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MODERNIZING THE STANDARD REVIEW PLAN

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ABSTRACT

The staff of the United States Nuclear Regulatory Commission (USNRC) uses Standard Review Plans (SRP) as guidance, to perform regulatory review of licensing applications consistently, in their different business lines. The SRP for the regulatory review of light-water reactor licensing is presented in Nuclear Regulatory Report (NUREG)-800. The SRP in the current form contains guidance from the past decades when risk informed regulatory concepts had not gained foot hold in the then new nuclear power industry. Many of the safety practices are now well understood and analytical processes for their inclusion in plant design are codified in industry codes and standards. The modernized SRP builds on the advances in the industry by eliminating guidance duplication and including risk information in decision making. The modernized guidance addresses the activities or processes required for compliance with a regulation and provides acceptance criteria that support the safety objectives embodied by the regulation. Risk insights which can now be developed from system analysis, uncertainty modelling and use of operating experience are used in the modernized SRP guidance development to identify critical issues for review and as a criterion for grading the depth of review. The NRC approach to regulatory review is reasonable assurance of safety and the modernized SRP, continues with this philosophy bringing greater clarity and focusing on priority review areas. Future reviews using the modernized SRP guidance will utilize risk insights in reaching a reasonable assurance finding. The key benefits to be derived from this modernization effort are a more direct relation between the requirement and acceptance criteria, and the use of risk insights in scoping the staff's review. Incorporation of the specific review areas identify the elements of the analytical process that are important to safety and support the basis for the staff's reasonable assurance of safety determination. A more longer-term benefit of this modernization process is in knowledge management. The modernized SRP reflects the current state of practice in regulatory review and documents the rationale for the current format of each of the modernized sections. This will ensure that reviews focus on the most risk significant aspects and assist the applicant in preparing the information necessary for regulatory review. More critically, the modernized guidance directs staff review to focus on issues that are necessary to provide reasonable assurance that the applicant has complied with the safety objective of the regulation.

OVERVIEW

This paper begins with an overview for the need to modernize the Standard Review Plan (SRP) at this juncture of the nuclear industry and highlight the key areas of modernization. This is followed by a historical account of the development of this unique document "The Standard Review Plan." And concludes with examples of segments of modernization in the SRP, which is being developed by the staff.

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HISTORICAL PERSPECTIVE

A brief history of the development of the SRP, is presented, here with the sole purpose of informing the reader the needs and review experience that culminated in the development of this unique document. The paper presents stages in the update of the document to accommodate technological advances and the demand for regulatory review efficiency; and to enhance communication between all stakeholders in the nuclear industry.

The Commission approval for a license to construct and operate a production or utilization facility, commensurate with requirement 50.34 of (USNRC, 10 CFR) 10CFR Part 50 is based on the information, summarized from the facility Safety Analysis Report (SAR), and presented in the license application. The application, documents and communicates the basis that demonstrate compliance with the regulatory requirements. Thus, the license application is the sole docketed source of information that provides the Commission staff's basis of reasonable assurance, that the if the facility is constructed and operated as defined by the SAR, the facility will not detract from public and environmental safety.

The SAR serves as the principal means of communication between the applicant and the Commission's staff in conveying information about the facility and the way in which it is to be operated. Effective communication is essential for the performance of an expeditious and adequate regulatory review of the application in support of licensing actions. To facilitate with this communication, the Atomic Energy Commission (AEC) which performed the regulatory oversight prior to the formation of the Nuclear Regulatory Commission (NRC) issued a guide, (AEC, 1966) in which a structured approach to the presentation of the information in the SAR was established. The guide provided a systematic approach to the regulatory review process by identifying systems that the staff considered are important to plant safety. And the technical issues necessary to establish that the safety requirement, in the regulations, are being appropriately addressed by the information in the application. This guidance was intended to clarify the informational needs of the staff required under Section 50.34 (USNRC, 10 CFR).

The AEC guidance was directed to the Commission staff for the development of their Safety Evaluation Report (SER) of the application and forms the basis of any recommendations on licensing actions to the Commission. The applicant from the guidance could identify the areas of review that would be undertaken by the staff under each system and the acceptance criterion that would be used to judge the

appropriateness of the presented information. The AEC hoped that by the issuance of this document, the applicant would be informed on the scope and depth of information that would be sought by the reviewers in the application. This would result in a consistent regulatory review of the different designs submitted in future applications. This document in addition provided insights on the regulatory experience of the time and served as an excellent knowledge management tool for future development of the regulatory review process.

The guide covered thematic areas with a qualitative identification of the scope and depth, of information, to be addressed in the application for each of these areas. This the Commission anticipated would facilitate appropriate transfer of information in a format that would facilitate the Commission's staff review. And conclude by corroborating the applicant's assessment, "that the construction and operation of the proposed facility meets the Commission's public safety objectives by compliance with the requirements of (USNRC, 10 CFR) Part 50.

Guidance was provided on thirteen major thematic areas and systems identified as Site, Reactor, Reactor Coolant Reactor System, Containment System, Engineered Safeguards, Instrumentation and Control, Electrical Systems, Auxiliary and Emergency Systems, Steam and Power conversion system, Radioactive wastes and Technical Specifications which specified the broad framework within the limits of which the reactor operations are to be conducted and the basis for the specific limits considered in the SAR. In addition, the document included an introduction and Summary section in which terms and phrases were defined to minimize the potential for their varied interpretation leading to delayed reviews.

Much experience was gained from application reviews using the AEC guidance in the years that followed. In the early 70's the NRC concluded that a new more detailed and structured document was needed that identified the primary and secondary review responsibilities, clearly stating the review responsibilities of the various branches in the organization and address the sometimes-complex interfaces between them. The SRP used the same content organization as Regulatory Guide 1.70. (USNRC, R.G. 1.70 , 1978) and solicited comments from the public on the conduct of the safety review of applications, in the development of the SRP. The SRP used seventeen functional branches which enveloped the thematic areas of the AEC guidance.

The SRP was prepared as guidance for the staff of the Office of Nuclear Reactor Regulation (NRR) to improve the quality and uniformity of their safety evaluation, providing a well-defined base from which to change the scope and requirements of the review. Another purpose of the SRP was to implement the NRR policy on making information about regulatory matters widely available to the interested members of the public and nuclear industry. This it was anticipated would improve communication and understanding of the staff review process by all interested parties. The application of this document to future safety reviews would have a stabilizing effect on the licensing process and enhance regulatory predictability, which would benefit the public and the nuclear industry. Thus, the first SRP was used as issued as NUREG-75/087 (USNRC, NUREG 75/087, 1975)

In 1981 the SRP was revised in its entirety and published as NUREG-800 (USNRC, NUREG-800, 1987). The revision was to accomplish three major objectives:

1. Completely identify the regulatory requirements relevant to the review
2. Explicitly explain how the review determines the satisfaction of the requirement and finally
3. To incorporate the large number of established regulatory positions

Two sections of note in this update are Acceptance Criteria and Review Procedure. The Acceptance Criteria for each Section of the SRP incorporates all the technical experience and practices gathered over past reviews. The Acceptance Criteria identifies all the NRC requirements. The technical basis for which

is in NRC Regulatory Guides, General Design Criteria, Codes and Standards, Technical Branch Positions and later Interim Staff Guidance.

These documents set forth procedures and methods deemed acceptable in the past by the staff as solutions to specific safety related issues in the topic being reviewed. It was anticipated that solutions codified in this manner would allow staff reviewers to take uniform well understood positions as similar safety issues arise in future reviews. It was understood that although other solutions are possible, their use may require additional review time, lengthening the review process. The second was the Review Procedure which provided a step-by-step process along which a reviewer proceeds to provide a reasonable verification that the applicable safety criteria are met.

CURRENT MODERNIZATION

The current SRP modernization process is expected to provide a systematic path to regulatory compliance and result in a logical and reproduceable safety evaluation. The modernization intends to establish a closer association between the Acceptance Criteria and the Review Procedure by demonstrating the relevance of the review to the regulatory requirement for which compliance is being sought. The SRP modernization intends to benefit from the efforts of NRC and the industry in addressing technical issues by adopting current industry codes and standards to avoid duplication of guidance wherever beneficial to support the regulatory safety objective. This will in addition eliminate the need to maintain some of the Regulatory Guides, the contents of which are include in the industry codes of practice. The guidance will include risk informed practices for SSCs design as practicable and use risk information in supporting safety conclusions.

However, the modernization retains the past purposes of the SRP as a document that provides a structured process to perform a safety review of an application and hence maintains the structural format derived from RG 1.70 (USNRC, RG 1.70 Rev3, 2001) with some additions to accommodate the needs of Part 52. The modernized SRP is more compact by addressing the common themes such as consideration of risk information in decision making; selection of review sections that are pertinent to the reactor design being considered (as the SRP is modelled to accommodate many designs and all systems may not apply to every design application); use of newer passive systems has eliminated the need for some systems applicable to older types of reactor design and finally the consideration of defense-in-depth in assessing plant system performance and margin assessment.

Even though the overall structure of the SRP remains quite the same as before, the format of the Sections has been modified to better reflect the relationship between the review scope and the regulation. The Area of Review now has a tabularized format which includes the Regulatory Requirement and associated Acceptance Criteria, subdivided into Specific Areas of Review, and finally the Finding. This is done for each regulation that applies to the safety review conducted in the Section.

EXAMPLES OF MODERNIZATION

For illustration some specific examples of modernization are presented in the following paragraphs implementing the modernization objectives presented above. In the modernized Section 3.7.1, “Seismic Design Parameters”, The Regulatory Requirement for Section 3.7.1 is General Design Criteria (GDC2) (10CFR50) and the Area of Review, now states “to ensure that an established methodology is used in developing foundation input response spectra (FIRS) that is consistent with the vibratory ground motion established under SRP Section 2.5.2 (USNRC, SRP) meeting the requirements of Appendix A “ Seismic and Geologic Siting Criteria for Nuclear Power Plants”, 10 CFR Part 100.” The logical steps to a finding of regulatory compliance are provided by the actions undertaken in the Specific Review Area. The Specific

Review Area now includes specific actions the implementation of which are designed to provide reasonable assurance that the safety of the outcome is satisfied. The finding is the result of the compilation of the assurances from each of the following specific review areas:

1. Ensure that the same process used to develop the vibratory ground motion reviewed under SRP Section 2.5.2 is applied in developing FIRS.
2. Ensure that the mean annual probabilities of exceedance used for the development of the hazard consistent performance-based soil spectra are those used in the development of the vibratory ground motion in SRP Section 2.5.2.
3. Reviews the process used to address the soil profile uncertainties used in the site amplification analysis.
4. Reviews checks performed to ensure that the free field motions are consistent with the FIRS.

The results of these actions provide the reasonable assurance that the FIRS, so computed support the safety objective of the regulation and hence support the actions necessary to comply with GDC2

For an illustration of indirect association of the Acceptance Criteria to the review process we again consider compliance with GDC2. GDC2 requires that SSCs important to safety include the effect of natural phenomena hazards in their design. Considering wind as the natural phenomena being considered, in Section 2.3.2 "Local Meteorology" a review of the appropriateness of the characterization of site-specific wind by the prescribed wind speed is conducted. This provides assurance that when the wind effects are considered in the design of the SSC it will be appropriate for complying with the requirements under GDC2. In Section 3.3.1 "Wind Loading" this characterized wind parameter is reviewed for appropriate conversion to a wind load specific to the SSC being evaluated in consideration of the site-specific wind flow pattern, structure type and orientation. The process for this wind speed to wind load conversion is no longer duplicate in the SRP, instead the reviewer is direct to the procedure given in ASCE -7. The review provides assurance that the site-specific wind speed has been reasonably converted into the design wind load and appropriate for use in the design of the SSC. This provides reasonable assurance that the wind load considered is appropriate for complying with the requirements of GDC2. Finally, in Section 3.8 the design of the SSC is reviewed and the load is included in the appropriate load combination for the design of the SSC performed to a design code such as ACI 349. In this segment of the review, the Acceptance Criteria for meeting the requirement of GDC2 is accomplished. This logic is followed throughout the SRP sections. So, a single Section may not always result in a direct regulatory compliance but will always support a regulatory requirement as demonstrated above. This allows for a logical series of technical outcomes that provide a reasonable assurance of safety.

To this date the SRP was periodically updated to include new analytical approaches and design methodologies. The practitioners in the nuclear industry have now developed standards that address the analytical practices routinely utilized by the industry. This has resulted in duplication of guidance on the analysis of engineering issues, often leading to a variation in guidance. Considering the mature status of the nuclear industry the current modernization of the SRP intends to systematically remove duplication of guidance on technical issues, except where there exists an established difference in regulatory position and the industry guidance. The duplicate information along with their basis documents will be relocated to Agency Knowledge Management systems for future use in staff development. The guidance on technical processes will be replaced by reference to industry consensus codes and standard as far as practicable.

As an example, in Section 3.7.1 "Seismic Design Parameters" all the guidance on how to develop FIRS from the results of Section 2.5.2 has been removed and replaced by reference to ASCE - 4 which prescribes the procedure for developing FIRS. The different site conditions that may be encountered and the processes to accommodate those in computing FIRS at different horizons is guided by reference to a published paper in a peer reviewed journal. Thus, significantly reducing the size of the SRP Section. Similarly, in Section 3.3.1 "Wind Loading" the process for computing wind loads from the design wind

speed has been removed from the guidance and replaced by reference to ASCE-7 which has captured this guidance. The information so removed will be relocated to the Knowledge Management system within NRC.

As a part of SRP modernization the Quality Assurance requirements are being removed from individual Sections of technical review and complied as actions to be undertaken under the Quality Assurance Program Plan. The Quality Assurance Branch will be entrusted with the review and enforcement of compliance with this program. The technical staff will gather assurance from the fact that the technical work and the results presented in the SAR are of the quality assured by the requirements of the quality program. No further review of these aspects is required in the technical review conducted under each of the SRP sections.

Much advancement has been made in risk quantification both in qualitative and quantitative terms. The risk models now include uncertainty both in epistemic and aleatory terms. These advances are now incorporated in the guidance using industry codes and standards and NRC guidance as necessary to provide the reviewer with adequate guidance on methods for considering risk in their evaluation process. It is clearly understood that all SSCs do not have the same level of contribution to plant level risk and this notion of risk is embedded in the current guidance in informing the scope of each safety review. The guidance promotes a graded approach to the application of safety requirements that are proportional to the risk contribution of the SSC. The guidance on the review of the SSC design incorporates assurance for a level of performance that support adequate public protection objectives of the regulatory requirement. The modernized guidance in this form incorporates the use of risk information and performance-based design considerations in the satisfaction of the public safety objectives of regulatory requirements. Consideration of uncertainty is essential in the above process and the modernized guidance embraces the use of probabilistic methods to better account for uncertainties in a systematic manner.

As an example of integration of accounting for uncertainties in the modernized guidance is in Chapter 2.5.2 which encourages the use of Probabilistic Seismic Hazard Assessment (PSHA) to enable inclusion of uncertainties associated with seismic hazard estimates. The hazard curves generated a base rock at selected annual probabilities of exceedance are risk informed. The design of the facilities to corresponding FIRS are performed to performance targets commensurate with the need to provide adequate public safety. The use of such design methodology is incorporated in the guidance by reference to ASCE-43.

The use of qualitative knowledge about risk is pervasive throughout the SRP. In Safety Classification (SC) of SSCs, for example, qualitative knowledge about the risk of system malfunction to plant safety is used to separate the SSCs with safety functions from those that do not have such safety functions. In doing so, the safety review of safety related SSCs are performed to a more stringent analytical and design standard than other non-safety related SSCs. The same principle is applied to seismic safety categories (SC), where the SSCs with safety functions are all assigned the category SC-1 for which the more stringent analysis and design standards are applied in the staff review. For other SC's the review standards are less stringent as their failure to perform is associated with less severe consequences hence has lower risk. This concept of using risk as the measure of scope and depth of a review is often known as "the graded approach." This is beneficial for both optimizing the review effort and construction cost while maintaining the plant level safety. The more explicit risk quantification from plant PRA's can be significant in optimizing operational and maintenance cost.

CONCLUSION

In concluding, the Commission's staff anticipates that when this modernized version of the SRP is published it will align staff safety evaluations with current engineering methods and practices in assuring adequate public protection. The applicants will benefit from the economies of a graded approach which result from using risk information and performance-based design. The SRP would serve as an appropriate standard for acceptance review and provide a checklist for identifying informational gaps that may exist in submitted applications. Finally, this modernized SRP aligns the technical efforts of the nuclear industry that support the safety requirements of the regulator.

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