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ASME Section III Alternate Requirements for Items with Minimal Contribution to Safety or Risk

Prepared for

United States Nuclear Regulatory Commission

1.0 Introduction

Many components in advanced (non-light water) nuclear applications do not have a significant contribution to safety or risk. Even with the increased ability of risk-based categorization processes to segregate components by safety- and risk-significance, there is little recognition of this advancement in the construction codes that support the nuclear fleet, including ASME Boiler and Pressure Vessel Code, Section III (ASME Section III).

The purpose of this white paper is to present the technical basis for proposed alternate requirements for the construction of ASME Section III, Division 5 nuclear items commensurate with an item's contribution to safety or risk.

2.0 Background

ASME Section III provides rules for the construction of nuclear components, such as pressure vessels, valves, and piping. ASME Section III has been developed, expanded, and refined over the last 50+ years to support the safety basis of the light water reactor (LWR) fleet, which requires a very high degree of integrity of the reactor coolant systems, critical components, piping, supports and other pressure boundary components. In recognition of the different operating regimes and failure modes for advanced reactors, Section III, Subsection NH evolved into ASME Section III, Division 5, which provides the rules for items in a high temperature reactor and provides rules for various Classes of construction, such as Class A and Class B.

When the LWR fleet was first constructed, systems, structures, and components were deterministically classified into two categories: safety-related or non-safety-related. These classifications determined if construction was in accordance with nuclear codes (safety-related) or industrial codes (non-safety related). The current body of regulations and codes were originally developed based on this approach. In the mid-1990s, there began a shift from deterministic rules to risk-informed approaches that were based on assessing core damage frequency (CDF) and large early release frequency (LERF). This shift was mainly driven by the desire to ensure that plant resources were directed to those areas with the highest risk and greatest impact to the plant safety case.

In 2004, the 10CFR50.69 process was established, which introduced four categorizations (RISC-1 through RISC-4) instead of two (safety-related and not safety-related) (See Figure 1):

- RISC-1 structures, systems, and components (SSCs) that are safety-related and perform safety significant functions.
- RISC-2 structures, systems, and components (SSCs) that are non-safety-related and perform safety significant functions.
- RISC-3 structures, systems, and components (SSCs) that are safety-related that only perform low safety significant functions.
- RISC-4 structures, systems, and components (SSCs) that are non-safety-related and only perform low safety significant functions.

RISC-2 components are components that were historically constructed to industrial codes because they are non-safety related; however, due to their high risk-significance, they require additional treatments applied to ensure that their safety functions are satisfied. Operating plants typically fulfilled this treatment through maintenance and monitoring.

RISC-3 components are components that are safety-related but have low safety significance. These components were traditionally constructed to nuclear codes, but the U.S. Nuclear Regulatory Commission (NRC) clarified that *industrial codes may be used* to construct such items commensurate with their contributions to safety or risk[1]. The final rulemaking of 10CFR50.69 discusses that while alternate treatments are required for RISC-3 components, the rule are purposefully not prescriptive to provide the licensees with more flexibility.

Advanced reactor designers are expanding the use of risk as a basis to determine safety significance and to select construction codes. Advanced reactor designs often include inherent safety features that result in many systems, structures, and components having a minimal contribution to safety or risk based on an established risk-based categorization process (e.g., NEI 18-04, 10CFR50.69). There is little recognition of this paradigm shift in the nuclear construction codes, including ASME Section III. This has resulted in a divergence where the ASME Section III construction requirements may not be consistent with a component's contribution to safety or risk even though the ASME Section III design rules are well suited for advanced reactor designs.

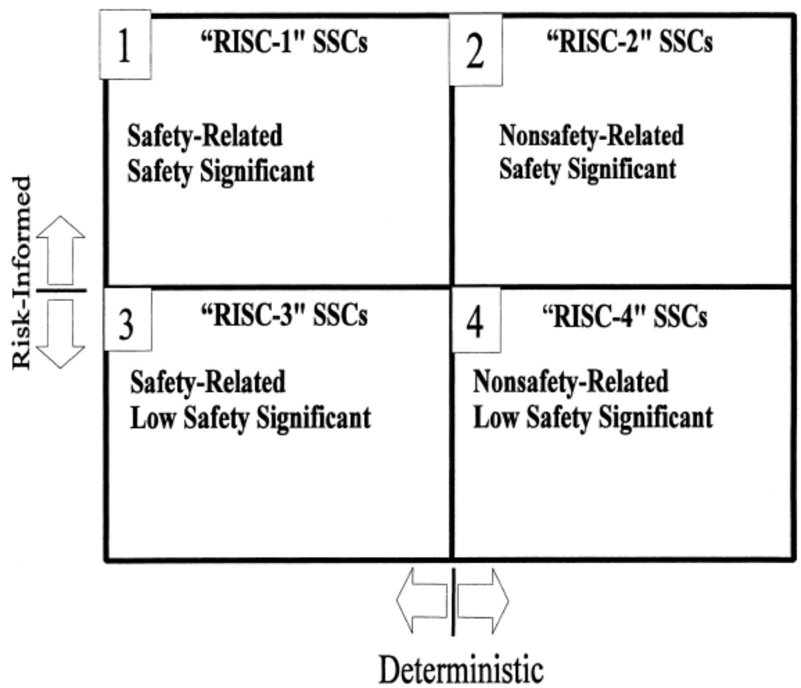

Figure 1. 10CFR50.69 RISC Categories

[1] 10CFR50.69 and "A Comparative Analysis of Special Treatment Requirements for Systems, Structures, and Components (SSCs) of Nuclear Power Plants with Commercial Requirements of Non-Nuclear Power Plants," published in 2002.

3.0 Selection of Construction Codes Based on Risk Assessment

Owners are responsible for establishing an item's contribution to safety or risk and determining an appropriate construction code and, as applicable, Code Class. The Owner, as the licensee or applicant, is responsible for providing and justifying the safety categorization process to the regulator. The Owner (or designee, such as a reactor designer) specifies the construction code and, as applicable, Code Class, in a Design Specification that is provided to a component vendor (e.g., N-Type Certificate Holder) to construct the item.

As discussed in Section 2.0, the regulatory framework as implemented through the 10CFR50.69 process *permits the use of industrial codes for items with low safety significance*, because industrial codes are commensurate with the item's contribution to safety or risk. Therefore, there are two options available to construct such items: (1) ASME Section III or (2) industrial codes (e.g., Section VIII, B31.1, B31.3). Each of these approaches have advantages and disadvantages, as highlighted in Figure 2 and described below.

ASME Section III Construction

- *Advantage:* ASME Section III design rules are well-suited for nuclear applications. ASME Section III includes Service Levels (e.g., faulted events); explicitly established design life; methods to assess neutron embrittlement; strain-based approaches for components in addition to vessels; and consistent design rules for vessels, pumps, piping, valves, supports, core supports, and containments.
- *Disadvantage:* Many ASME Section III requirements are based on the need for a high degree of assurance of pressure integrity consistent with the safety basis of the LWR fleet. This need results in requirements that exceed the assurance necessary for items with minimal contribution to safety or risk, which in turn results in construction where value is not aligned with the safety basis for an advanced reactor design or an individual item's actual contribution to safety or risk.

Industrial Code Construction

- *Advantage:* The requirements for construction are commensurate with an item's minimal contribution to safety or risk. Additionally, the supplier base for industrial components is much larger, resulting in increased market competition and gained efficiencies.
- *Disadvantage:* Industrial code design rules are not well suited for the service and conditions commonly required for nuclear plants, as these codes were not developed specifically for nuclear applications. For example, industrial codes do not have Service Levels that support events such as accidents, seismic events, or faulted events.

ASME Section III	Industrial Codes + Additional Requirements
☑ Rules well suited for nuclear applications	☑ Value commensurate with item's contribution to safety and risk
☒ Value may not be commensurate with item's contribution to safety and risk	☒ Industrial design rules not well suited for nuclear application

Figure 2. Advantages and Disadvantages of ASME Section III and Industrial Codes

4.0 Proposed Alternate Requirements and Technical Basis

ASME Section III is proposing alternate requirements to construct items with minimal contribution to safety or risk which pairs nuclear design rules with alternate general construction requirements consistent with industrial codes. This strategy combines the advantages of each construction approach, discussed above: leveraging the design rules developed specifically for nuclear applications, and aligning ASME Section III construction requirements with typical industrial codes to provide greater value to the nuclear industry for construction of this scope of items.

It remains the Owner's responsibility to (1) determine the applicability of the alternate requirements using the Owner's categorization process and (2) ensure the use of the alternate requirements is consistent with the selected categorization process. The N-Type Certificate Holder is only permitted to use the alternate requirements at the direction of the Owner.

As the goal of the proposed alternate requirements is to maintain the advantages of ASME Section III design rules, no parts of HXX/NX-3000 (Design) or HXX/NX-4000 (Fabrication and Installation) are modified. The proposed alternate construction requirements aligned with industrial codes may be used in lieu of ASME Section III requirements in the areas of:

- Materials procurement,
- Non-destructive examination (NDE) and testing, and
- General requirements.

These three focus areas to increase value are discussed in detail below. Table 1 provides an overview of the major alternate requirements specific to each Code Class/Subsection.

Alternate Material Procurement Requirements

The proposed alternate requirements permit materials to be procured from organizations other than ASME Certified Material Organizations (MOs) and audited Approved Suppliers (ASME Section III, NCA-3800 or NCA-3900). These alternate requirements align with requirements for procurement of materials under industrial codes, such as ASME Section VIII or B31.1, which are acceptable construction codes for items with a minimal contribution to safety or risk.

These alternate requirements do not change the material specifications that are allowed under ASME Section III. Additionally, the alternate requirements do not change any technical requirements in HXX/NX-2000 (which include requirements for NDE, repairs, impact testing, and fracture toughness), as these meet important service needs such as ensuring ductility and creep life. Therefore, the specific technical and testing requirements for materials in nuclear applications are maintained.

Alternate Examination and Testing Requirements

Examinations, UT in Lieu of RT: The proposed alternate requirements permit ultrasonic testing (UT) in lieu of radiography (RT) for all required volumetric examinations. UT in lieu of RT is accepted, by all major industrial codes, including ASME B16.34, B31.1, B31.3, and Section VIII. Therefore, permitting UT in lieu of RT for ASME Section III is consistent with industrial codes which are acceptable for an item that has a minimal contribution to safety or risk.

Progressive Sampling for Examinations of Piping: The proposed alternate requirements permit progressive sampling for examinations of circumferential butt and girth welds in moderate energy Class B piping systems. Progressive sampling for examinations is permitted by ASME B31.3 for moderate energy piping under normal fluid service. Therefore, permitting progressive sampling in the examination of welds for ASME Section III is consistent with industrial codes which are acceptable for a piping system that has a minimal contribution to safety or risk.

Valve Hydrostatic Test Holding Time: The proposed alternate requirements permit shell hydrostatic tests and closure tests of valves using holding times as specified in ASME B16.34. Therefore, permitting alternate hold times for ASME Section III is consistent with industrial codes which are acceptable for a valve that has a minimal contribution to safety or risk.

Moderate Energy Piping System Hydrostatic Test Requirements: The proposed alternate requirements permit moderate energy piping to be hydrostatically tested using the initial service leak test at the system operating pressure in lieu of a higher-pressure hydrostatic test. This is consistent with B31.3 requirements for Category D fluid service. Therefore, permitting a system operating pressure leak test in lieu of a hydrostatic test for Section III is consistent with industrial codes which are acceptable for a low energy piping system that has a minimal contribution to safety or risk.

Alternatives to Subsection NCA: The proposed alternate requirements permit alternative quality requirements. Alternate quality requirements will be consistent with industrial code requirements and treatment of RISC-2, RISC-3 and RISC-4 items categorized using 10CFR50.69. Therefore, it is acceptable to permit alternative Subsection NCA requirements for ASME Section III, consistent with industrial codes, which are acceptable for an item that has a minimal contribution to safety or risk.

Corrective Action Program: The proposed alternate requirements require the N-Type Certificate Holder to maintain a corrective action program to track and monitor the quality of items constructed to the alternate requirements.

5.0 Implementation Approach

ASME Section III is proposing the alternate requirements for items with minimal contribution to safety or risk in three steps[2] (Figure 3):

- The alternate material procurement requirements are currently at ASME Section III Standards Committee for consideration in the 2023 Code Edition (C&S Record 22-979)
- The alternate requirements for examination and testing will be proposed as a Code Case between the 2023 Code Edition and 2025 Code Edition publications (C&S Record 21-1257 and Record TBD)
- The approach for the alternate quality assurance requirements is under development as alternative rules need to be within an N-Type Certificate Holder's QA program to permit stamping.

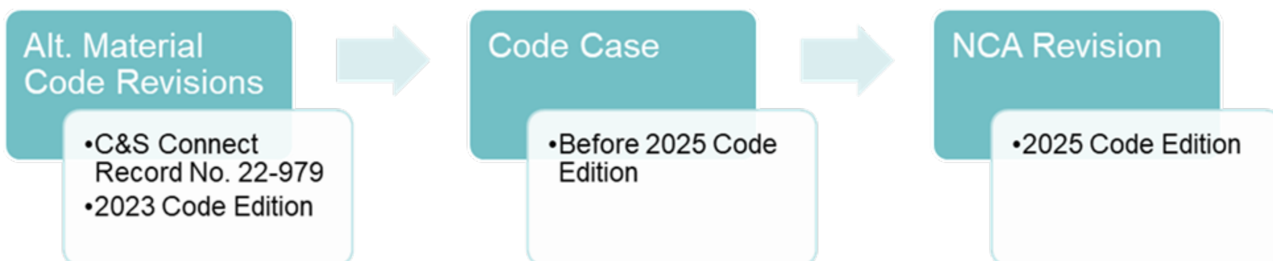

Figure 3. Current Approach to Incorporation of Alternate Requirements in ASME Section III

[2] The Task Group on Alternate Requirements also has C&S Record 21-1257 that was balloted to several Section III committees. The proposed Code Case in C&S Record 21-1257 has evolved into the 3 separate actions discussed in Section 5.0 and shown in Figure 3.

Table 1. Proposed Alternate Requirements

Item's Classification	Material Procurement and Quality Program	UT in lieu of RT	Alt Piping Examinations	Valve Test Hold Times	Hydro Testing of Piping
Class A	X	X	-	X	-
Class B	X	X	X – limited to moderate energy systems	X	X – limited to moderate energy systems
Subsection HG Internal Structures	X	NA[(1)]	-	-	-
Subsection NB	X	X	-	X	-
Subsection NCD	X	X	X – limited to moderate energy systems	X	X – limited to moderate energy systems
	X	X	X – limited to moderate energy systems	X	X – limited to moderate energy systems
Subsection NG Internal Structures	X	NA[(1)]	-	-	-
Metal Containments	X	X	-	-	-
Supports	X	X	-	-	-

Note:

1. Ultrasonic testing in lieu of radiographic testing is already permitted for internal structures.