach extends and enhances the traditional, deterministic approach by considering risk in a more coherent and complete manner.

In this paper, consistent with Commission direction,[2] the staff affirms its commitment to increasing the use of RIDM by identifying current challenges and strategies needed to overcome those challenges. Although this paper includes high-level agencywide challenges and strategies, the emphasis on reactor licensing topics reflects current stakeholder and NRC priorities.

Challenges towards further progress in RIDM are identified in the paper as follows.

1) Staff members have varying degrees of awareness, knowledge, and support for RIDM processes and applications.

2) The staff has not fully integrated reviews to include complementary insights from traditional engineering and risk assessment approaches.

3) Guidance for reviewing formal risk-informed applications is well developed; however, guidance for using risk insights in reviews of applications that are not designated as "risk-informed" needs further development.

4) Not all licensees have PRAs with sufficient maturity (in terms of scope, level of detail, technical elements, and plant representation) to support more complex risk-informed initiatives; this variability limits generic applicability of initiatives.

5) Unrealistic PRA modeling assumptions can mask or change high-risk contributors leading to over or underestimates of total risk thereby potentially affecting operational flexibility.

6) Aggregated quantitative risk values can approach risk acceptance guidelines potentially limiting licensees' ability to implement certain initiatives.

The set of strategies described in this paper represent a multifaceted approach to overcoming challenges. Strategy I evaluates and updates RIDM guidance to foster a collaborative review process and a broadened understanding of risk and risk insights. Strategy II develops a graded approach for using risk information in licensing reviews. Strategy III enhances mandatory training requirements related to RIDM for managers and staff. Strategy IV advances NRC and industry risk-informed initiatives. Strategy V enhances communication on risk informed activities. Although successful execution of these strategies will benefit both current and future licensees, next generation advanced non-light water reactor (non-LWR) developers are increasingly using PRA throughout the design process. The staff believes that measures to

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1 Volume 60 of the *Federal Register*, page 42622 (60 FR 42622; August 16, 1995), "Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities; Final Policy Statement" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML021980535).

2 SRM-M170511, "Staff Requirements – Briefing on Risk-Informed Regulation, 9:00 A.M., Thursday, May 11, 2017, Commissioners' Conference Room, One White Flint North, Rockville, Maryland (Open to Public Attendance," dated June 26, 2017 (ADAMS Accession No. ML17177A397).

adopt a more risk-informed performance-based regulatory framework would provide the greatest benefits to licensees of these advanced non-LWR technologies.[3]

To implement overarching strategies at a tactical level, the staff is developing a detailed action plan for the reactor program. The plan is intended to enhance the integration of risk information into regulatory decision-making practices and processes to improve the technical basis for regulatory activities, increase efficiency, and improve effectiveness and consistency with established processes. Some actions are already underway, as described in this paper; additional information will be provided in the periodic updates that were directed by the Commission in SRM-M170511.

DISCUSSION:

Challenges towards Further Progress in Risk-Informed Decision-Making

Challenges associated with progressing RIDM evolve as PRA tools and techniques improve, policy and guidance documents are developed, and regulatory experience with executing risk-informed initiatives is gained. Moreover, though high-level challenges encompassing multiple areas within the NRC regulatory purview are described below, additional challenges specific to a regulatory application may materialize. The following six items represent the current status of perceived high-level challenges towards further progress in RIDM.

(1) Staff members have varying degrees of awareness, knowledge, and support for RIDM processes and applications.

In general, staff—including managers—who have worked on risk-informed initiatives (e.g., as a technical reviewer from an engineering organization) or have taken training on PRA and risk-informed activities have the highest level of awareness and acceptance of RIDM processes and applications. Some staff are not as familiar or experienced with the used of RIDM and the benefits it can bring to the overall regulatory approach. Challenges 2 and 3 relate to this challenge, but addressing this overarching change-management challenge and culture change is essential to making progress on RIDM.

The NRC provides formal training on both the regulatory aspects of RIDM and on specific quantitative risk techniques and applications. This training is required as part of several formal staff qualification programs, as described in Enclosure 1. Only certain staff—such as new technical reviewers or developing PRA practitioners—are required to take these courses, and no managers are currently required to take them. In addition, much of the training focuses on the technical aspects of PRA as opposed to how qualitative or quantitative risk information can be used to inform regulatory decisions and processes. Without training and experience on applying RIDM, the staff will find it more difficult to apply RIDM concepts in a consistent and efficient manner.

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[3] SECY-15-0168, "Recommendations on Issues Related to Implementation of Risk Management Regulatory Framework," dated December 18, 2015 (ADAMS Accession No. ML15302A135 (package)).

(2) The staff has not fully integrated reviews to include complementary insights from traditional engineering and risk assessment approaches.

The staff has many years of experience understanding safety in terms of the existing largely deterministic regulatory framework. Although both risk considerations and engineering judgment are intrinsic to the deterministic framework, the level of staff knowledge and familiarity with risk assessment methodologies inhibits the widescale adoption of risk-informed approaches. In addition, inconsistency in appreciation of the complementary relationship between traditional engineering and risk assessment, as well as how safety enhancements may be realized when risk information is considered, further impedes progress.

Review of license applications that have relied upon the concept of design-basis events and DBAs and adherence to deterministic design criteria have provided an adequate licensing approach. This approach considered risk implicitly in determining and protecting against credible events, but did not include a quantitative approach to identify key accident sequences. The probabilistic approach enables these risk insights to be considered in a more coherent and complete manner. Moreover, the set of design-basis events and DBAs has not been updated to reflect insights from power reactor operating history or the more quantitative risk tools that are currently available (i.e., PRAs). A risk-informed regulatory approach, in which greater focus and protective measures are applied to structures, systems, and components (SSCs) according to risk significance, is fundamentally different from the traditional approach in which all SSCs credited for mitigating and preventing DBAs are of equal importance.

As a practical matter, the regulatory framework has matured and evolved to create an environment more open to considering risk in decision making. As a result, the staff has received requests from licensees to relax, what they consider to be, overly conservative, deterministic requirements. Additional efforts are needed to develop a shared understanding that such relaxations, when viewed in terms of risk significance, can enable NRC and industry to focus on areas of higher risk significance, and potentially realize improvements in both safety and efficiency.

(3) Guidance for reviewing formal risk-informed applications is well developed; however, guidance for using risk insights in reviews of applications that are not designated as "risk-informed" needs further development.

The staff seeks to develop high-quality licensing review products that clearly document the regulatory and technical bases for the conclusions reached. Accordingly, the staff relies on well documented processes and procedures and examines precedents to ensure that the NRC's principles of good regulation are met. The staff effectively uses largely deterministic-based guidance documents to perform licensing reviews. For submittals that formally request risk-informed changes to a plant licensing basis, the staff

uses well-defined and -tested guidance documents (i.e., changes submitted according to Regulatory Guide (RG) 1.174[4] and RG 1.200[5]).

However, the lack of guidance for considering risk information in reviews historically evaluated using existing deterministic prescriptive methods and procedures inhibits the staff's use of risk information.[6] Commission policy and regulations generally do not preclude the use of such risk information; however, the staff typically has not considered this information in the absence of well-documented and -vetted processes and procedures. Moreover, many existing licensing guidance documents do not include explicit discussions on opportunities to consider risk information or on how risk information may impact regulatory conclusions. This has led to inconsistent approaches to handling this information.

This challenge is highlighted by recent license amendment requests (LARs) to extend emergency diesel generator (EDG) technical specification completion times.[7] In one such LAR requesting a one-time extension from 10 days to 21 days to conduct repairs, perform a root cause investigation, and evaluate the extent of condition, the licensee included quantitative risk information even though it had not submitted the LAR as a formal risk-informed change. The staff systematically considered both the deterministic and risk analyses (e.g., risk reductions provided by compensatory measures and incremental conditional core damage probability and incremental large early release probability for the plant specific configuration) in its review and documented a full description of the regulatory and technical bases for its conclusions in the safety evaluation. Furthermore, the additional risk information allowed the NRC staff to accelerate its risk informed review of an anticipated second formal risk-informed LAR.

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4 RG 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," Revision 2, dated May 2011 (ADAMS Accession No. ML100910006).

5 RG 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," Revision 2, dated March 2009 (ADAMS Accession No. ML090410014).

6 As described later, the staff has updated NUREG-0800 (Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants) to provide guidance regarding the use of risk insights for focusing the scope of staff reviews of LWR reactors. However, additional guidance is needed to clarify how to perform the risk-informed aspects described in NUREG-0800. Guidance is also available regarding special circumstances that necessitate the consideration of risk information in traditionally deterministic licensing submittals (Section 19.2, Appendix D, "Use of Risk Information in Review of Non-Risk-Informed License Amendment Requests," dated June 2007 (ADAMS Accession No. ML071700658)).

7 (1) "Palo Verde Nuclear Generating Station, Unit 3—Issuance of Amendments Re: Revision to Technical Specification 3.8.1, "AC [Alternating Current] Sources—Operating (Emergency Circumstances) (CAC No. MF8961)," dated December 23, 2016 (ADAMS Accession No. ML16358A676), (2) "Palo Verde Nuclear Generating Station, Unit 3—Issuance of Amendments Re: Revision to Technical Specification 3.8.1, "AC [Alternating Current] Sources—Operating (Emergency Circumstances) (CAC No. MF9019)," dated January 4, 2017 (ADAMS Accession No. ML17004A020), and (3) "Donald C. Cook Nuclear Plant Unit 1, Emergency License Amendment Request to Extend the Allowed Outage Time for an Emergency Diesel Generator," dated May 28, 2015 (ADAMS Accession No. ML15149A412).

Concerns were raised by internal and external stakeholders about the bases for the conclusions reached, and the staff carefully considered and addressed the concerns.[8,9] These multiple perspectives highlight the importance of clear and specific guidance for using risk insights and for documenting staff rationale in historically deterministic reviews. Additional information on this example LAR is provided in Enclosure 2.

(4) Not all licensees have PRAs with sufficient maturity (in terms of scope, level of detail, technical elements, and plant representation) to support more complex risk-informed initiatives; this variability limits generic applicability of initiatives.

The acceptability of a licensee's PRA for a risk-informed application is determined by PRA scope, level of detail, technical elements, and plant representation. The PRA is the main quantitative tool used to examine risk; however, development and use of a PRA is voluntary for operating reactors, and this has contributed to variability in the acceptability of licensee PRAs. RG 1.200 describes one approach for determining whether a PRA is sufficient to provide confidence in the results so that it can be used in regulatory decision-making. Specifically, RG 1.200 addresses baseline PRA acceptability for regulatory applications, which allows for application of a graded approach in which PRA acceptability is commensurate with the extent of the changes requested (e.g., increased operational flexibility requires a higher level of detail and plant representation). Therefore, it is difficult to develop generic regulatory approaches that would use a licensee's PRA as input to RIDM. Specifically, PRA variability means that not all licensees can implement all risk-informed initiatives.

This challenge is mitigated for new reactor licensees with design certifications and combined licenses under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," because the NRC established requirements for design-certification and plant-specific PRA information (10 CFR 52.47, "Contents of applications; Technical information," and 10 CFR 52.79, "Contents of applications; Technical information in final safety analysis report," respectively) and for the development, maintenance, and periodic upgrade of plant-specific PRAs (10 CFR 50.71(h)). This latter requirement for combined license holders includes provisions for the PRA to be developed in accordance with NRC-endorsed consensus standards such as those addressed by RG 1.200. In the design certification process, plant designers and NRC reviewers are still challenged because risk-significant aspects evolve with design changes; therefore, it is not always clear what level of scope, detail, and plant representation is sufficient to reasonably estimate risks. Moreover, although RG 1.200 applies to new LWRs, consensus PRA standards for advanced non-LWRs are still under development.

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8 "DPO Case File for DPO-2017-001 and DPO-2017-002 (Public)," dated July 21, 2017 (ADAMS Accession No. ML17202G468).

9 LTR-17-0257, David Lochbaum, Director, Nuclear Safety Project, Union of Concerned Scientists, Letter Re: Two Decisions Issued by the NRC Staff in January Regarding the Licensing Basis for Loss-of-Coolant Accident and a Concurrent Loss-of-Offsite Power (ADAMS Package Accession No. ML17181A349 (package)).

(5) Unrealistic PRA modeling assumptions can mask or change high-risk contributors leading to over or underestimates of total risk thereby potentially affecting operational flexibility.

PRAs are intended to be realistic to maximize the insights gained. Because of modeling capability limitations, data limitations, and practical constraints, however, PRAs can have conservatisms or nonconservatisms such that "actual risk" can be either lower or higher than the calculated value. For example, in fire PRA, some licensees have opted to use conservative inputs in lieu of performing costly activities such as detailed cable tracing. As a consequence, excessive conservatism may mask potential high-risk contributors and may result in regulatory controls that exceed what may otherwise be necessary for reasonable assurance of adequate protection. In addition, in the NRC's regulatory process, adoption of demonstrably conservative approaches may facilitate and streamline licensing reviews and oversight, yet come at a cost of less regulatory flexibility and increased operational costs without an actual improvement in the level of safety or security.

At the same time, the staff recognizes that current PRAs may have modeling limitations (e.g., errors of commission are not explicitly modeled) or include nonconservative approaches that are addressed elsewhere though the integrated risk-informed framework. In these cases, even though the PRA analyses may be acceptable under endorsed standards and reflect current state-of-the-practice, the "actual risk" may be higher than the quantified PRA value.

Differences in PRA realism across the industry complicate the staff's ability to understand and appropriately review risk-informed applications and their risk impact.

(6) Aggregated quantitative risk values can approach risk acceptance guidelines potentially limiting licensees' ability to implement certain initiatives.

The Commission's Safety Goal Policy Statement[10] established quantitative health objectives from which the risk acceptance guidelines reported in RG 1.174 are derived. The industry has stated that aggregated risks (i.e., the sum of risk values from individual changes) caused by the adoption of multiple risk-informed initiatives, PRA conservatisms, or both, may result in quantitative risk values approaching or exceeding regulatory guidelines, thus potentially restricting future adoption of risk-informed initiatives.

The issue of risk aggregation may be compounded for some plants when conservative or qualitative estimates of the risk from external hazards (e.g., fire,[11] seismic, flooding) is included in the quantification per applicable regulatory guidance. In addition, updated knowledge can reveal that the estimated frequency or severity of external events has changed from that originally thought when plants were designed, thus potentially increasing or decreasing margin to the regulatory risk guideline values. In either case, implementation of state-of-the-practice methods and present-day information

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[10] 51 FR 30028, "Safety Goals for the Operation of Nuclear Power Plants; Policy Statement," dated August 21, 1986 (republished) (ADAMS Accession No. ML051580401).

[11] Internal fire is traditionally treated as an external hazard in PRAs (i.e., not part of the internal events PRA model).

(e.g., post-Fukushima) to reassess key vulnerabilities associated with external hazards and inclusion of the associated quantitative risks may shift plant risk profiles. These shifting risk profiles could affect future regulatory decisions.

In a few cases, the staff believes that aggregation of fire PRA results with revised external hazards risk information could conceivably challenge quantitative thresholds used in existing RIDM guidance documents (e.g., RG 1.174). Nevertheless, the staff has reasonable confidence that U.S. nuclear plants have significant margins to meet the Commission's safety goals in consideration of the substantive post-Fukushima safety enhancements.

Strategies and Specific Measures to Overcome Challenges towards Further Progress in Risk-Informed Decision-Making

The staff's vision is that RIDM—and notably, the safety focus and efficiency benefit that results—will be applied broadly across regulatory activities in the reactor program.[12] To overcome the challenges identified above, the staff is implementing five overarching strategies that will enhance the integration of risk information into regulatory decision-making practices and processes; improve the technical basis for regulatory activities; and increase the efficiency, effectiveness, and consistency of RIDM. The table below lists these strategies and their linkage to the challenges described above.

Strategy / **Challenge**	Strategy I *Evaluate and Update Guidance*	Strategy II *Develop Graded Approach*	Strategy III *Enhance Staff Training*	Strategy IV *Advance Risk Initiatives*	Strategy V *Increase Communication*
(1) Knowledge and Support	X		X		X
(2) Review Integration	X	X	X		X
(3) Guidance Development	X	X	X		X
(4) PRA Acceptability				X	X
(5) PRA Realism	X			X	X
(6) Risk Aggregation	X			X	X

The staff is planning specific actions related to each of these strategies. In some cases, actions are already underway and are described along with the appropriate strategy. The staff will monitor progress in addressing each of the identified challenges as these strategies are implemented and will adjust its approach as appropriate. The staff's periodic updates to the Commission, as directed by SRM-M170511, will summarize this progress and any necessary adjustments.

Strategy I: Evaluate and Update Guidance

The staff periodically reviews the adequacy of existing guidance and decisions that involve significant resources or differing staff views. In addition, the staff often develops or revises guidance in response to Commission direction, operating experience, and stakeholder feedback. Accordingly, the staff is actively engaged in updating key RIDM guidance, as

[12] Risk-informed approaches are also applied in the materials and waste arenas, as reflected in the "Risk-Informed Activities" page on the NRC public Web site (https://www.nrc.gov/about-nrc/regulatory/risk-informed/rpp.html). As this paper resulted from a Commission briefing on operating-reactor risk-informed activities that reflected significant stakeholder and Commission interest in progress in this area, the discussion herein is focused on the reactor program.

evidenced by efforts associated with the forthcoming RG 1.174, Revision 3,[13] and the publication of NUREG-1855, Revision 1,[14] on the treatment of uncertainties associated with PRAs in RIDM. Moreover, as risk-informed initiatives, such as technical specifications (TS) Initiative 4b on risk-informed completion times and 10 CFR 50.69, "Risk-informed categorization and treatment of structures, systems and components for nuclear power reactors," are implemented, new and revised inspection procedures and field guides are developed. Despite ongoing efforts, as highlighted by Challenge 3, additional effort is warranted to more fully equip the staff with the tools necessary to use quantitative and/or qualitative risk information in both traditionally deterministic and formal risk-informed licensing reviews.

Two examples of new guidance-development activities related to this strategy are listed below. Both examples are described in the Office of Nuclear Reactor Regulation (NRR) action plan focused on RIDM in licensing reviews which was made publicly available in August 2017.[15]

- **Task 2: Broaden the definition of risk [broaden the understanding of risk and risk insights] beyond just a quantitative value.** The staff considers the "risk triplet" with regards to risk information—what can go wrong, how likely is it, and what are the consequences. RG 1.174 describes how each of these questions is addressed in an integrated RIDM approach. Specifically, consideration of quantitative risk is just one of five key principles, along with defense-in-depth philosophy, safety margins, performance-measurement strategies, and regulatory compliance. All safety regulation is ultimately concerned with risk, and well-informed engineering judgement is one form of risk-informed thinking. In completing this task, the staff is leveraging the paradigm from the successful "Risk-Informed Thinking" workshops to develop ways that risk considerations can be understood beyond quantitative metrics such as core damage frequency. The staff will report to office management in March 2018, and needed tools and training will be prepared in coordination with the other actions described in this paper.

- **Task 4: Review Branch Technical Position (BTP) 8-8, "Onsite (Emergency Diesel Generators) and Offsite Power Sources Allowed Outage Time Extensions," to determine if clarification is needed for use of a 14-day backstop for deterministic evaluations; applicability of the guidance to one-time and permanent extensions; and defense-in-depth considerations, particularly with respect to mitigating the consequences of a loss of offsite power coincident with a loss-of-coolant accident with a single failure.** In completing this task, the staff is collecting and reviewing guidance, interviewing staff who developed and use BTP 8-8, evaluating reviews performed using BTP 8-8, and preparing recommended changes for office management review by March 2018.

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[13] Draft Regulatory Guide (DG) -1285, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to The Licensing Basis," dated March 31, 2017 (ADAMS Accession No. ML12012A006).

[14] NUREG-1855, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decisionmaking," Revision 1, issued March 2017 (ADAMS Accession No. ML17062A466).

[15] "Risk Informed Decision-Making Tasking Action Plan," dated August 11, 2017 (ADAMS Accession No. ML17219A375 (package)).

Strategy II: Develop a Graded Approach for Using Risk Information in Licensing Reviews

A graded approach seeks to leverage risk insights across the spectrum of licensing review types. Reactor licensing applications can be binned into three main types according to the degree in which risk information is used. Type 1 includes traditionally deterministic requests that demonstrate regulatory compliance largely through the use of NRC-approved prescriptive analyses. In these cases, quantitative PRA results have rarely been included. Type 2 includes licensing submittals that contain quantitative or qualitative risk information but are not formally submitted using the guidance in RG 1.174 and RG 1.200. Lastly, Type 3 applications are formal risk-informed changes that use quantitative risk information derived from a RG 1.200-compliant PRA and are subject to the review guidelines in RG 1.174.

The staff's plans to develop guidance for applying risk insights in traditionally deterministic submittals should provide benefits for Type 1 and Type 2 reviews. Type 1 reviews have continued largely outside the RIDM framework; while they are not particularly challenged, they have not benefited from the safety focus and efficiency gains RIDM can bring. Type 2 reviews have typically been the most challenging since staff guidance to integrate risk information into reviews outside of the RG 1.174 and RG 1.200 construct needs further development. A framework that supports a graded review approach for these types of reviews already appears in the "Scope of Review of License Application (Initial Applications and Amendments)" subsection of the introduction to NUREG-0800.[16, 17] Specifically, NUREG-0800 states that the most detailed, indepth review would be applied to SSCs determined to be both safety related and risk significant and that a progressively less detailed review would be applied to SSCs that are determined to be nonsafety related or not risk significant.

The following examples reflect current staff actions related to the leveraging risk insights in Type 1 and 2 reviews. The second example is described in the NRR RIDM action plan referenced above.

- **Enhanced safety-focused SSC review tool.** An SSC review tool guides reviewers in considering plant design features in 11 key areas (e.g., novel design, regulatory compliance issues, risk insights, relationship to defense-in-depth, and relationship to safety margins) to help formulate the scope and depth of review activities. This approach is being applied to the enhanced safety-focused review for the NuScale design certification. Lessons learned from this review can be applied to operating-reactor reviews.

- **Task 3: Develop a graded approach for using risk information more broadly in licensing reviews.** As part of this task, the staff is developing, assessing, and piloting a risk-screening tool to help determine the appropriate level of its review (e.g., limited review, typical review, or complex review) using risk insights with other relevant factors. A report will be issued in Spring 2018, informed by insights from recent new reactor licensing reviews.

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16 NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Revision 2, issued March 2007 (ADAMS Accession No. ML070630046).

17 NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: Small Modular Reactor Edition," Revision 0, issued January 2014 (ADAMS Accession No. ML13207A315).

The staff's approach to Type 3 reviews can be further strengthened and integrated by employing a collaborative review process. Historically, reviews of complex reactor licensing submittals have involved multiple disciplines, including risk analysis, yielding inputs that are integrated after each review is complete. Although this approach ensures that all technical areas are addressed, recent experience in the review of technically complex and often voluminous risk-informed initiatives, such as National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," and TS Initiative 4b, revealed that close collaboration of risk analysts with the rest of the technical review team throughout the duration of the review can lead to an enhanced and shared understanding of important safety-significant aspects and conclusions. This close collaboration was key to the completion of the initial TS Initiative 4b review. In addition, the staff has successfully leveraged this collaborative approach in its review of the pilot risk-informed LAR that addresses the NRC's Generic Safety Issue 191.[18]

Two examples illustrate ongoing actions related to employing a collaborative review approach to advance this strategy. The second example is described in the RIDM action plan referenced above.

- **Enhanced safety-focused SSC review tool**. The SSC tool referenced above for the NuScale review, in conjunction with available design information and existing review guidance, facilitates structured cross discipline discussions about the review or specific functions of a particular SSC. Staff in the Office of New Reactors has successfully used these discussions to prioritize review activities.

- **Task 1: Expand the use of license review teams.** As described in the RIDM action plan, the objective is to build upon the successes of previous risk-informed reviews and enhance collaboration between the engineering staff and the PRA practitioners. The staff is currently collecting and evaluating information from a spectrum of recently completed reviews and is developing attributes of successful licensing review teams. Preliminary insights, observations, and recommendations will be provided in a report to the Director of NRR in the Spring of 2018.

Strategy III: Enhance Mandatory Training Requirements Related to Risk-Informed Decision-Making for Managers and Staff

The NRC provides over 30 formal staff training courses on technical and regulatory aspects associated with RIDM. Enclosure 1 summarizes these courses, which are designed to meet the needs of individual staff members with varied backgrounds and roles. These range from high-level overviews of RIDM and PRA methods for general audiences to detailed PRA technology topics for practitioners and process-focused courses for managers. Courses are available to all staff members with several integrated as requirements in formal staff qualification programs.[19]

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[18] "South Texas Project, Units 1 and 2—Issuance of Amendments, Re: Change to Design Basis Accident Analysis Using a Risk-Informed Methodology To Account for Debris in Containment (CAC Nos. MF2400 and MF2401)," dated July 11, 2017 (ADAMS Accession No. ML17019A001 (package)).

[19] For example, Office of Nuclear Reactor Regulation Office Instruction ADM 504, "Qualification Program," requires all qualified staff members, regardless of technical expertise, to participate in the PRA Basics for Regulatory Applications course. Likewise, all qualified NRC inspectors are required to participate in a Probabilistic Risk Assessment Technology and Regulatory Perspectives course. Extensive formal training in PRA and RIDM is required for reliability and risk analysts in programs such as ADM-507, "'Grow Your Own' PRA Analysts Training Qualification Program"; ADM 504, Appendix M, "Reliability and Risk Analysts"; and

As noted above, however, only some NRC employees—such as new technical reviewers or developing PRA practitioners—are required to take these courses. Also, as Challenge 3 describes, many courses focus on the technical aspects of PRA as opposed to describing how risk information can be used to inform regulatory decisions.

To address these issues, the NRC is now offering several new courses, including the Risk-Informed Thinking Workshop, which provides participants with hands-on experience in applying RIDM using scenarios of practical agency work. The staff intends to update position-specific qualification and requirements for both operating- and new-reactor staff (included in two office instructions) as part of the ongoing office merger activities, and will include the Risk-Informed Thinking Workshop, or an equivalent course, as a qualification requirement. Furthermore, the staff will evaluate whether aspects of the workshop could be integrated with appropriate modules of the Fundamentals of Reactor Licensing Workshop for Technical Reviewers, which is taught by NRC staff and managers and is intended to be taken by technical reviewers at initial qualification and every six years thereafter.

The staff is also preparing a new course for NRC managers (Perspectives on Risk-Informed Decision-Making for NRC Managers) that will focus on practical applications of PRA and describe how risk insights can inform decision-making. During the pilot phase, the target audience for this course is supervisors who are primarily responsible for operating reactor licensing, oversight, or rulemaking regulatory decisions. If this course is successful, the staff will make it mandatory for all supervisors and senior managers in the reactor program.

Strategy IV: Advance Risk-Informed Initiatives

The NRC continues to use the Risk-Informed Steering Committee (RISC) to advance risk-informed initiatives. RISC is a senior management committee with members from each of the program offices. The industry also has a RISC composed of senior managers. Since inception in 2014,[20,21] the NRC RISC's objectives include: to engage industry and listen to concerns relative to the use of PRA to support regulatory decision-making; communicate NRC actions in the area of risk-informed decision-making; to discuss what initiative can be taken by the NRC to incentivize industry to continue to develop PRAs to help both reduce uncertainty and provide a framework to make decisions in light of uncertainty; and to discuss industry actions necessary to achieve the vision for future use of PRA to support regulatory decisions.

The NRC and industry RISCs meet periodically. Active topics with the RISCs include: TS Initiative 4b, the peer review facts and observations closure process, 10 CFR 50.69, credit for diverse and flexible coping strategies (FLEX) in RIDM, Fire PRA realism, PRA methods vetting process, realism in the Reactor Oversight Process, and risk aggregation. Importantly, RISC initiatives change and evolve as industry and NRC knowledge increases, existing challenges are resolved, and new challenges are revealed. A summary of active RISC initiatives is provided in Enclosure 3.

Appendix C-9, "Senior Reactor Analyst Training and Qualification Program," to Inspection Manual Chapter 1245, "Qualification Program for New and Operating Reactor Programs."

20 G20130895/LTR-13-0958, Anthony Pietrangelo, Nuclear Energy Institute, to Chairman Macfarlane, NRC, Letter Re: Industry Support and Use of Probabilistic Risk Assessments and Risk-Informed Regulation, dated December 19, 2013 (ADAMS Accession No. ML13354B997).

21 "Summary of February 7, 2014, Public Meeting on Issues Related to Current Risk-Informed Processes," dated March 18, 2014 (ADAMS Accession No. ML14057A519).

Strategy V: Enhance Communication on Risk-Informed Activities

The NRC is leveraging various communication tools to ensure that all stakeholders, including the regional offices, are aware of new and enhanced risk training courses and guidance, ongoing RIDM initiatives, and plans and experience using risk information. For example, staff members with expertise in risk thinking and RIDM are sharing knowledge and experience through presentations at branch and division meetings across the offices. These presentations are currently being used to promote awareness of the risk screening tool for operating-reactor licensing reviews described in Strategy II. Similarly, the PRA group in the Office of New Reactors presented to individual technical branches at the beginning of multiple design certification reviews, to present risk insights for the design and areas of high safety significance in a tailored and informative manner; the operating-reactor strategy builds on this successful approach. In addition, seminars on RIDM for NRC inspectors and enhanced inclusion of RIDM topics at regional and senior reactor analyst counterpart meetings are also planned.

Risk Informed Decision-Making for Advanced Reactors

Although the NRC has established an incremental approach to incorporating risk-informed regulatory improvements for current and near-term licensees, the adoption of a more risk-informed, performance-based regulatory framework would provide the greatest benefits for new reactor designs that use nontraditional technologies.[22] The U.S. Department of Energy, national laboratories, and reactor developers are working on designs and potential deployment of reactor technologies significantly different from the LWRs in the operating fleet. The non-LWR designs may have many of the attributes identified in the NRC's Policy Statement on the Regulation of Advanced Reactors.[23] The characteristics of advanced reactors can include less complex shutdown and decay heat removal systems, longer thermal constants, simplified safety systems, and reduced susceptibility to severe accidents. Advanced reactor developers are increasingly using PRA throughout the design process.

Documents such as NUREG-1860[24] and more current interactions with participants in the U.S. Department of Energy's advanced reactor technologies programs reflect the staff's efforts to better integrate risk-informed approaches into the design and licensing of advanced reactors. The staff is working with the developers and other stakeholders to address risk insights and the use of PRA to identify licensing-basis events, safety classification of SSCs, defense-in-depth strategies, and other aspects of a licensing framework for non-LWRs. A core team consisting of staff from key technical disciplines, including risk assessment, is building upon the approaches described in SECY-11-0024[25] to support the generic and design-specific interactions related to non-LWRs. This current effort is an important facet of the NRC's overall plan to achieve non-LWR mission-readiness objectives to ensure that the NRC is ready to efficiently and

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22 SECY-15-0168, "Recommendations on Issues Related to Implementation of Risk Management Regulatory Framework," dated December 18, 2015 (ADAMS Accession No. ML15302A135 (package)).

23 73 FR 60612, "Policy Statement on the Regulation of Advanced Reactors," dated October 14, 2008 (ADAMS Accession No. ML082750370).

24 NUREG-1860, "Feasibility Study for a Risk-Informed and Performance-Based Regulatory Structure for Future Plant Licensing," Volumes 1 and 2, issued December 2007 (ADAMS Accession Nos. ML080440170 and ML080440215).

25 SECY-11-0024, "Use of Risk Insights to Enhance the Safety Focus of Small Modular Reactor Reviews," dated February 18, 2011 (ADAMS Accession No. ML110110688 (package)).

effectively review potential licensing applications for non-LWR technologies. In December 2016, the NRC published its vision and strategy document[26] with a goal to further develop the agency's non-LWR regulatory, technical, and policy infrastructure. The staff is preparing its first annual status paper on advanced reactors activities that will summarize application of PRA technology. The staff anticipates that it will submit this paper to the Commission by January 2018.

CONCLUSION:

Additional safety enhancements may be realized and operational flexibility may be gained when likelihood, or probability, is considered in conjunction with postulated accident scenarios and their consequences. The staff's plans to address challenges in employing RIDM, as described in this document, focus strategically on realigning a traditionally deterministic regulatory framework and staff culture, enhancing familiarity with RIDM principles through integrated reviews and targeted training, and advancing the technology to address challenges with PRAs that exist particularly for operating reactors. Consistent with Commission direction, the staff will provide annual updates to the Commission that summarize the progress made in achieving the desired outcomes. The staff plans to conduct the activities described in this paper in accordance with previous Commission direction in SRM-M170511 and using resources already budgeted to licensing and guidance development work, following the agency's planning, budgeting, and performance management process.

COORDINATION:

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

/RA/

Victor M. McCree
Executive Director
for Operations

Enclosures:
1. Summary of NRC Training Related to RIDM for Managers and Staff
2. Summary of Staff Actions Related to Example LARs
3. Summary of Active Topics with the RISC

[26] U.S. Nuclear Regulatory Commission, "NRC Vision and Strategy: Safely Achieving Effective and Efficient Non-Light Water Reactor Mission Readiness," issued December 2016, (ADAMS Accession No. ML16356A670).

SUBJECT: PLANS FOR INCREASING STAFF CAPABILITIES TO USE RISK INFORMATION IN DECISION-MAKING ACTIVITIES DATED OCTOBER XX, 2017

*via e-mail

ADAMS PKG Accession No.: ML17270A197 **SRM-M170511-2**

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