# ASME NTB-5-2022

## Guidance for Determination of Risk-Informed Safety Classification for Light Water Reactor Nuclear Facility Pressure Retaining Components

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**ASME NTB-5-2022**

# GUIDANCE FOR DETERMINATION OF RISK-INFORMED SAFETY CLASSIFICATION FOR LIGHT WATER REACTOR NUCLEAR FACILITY PRESSURE RETAINING COMPONENTS


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# FOREWORD

Over the last forty years there have been significant gains in the understanding of pressure boundary component integrity, factors that impact component reliability, the impact of inspections and the type of inspection, as well as risk assessment insights related to operating nuclear power reactors. This experience has brought about changes related to operating and inspection requirements including changes to ASME Section XI and Operation and Maintenance (OM) requirements, augmented inspection programs mandated by the regulator as well as plant specific actions taken by individual owners.

For ASME Section XI programs, these efforts have included new and revised code cases (e.g. N560, N577, N578, N660, N716 and N752) and the development of pilot and follow-on plant specific applications. For U.S. Nuclear Regulatory Commission (NRC) mandated programs, these efforts have included integration with risk-informed in-service inspection (ISI) programs, performance based initiatives as well as extension to new areas including break exclusion region/high energy line break BER/HELB requirements.

The action discussed in this NTB takes advantage of the aforementioned work and proposes a balanced action that reduces undue burden while ensuring plant safety. This action was in part spurred on by the NRC's Advisory Committee on Reactor Safeguards (ACRS), who in 1999, chided the industry as being "overly timid" in implementing risk-informed technology.

Thus, this action represents the next step in the use of risk-informed technology for defining ASME Section III requirements. This action builds upon the work done at ASME Sections III and XI and OM Code, the industry and the NRC in developing and implementing risk-informed classification, in-service and pre-service inspection activities as well as in-service testing activities. This action provides a balanced and reasonable alternative to existing requirements for pressure boundary classification and applicable "treatment" activities. This approach provides for transparency, reproducibility and stability to the code, code users, as well as regulatory bodies.

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# ABSTRACT

Code Case N660, Revision 0 "Risk-Informed Safety Classification for Use in Risk-Informed Repair/ Replacement Activities," was published by ASME and was developed to expand the breadth of risk informed ASME Section XI requirements to pressure boundary components. This effort was conducted in conjunction with NRC and industry efforts dealing with risk informing Title 10 Code of Federal Regulations Part 50 (10CFR50) as outlined in SECY-98-300 (NRC, 1998).

Since N660, Rev 0 was published several important accomplishments have occurred. The South Texas Project (STP) exemption request was approved and implementation is underway, N660, R0 was tested on a number of systems, a final 10CFR50.69 rule was published, NEI00-04 was developed and updated and trial applications were conducted.

Based upon lesson learned from the above, an alternative to N660 was developed (draft code case N752) and used by ANO, Unit 2 in their risk-informed repair/replacement application. Draft code case N752 was ultimately updated to reflect lessons learned from this NRC approved application and was published in 2019.

Since that time, Vogtle Units 1 and 2 have been approved to use the draft code case N752 methodology in their 10CFR50.69 pilot plant application which was approved by the NRC in 2014. More recently, the US industry is moving quickly forward with site specific 10CFR50.69 license amendment requests (thirty three additional units approved to date), each using code case N752 methodology for categorization of the pressure boundary.

Further, Regulatory Guide 1.26, has been updated (revision 5) to reflect the use of risk-informed classification processes. In particular, it references regulatory positions for the acceptable use of processes to determine the safety significance of SSCs and place them into the appropriate risk-informed safety class (RISC) categories

This document provides guidance for determination of risk-informed safety classification for light water reactor (LWR) nuclear facility pressure retaining components and their welded attachments and supports, ASME Section III, Division 1, Subsections NCA, NB, NC, ND, and NF.

## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AISC | American Institute of Steel Construction |
| ANSI | American National Standards Institute |
| API | American Petroleum Institute |
| ASME | American Society of Mechanical Engineers |
| CCDP | Conditional Core Damage Probability |
| CFR | U.S. Code of Federal Regulations |
| CLERP | Conditional Large Early Release Probability |
| FMEA | Failure Modes and Effects Analysis |
| HSS | High-Safety Significant |
| IE | Initiating Event |
| LSS | Low-Safety Significant |
| NRC | U.S. Nuclear Regulatory Commission |
| O&M | Operations and Maintenance |
| PDF | Portable Document Format |
| PRA | Probabilistic Risk Assessment |
| PWR | Pressurized Water Reactor |
| QA/QC | Quality Assurance / Quality Control |
| RISC | Risk Informed Safety Classification |
| SCADA | Supervisory Control and Data Acquisition |
| Section III | Section III of the ASME Boiler and Pressure Vessel Code, Rules for Construction of Nuclear Facility Components |
| SME | Subject Matter Expert |

# DEFINITIONS

**basic safety function** – one of the key safety functions of the plant; reactivity control, core cooling, heat sink, and reactor coolant system (RCS) inventory [Note: loss of a single train would typically not constitute a loss of a function]

**completion time (CT)** – the amount of time allowed for returning a component or function to service. In the context of this document, the required action is to restore operability (as defined in the technical specifications) to the affected system or equipment train

**conditional consequence** – an estimate of an undesired consequence, such as core damage or a breach of containment, assuming failure of an item (e.g., conditional core damage probability (CCDP))

**conditional core damage probability (CCDP)** – an estimate of the probability of core damage given a specific failure (e.g., piping segment failure)

**conditional large early release probability (CLERP)** – an estimate of the probability of large early release (i.e., breach of containment) given a specific failure (e.g., piping segment failure)

**containment barrier** – containment barrier is defined as a component(s) that provides a containment boundary / isolation function such as normally closed valves or valves that are designed to automatically close when containment isolation is required

**core damage** – uncovery and heatup of the reactor core to the point at which prolonged oxidation and severe fuel damage are anticipated and involving enough of the core, if released, to result in offsite public health effects

**failure** – an event involving leakage, rupture, or other condition that would prevent an item from performing its intended safety function

**failure mode** – a specific functional manifestation of a failure (i.e., the means by which an observer can determine that a failure has occurred) by precluding the successful operation of a piece of equipment, a component, or a system (e.g., fails to start, fails to run, leaks)

**failure modes and effects analysis (FMEA)** – a process for identifying failure modes of specific items and evaluating their effects on other components, subsystems, and systems

**failure potential** – likelihood of ruptures or leakage that result in a reduction or loss of the pressure-retaining capability of the item or the likelihood of a condition that would prevent an item from performing its safety function (e.g., fails to start, fails to run)

**high-energy piping system** – a system that is either in operation or maintained pressurized under conditions where either or both of the following are met:

a. operating temperature exceeds 200 ºF (95 °C), or
b. operating pressure exceeds 275 psig (1.90 MPa)

**high-safety-significant (HSS) function** – a function that has been determined to be safety significant from an approved risk-informed categorization process using a plant-specific probabilistic risk assessment and / or other relevant deterministic information (e.g., defense-in-depth philosophy[1] considerations) as described in I-3.2.

**initiating event (IE)** – any event either internal or external to the plant that perturbs the steady state operation of the plant, if operating, thereby initiating an abnormal event, such as an earthquake or a transient or loss of coolant accident (LOCA) within the plant. Initiating events trigger sequences of events that challenge plant control and safety systems whose failure could potentially lead to core damage or large early release

[1] U.S. NRC Regulatory Guide 1.174 provides a definition for defense-in-depth philosophy

**large early release** – the rapid unmitigated release of airborne fission products from the containment to the environment occurring before the effective implementation of off-site emergency response and protective actions such that there is a potential for early health effects

**loop –** a subset of a system or a train (e.g. many emergency core cooling systems in PWR plants contain four injection paths also known as injection loops

**low-safety-significant (LSS) function** – a function not determined to be high-safety significant from an approved risk significance categorization process using a plant-specific plant probabilistic risk assessment and / or other relevant deterministic information (e.g., defense-in-depth philosophy[1] considerations) as described in I-3.2.

**operator recovery action** – a human action performed to regain equipment or system operability after a specific failure or human error in order to mitigate or reduce the consequences of the failure

**piping segment** – a continuous portion of piping, components, or a combination thereof in which a failure (i.e., loss of its pressure-retaining function) at any location results in the same consequence (e.g., loss of a system, loss of a pump train)

**plant mitigative features** – systems, structures, and components that can be relied on to prevent an accident or that can be used to mitigate the consequences of an accident

**probabilistic risk assessment (PRA)** – a qualitative and quantitative assessment of the risk associated with plant operation and maintenance that is measured in terms of frequency of occurrence of risk metrics, such as core damage or a radioactive material release and its effects on the health of the public (also referred to as a probabilistic safety assessment, PSA)

**risk metrics** – a determination of what activity or conditions produce the risk, and what individual, group, or property is affected by the risk

**spatial effect** – a failure consequence affecting other systems or components, such as failures due to pipe whip, jet impingement, jet spray, loss of inventory due to draining a tank, or flooding

**success criteria** – criteria for establishing the minimum number or combination of systems or components required to operate, or minimum levels of performance per component during a specific period of time (mission time), to ensure that the safety functions are satisfied

**train** – as used in this document, a train consists of a set of equipment (e.g., pump, piping, associated valves, motor, and control power) that individually fulfills a safety function (e.g., high pressure safety injection) with a mean unavailability of 1E-02 as credited in Table I-2 and Table I-3. A half train (0.5 trains) should have a mean unavailability of 1E-01, 1.5 trains should have a mean unavailability of 1E-03, etc.

**unaffected backup train** – a train that is not adversely impacted (i.e., failed or degraded) by the postulated piping failure in the FMEA evaluation. Impacts can be caused by direct or indirect effects of the postulated piping failure.

# 1 SCOPE

This document provides a process for determining the Risk-Informed Safety Classification (RISC) of light water reactor nuclear facility Class 1, 2 and 3 pressure-retaining components and their welded attachments and supports. Pressure retaining components may include passive components (e.g., piping, vessels, tanks, etc.) and the pressure-retaining portion of active components (e.g., valve bodies, pump casings, etc.) and their welded attachments and supports.