STP/NU-001

RISK INITIATIVES IN ASME NUCLEAR CODES AND STANDARDS

ASME STANDARDS TECHNOLOGY, LLC

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FOREWORD

This document is the result of a research and development project administered by the ASME Standards Technology, LLC on behalf of ASME Nuclear Codes & Standards (C&S).

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SUMMARY

This report documents the historical technical basis and provides an assessment of coherence among the nuclear power plant risk-informed initiatives that have been undertaken in the ASME Section XI, Operations and Maintenance (O&M), and Nuclear Risk Management organizations of ASME Nuclear C&S. Five risk-informed inservice inspection (ISI) and repair/replacement Code Cases are discussed relative to ASME Section XI initiatives and six risk-informed inservice testing (IST) Code Cases are summarized relative to ASME O&M Committee actions. Finally, discussion of the ASME Probabilistic Risk Assessment (PRA) Standard for nuclear power plant applications is provided including the development of two Addenda to the PRA Standard within the ASME Committee on Nuclear Risk Management (CNRM).

The conclusion of this review of completed ASME risk-informed initiatives is that coherence definitely exists across these standards actions. Figure 6 is presented to illustrate the relationship and foundation of how the various ASME Code Cases and the PRA Standard are used to implement risk-informed safety classification (RISC) and treatment of structures, systems, and components (SSCs). Coherence is derived from the application of a dozen or so common attributes across the risk-informed ISI, repair/replacement, and IST Code Cases, as given in Table 5.

Because these initiatives emerged at different times and without a central plan that was common across the ASME Nuclear C&S committees, there is variation in how the attributes are applied. The applications themselves also contribute to this variation. However, this review of each of the key attributes shows that consistency still exists across the applications relative to the intent that is to be derived from each attribute. Variation within an attribute is acceptable as long as its intended purpose is achieved. However, it is recommended that cognizant groups within the ASME Nuclear C&S organization review these attributes across current and emerging ASME risk-informed initiatives to ensure that coherency and consistency are fully achieved.

It is hoped that as the various ASME Nuclear C&S committees continue to move forward in the use of risk-informed technology in standards development actions, this report will be used as a reference for ensuring or enhancing coherence in future ASME initiatives.

1 INTRODUCTION

The purpose of this report is to document the historical technical basis for and provide an assessment of "coherence" for the nuclear power plant risk-informed initiatives that have been undertaken in the Section XI, O&M, and Nuclear Risk Management organizations of ASME Nuclear C&S. In this context, risk-informed refers to the consideration of relative impact on public health risk, in addition to traditional factors such as safety margins and defense-in-depth, in determining test, inspection, or other requirements for Nuclear C&S. Coherence is generally defined as a measure of consistency in the application of various risk attributes and criteria among the various risk initiatives.

Prior to the development of risk-informed approaches, requirements for safety margins were developed based on the engineering judgment and experience, sometimes adapted from other industries, of the expert practitioners constituting the C&S Committees. The accumulation of many years of commercial nuclear plant operating experience and the development of sufficient consensus among practitioners and regulators regarding the adequacy of PRA technology, provided a basis for applying risk-informed techniques within ASME Nuclear C&S. This approach has been used to identify those SSCs covered by Nuclear C&S that are most risk-significant. Therefore, resources to address operation, maintenance, inspection, and test activities required by the Nuclear C&S for these SSCs could be better focused and more effectively applied while maintaining a high level of safety. A key premise of this process is that changes to these requirements will, at most, result in small increases in risk that are acceptable per regulatory criteria.

While the technical basis exists for each of the above ASME Nuclear C&S actions, this document provides some historical perspective regarding the development of these risk-informed initiatives and addresses how they may be used coherently with each other. A discussion is also provided on how these attributes serve as a foundation for emerging or future risk initiatives that are already underway or that are being planned within the ASME Nuclear C&S organization.

This report is intended to be used as a means for providing engineers new to the field, and experienced engineers whose activities may focus on only one aspect of using risk technology, with a general understanding of the key considerations related to risk insights within ASME Nuclear C&S. It is not intended, however, to be a formal tutorial on these topics. The report has been prepared considering the needs of both U.S. and international audiences. To better address the needs of the latter, background information has been included to help explain why the above initiatives were undertaken by ASME and how they may be integrated into a larger risk-informed regulation framework.

This report focuses on successful initiatives within ASME Nuclear C&S for risk-informed ISI, IST, and the development of the PRA Standard for use in nuclear power plant applications. Many other developments such as for ASME Section III design activities are also underway; that work, however, is in the early stages of development.

The report is organized as follows. The background and history of the risk-informed ISI / IST and PRA Standard developments are provided in Section 1. Section 2 provides details of various ASME Nuclear C&S that have been developed and approved for use in the nuclear power industry worldwide. A description of the coherence among these risk-informed standards is provided in Section 3.

1.1 Background and History

ASME recognized the need for risk-informed methods in the formulation of policies, codes, standards, and guides in the late 1980s by organizing multi-disciplinary research task forces on risk-informed ISI and risk-informed IST. These research groups, financially supported by both domestic and international organizations from industry and government, including the U.S. Nuclear Regulatory Commission (NRC), worked to determine appropriate risk-informed methods for developing inspection and testing guidelines for several applications. Initial pilot plant applications were used to demonstrate the proposed methods. A series of ASME publications [References 1-6] presents this work, which includes both nuclear and industrial applications.

From this work, ASME was able to demonstrate that risk-informed methods offered the potential to technically enhance existing ISI and IST programs by relating inspection and test requirements to the failure modes of a component and its associated risk. Codes and Standards development using these new insights could provide alternative requirements that were more attractive to users compared to the prescriptive set of general requirements that had been developed using traditional engineering judgment with some implicit risk considerations. Risk-informed strategies could be structured to enhance examinations and tests for high safety significant (HSS) components and to reduce unnecessary requirements for low safety significant (LSS) components. ASME determined that these enhancements could be performed using an existing plant's PRA when they were blended with appropriate expert judgment and operational experience. Implementation of these methods would offer the ability for industry and the regulator to better focus and allocate limited resources to the HSS components, thereby enhancing overall plant safety. ISI and IST programs would also now be better correlated with PRA results and insights for each nuclear plant.

Given these promising results, ASME worked with the NRC, owners, and industry groups during the last decade to incorporate other risk-informed ISI and IST approaches into ASME C&S, NRC Regulatory Guides, and other industry documents. A diagrammatic outline of the process for development, endorsement, and implementation of ASME C&S appears in Figure 1. C&S development is the result of stakeholder cooperation through interfaces for providing input and feedback among the cognizant organizations. In addition to NRC and licensee cooperation, ASME also seeks the cooperation of manufacturers, constructors, designers, laboratories, material suppliers, and general interest parties. ASME C&S committees are volunteers from each of these identified parties working together to develop consensus C&S to address the needs of all stakeholders, including industry, government, other regulatory bodies, and the public. Only C&S developed through this process can meet national consensus standards requirements and the quality expectations of ASME. The NRC reserves the right to fully or partially endorse C&S and to take exceptions or not endorse these documents in the U.S. regulations.

1.1.1 Risk-Informed ISI and Testing

ASME, in its consensus C&S process, provides three formal methods (in addition to regularly scheduled Editions) for technical information affecting C&S, to reach the public: Addenda, Interpretations, and Code Cases. Code Cases are issued for voluntary use to clarify the intent of existing requirements or to provide, when the need is urgent, rules for a new technology such as the risk-informed application processes now being used for ISI and IST.

Code Cases were chosen to incorporate risk-informed research results for ISI and IST. In the case of ISI, three Code Cases [7-9] have been approved through the efforts of Section XI of the ASME Boiler and Pressure Vessel Code (BPVC). In the IST area, the ASME O&M Committee has also developed a series of Code Cases [10-15]. These Cases are currently being incorporated into Editions or Addenda of their parent C&S or into new C&S. The results of research programs, industry developments, and pilot plant applications on risk-informed technology have formed the technical bases for initiating the Code changes.

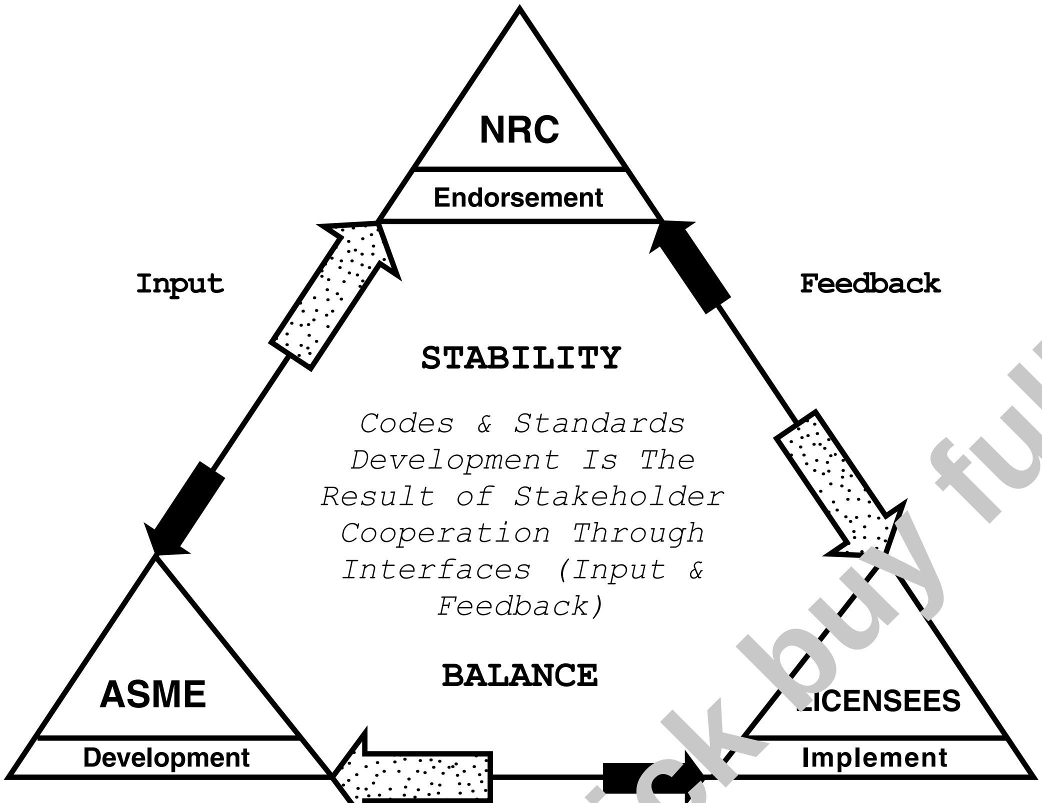

Figure 1 - Process to Develop ASME Nuclear C&S

As these Code Cases are incorporated into their applicable Codes, the NRC needs to reach a decision on the acceptability of these revisions. As shown in Figure 1, the endorsement of ASME C&S is the sole responsibility of the NRC in conjunction with implementation of these new requirements by licensees.

The pilot plants for ISI and IST began to receive NRC approval in 1998. The remainder of the industry has developed plant-specific programs or is budgeting resources to initiate work on at least one of these applications at the present time. To support this major initiative, the NRC has developed Regulatory Guides 1.175 [16] and 1.178 [17] for plant-specific, risk-informed decision-making for IST and ISI, respectively. The above ASME information and results were used by the NRC in the development of these documents, and these ASME applications provided useful examples during the development of NRC Regulatory Guide 1.174 [18].

1.1.2 PRA Standard

ASME recognized that the scope and adequacy of PRAs were important elements encompassing the above risk-informed C&S applications as well as future initiatives. In the summer of 1997, the ASME BNCS recommended development of a consensus standard for the use of PRA in the nuclear industry. After approval of this recommendation by the ASME Council on Codes & Standards, an ASME Project Team and a new Standards Committee, the CNRM, were formed in early 1998. The mission of the CNRM was to execute the development of a PRA Standard that would provide a foundation for all existing and future risk-informed applications for nuclear power plants. ASME issued the Standard in April 2002 [19].