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Plant Systems Design

AN AMERICAN NATIONAL STANDARD



The American Society of Mechanical Engineers

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FOREWORD

At the time work on this Standard was begun, the financial and schedule risk for developing nuclear facilities, including power generation; fossil power generation facilities (e.g., coal, natural gas); oil refining; oil and natural gas production; petrochemical; chemical; and hazardous waste plants and facilities was growing to unacceptable levels. This Standard was created to improve the outcomes in developing new plants.

The focus of this Standard is on new plant design. However, it can be used for design of new capabilities being added to existing plants. It includes requirements and guidance that considers the entire life cycle of a plant from initial design through decommissioning.

Plant hazards and sources of unavailability are identified and evaluated in all design phases. These integrated design and risk evaluation processes provide assurance that health, safety, and environmental risk objectives, as well as production risk objectives, are met and that the plant design is optimized for product quality, safety, and life cycle availability.

Relative to current design practices, the objectives of this Standard are to:

(a) optimize integration of health, safety, and environmental risk evaluations with design

(b) reduce new plant design, construction, commissioning and life cycle costs

(c) reduce licensing and construction uncertainty

(d) further optimize operating plant product quality and availability

These objectives are accomplished by providing a technology independent framework (see Part 2, Design Development Processes), including requirements and guidance, for organizations to perform the following activities, which are the focus of this Standard:

(a) Conduct systematic plant hazard and risk evaluations and analyses in the early phases of design that:

(1) advance as the design matures and

(2) provide structure to the development of qualitative and quantitative risk and availability assessments that include reliability.

(b) Incorporate and integrate existing systems engineering design processes, practices and tools with traditional architect engineering design processes, practices, and tools.

(c) Integrate probabilistic design processes, practices and tools with traditional deterministic design processes using reliability and availability targets.

Key concepts that are implemented with this Standard are:

- It supports the design of new first-of-a-kind plants that incorporate new technologies.
- It can be used for design of new processes or capabilities being added to existing plants
- Requirements definition and design processes consider the entire life cycle of a plant
- The processes described herein establish required activities and guidance to reduce development and operational risks and costs for such facilities.
- Organizations implementing this Standard are expected to integrate them into their design processes and procedures.
- It provides processes, practices, and tools to address hazards and risks associated with operation of the plant. It includes risks to plant production and safety.
- It does not directly address occupational safety risk, e.g., slips and falls. It is the responsibility of the project organization to ensure occupational safety risks, as well as related and applicable regulatory requirements and guidance, applicable to the plant have been incorporated into the design.
- Organizations will improve the quality and transparency of designs by implementing processes and guidance provided by this Standard, resulting in safer and more efficient designs with quantified risks.
- The provisions of this Standard center on the “what” and the “why” for the three focus activities identified above. References to additional national standards and other sources are provided for the detailed “how” to perform the activities. Nonmandatory appendices provide additional information or guidance when using this Standard for clarification, illustration, example, and general information.

This Standard may reference documents and other standards that have been superseded or withdrawn at the time the standard is applied. A statement has been included in the references section that provides guidance on the use of references.

This Standard was approved by the ASME Standards Committee on Plant Systems Design on July 7, 2025. It was approved as an American National Standard by the American National Standards Institute (ANSI) on January 5, 2026.

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Revisions and Errata. The committee processes revisions to this Standard on a periodic basis to incorporate changes that appear necessary or desirable as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published in the next edition of the Standard.

In addition, the committee may post errata on the committee web page. Errata become effective on the date posted. Users can register on the committee web page to receive email notifications of posted errata.

This Standard is always open for comment, and the committee welcomes proposals for revisions. Such proposals should be as specific as possible, citing the paragraph number, the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent background information and supporting documentation.

Cases

(a) The most common applications for cases are

(1) to permit early implementation of a revision based on an urgent need

(2) to provide alternative requirements

(3) to allow users to gain experience with alternative or potential additional requirements prior to incorporation directly into the Standard

(4) to permit the use of a new material or process

(b) Users are cautioned that not all jurisdictions or owners automatically accept cases. Cases are not to be considered as approving, recommending, certifying, or endorsing any proprietary or specific design, or as limiting in any way the freedom of manufacturers, constructors, or owners to choose any method of design or any form of construction that conforms to the Standard.

(c) A proposed case shall be written as a question and reply in the same format as existing cases. The proposal shall also include the following information:

(1) a statement of need and background information

(2) the urgency of the case (e.g., the case concerns a project that is underway or imminent)

(3) the Standard and the paragraph, figure, or table number

(4) the editions of the Standard to which the proposed case applies

(d) A case is effective for use when the public review process has been completed and it is approved by the cognizant supervisory board. Approved cases are posted on the committee web page.

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PART 1 GENERAL PRINCIPLES AND COMMON REQUIREMENTS

Section 1-1, Introduction

1-1.1 Purpose

This Standard provides requirements and guidance for design processes, methodologies and tools that will enable designers to provide safer and more efficient designs with quantified risks. Part 2 of this Standard provides a technology independent framework for organizations responsible for implementing this Standard to perform the following activities:

a) a) Conduct a systematic plant hazard evaluation and risk analysis in the early phases of design that:
    a. advance as the design matures, and
    b. provide structure to the development of qualitative and quantitative risk and availability assessments that include reliability.
b) Incorporate and integrate existing systems engineering design processes, practices and tools with traditional architect engineering (AE) design processes, practices and tools.
c) Integrate risk-informed probabilistic design processes, practices and tools with traditional deterministic design processes using reliability and availability targets.

The processes described herein establish a minimum set of requirements for the responsible organization to follow in order meet the intent of this Standard and to appropriately integrate them into their existing design processes and procedures. In this Standard, responsible organization (RO) has a very specific meaning. It is an organization responsible for performing one or more activities required by this Standard as contracted with the customer and specified in project planning documents.

The RO selects and implements specific requirements necessary for implementation of this Standard including support for accidents or expected operational occurrences through design analyses, experimental models, conformance with applicable regulations, industrial codes and standards, and experience gained from similar designs. Section 1.1.10, Project Planning and Management, requires the RO to document this selection in a plan describing how applicable parts of this Standard are integrated into overall project planning and design processes.

1-1.2 Objectives

The objectives of this Standard are to:

a) reduce technical risk to project scope, cost and schedule
b) optimize integration of health, safety, and environmental risk evaluations with design
c) reduce new plant design, construction, commissioning, and life cycle costs
d) reduce licensing and construction uncertainty
e) further optimize operating plant product quality and availability

Incorporating the above objectives within this Standard as enhancements to current industry design practices will:

(a) reduce design errors or omissions that can increase the cost of design, construction, operation, maintenance, decontamination, decommissioning, and disposal