Standards and Certification Training

Module B – Process

B10. Performance-Based Standards

MODULE B COURSE OUTLINE

B1. ASME Organizational Structure
B2. Standards Development: Staff and Volunteer Roles and Responsibilities
B3. Conformity Assessment: Staff and Volunteer Roles and Responsibilities
B4. Initiating and Terminating Standards Projects
B5. Consensus Process for Standards Development
B6. The Basics of Parliamentary Procedure
B7. The Appeals Process
B8. International Standards Development
B9. ASME Conformity Assessment Programs
B10. Performance-Based Standards
B11. Consensus Process for Standards Interpretation and Code Cases

Module B contains eleven submodules. This is Module B10 – performance-based Standards.

REVISIONS

DATE	CHANGE
06/30/26	Editorially revised, new slide on qualitative vs. quantitative requirements, updated reference to CSP-62 with guidance.
09/07/17	Editorially revised and restructured presentation
9/20/12	Minor revisions to update format, revised the slide titles and other minor editorial revisions
11/22/10	Changed "Codes and Standards Board of Directors" to "Council on Standards and Certification" throughout

LEARNING OBJECTIVES

At the end of this module you will be able to:

- Understand the concept of performance-based standards
- Describe the advantages of such standards
- Provide examples of performance-based provisions in ASME standards
- Describe the actions standards committees can take to incorporate performance-based specifications into their standards

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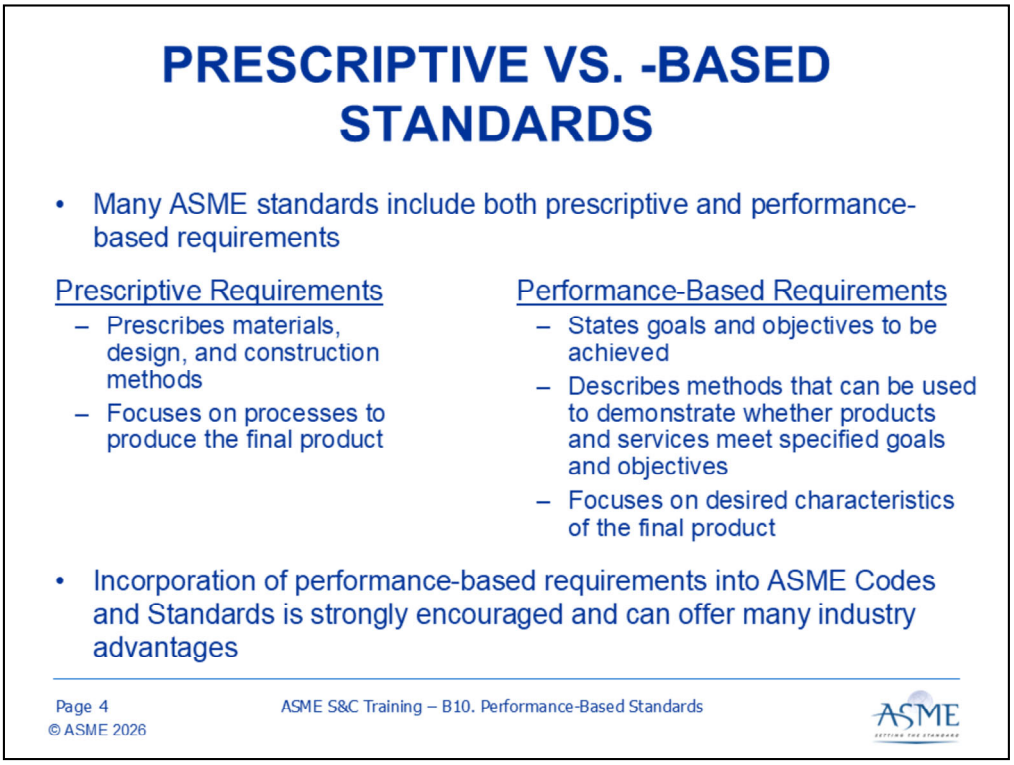


Many ASME standards include both prescriptive and performance elements, but most lean heavily towards being prescriptive specifications.

- A prescriptive standard, typically prescribes materials properties, design requirements and construction methods without necessarily stating goals and objectives.
- A performance-based standard, also known as objective based standards, states goals and objectives to be achieved and describes methods that can be used to demonstrate whether or not products and services meet the specified goals and objectives. A performance-based standard focuses on desired characteristics of the final product, service or activity rather than requirements for the processes to produce it.

The incorporation of performance-based requirements is strongly encouraged as the addition of performance-based requirements can offer many industry advantages.

QUALITATIVE VS QUANTITATIVE REQUIREMENTS

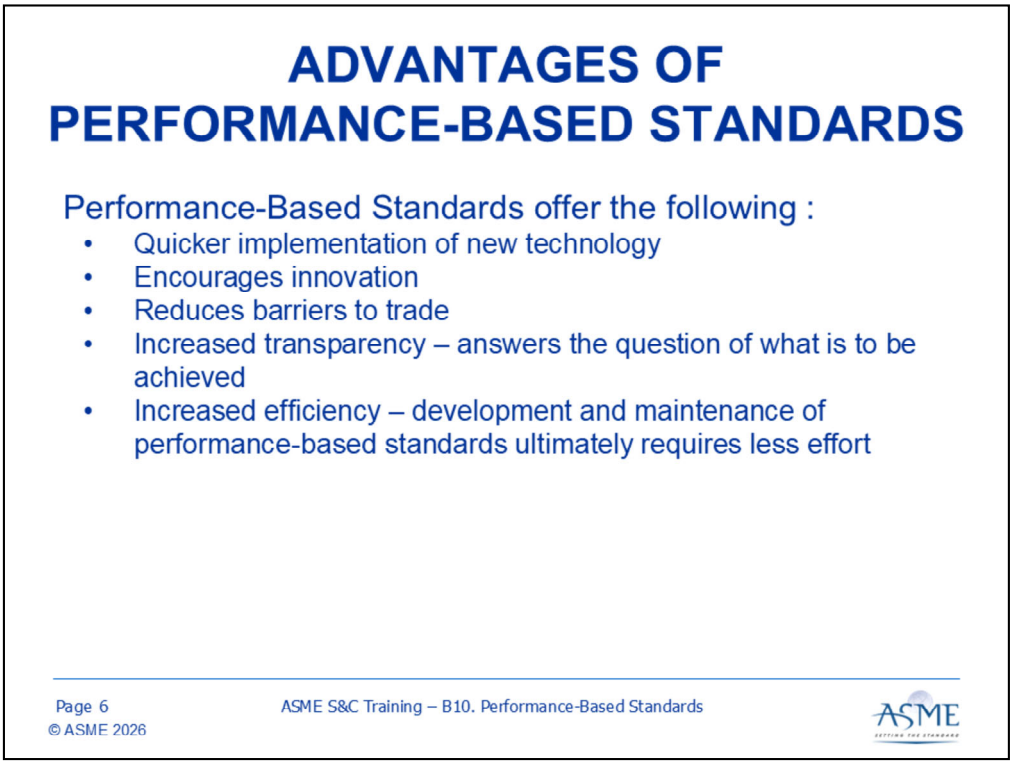
- Many ASME standards include both qualitative and quantitative requirements

Qualitative Requirements
- Relating to, measuring, or measured by the quality of something rather than its quantity.
- Non-numerical
- Information relating to characteristics or features

Quantitative Requirements
- Relating to, measuring, or measured by the quantity of something rather than its quality.
- Numerical
- Can be objectively counted, measured, or calculated

Many ASME standards include both qualitative and quantitative requirements.

- A qualitative requirement refers to a non-numerical, descriptive requirement that relates to characteristics or features.
- A quantitative requirement is a numerical requirement that can be objectively counted, measured, or calculated.



There are many advantages to incorporating performance-based requirements into codes and standards. Specifically, performance-based standards:

- Allow earlier use of new technology. The users of these standards are free to implement new technology as soon as it is demonstrated, without waiting for standards development committees to modify standards to explicitly permit use of new technology.
- Encourage people to find optimal ways to meet performance criteria, which results in building the knowledge base and developing the entrepreneurial spirit, which in turn leads to economic development.
- Reduce barriers to trade by permitting the use of new or nontraditional parts and methods when their use meets the performance criteria. This widens the marketplace, no longer limiting the acceptable suppliers to those manufacturers or countries with specific resources.
- Have clearly stated goals and objectives, which answer the question of what is to be achieved. For most prescriptive standards, the goals and objectives are implied at best.
- Ultimately require less effort for development and maintenance. While it may be more difficult to establish goals and objectives initially, the decision for inclusion of various requirements is much simpler. Maintenance can be simpler as well. For example, a standard that describes the properties of acceptable materials of construction is much easier to maintain than one that lists acceptable materials by reference to various material standards.

The next few slides will give examples of performance-based and prescriptive requirements and offers suggestions on how performance-based requirements could be incorporated into a code or standard.

PERFORMANCE-BASED REQUIREMENTS EXAMPLE 1

This is one method for incorporating a performance-based specification:

"Bolted flanged joints shall be leak-free for the intended service. The joint shall be hydrotested at 1.5 times the design pressure without leaking and shall be demonstrated to be able to withstand expected external forces without leakage while at design pressure and temperature."

Advantage *– allows users complete freedom to use any suitable products*

Disadvantage *– testing and calculations are required for proven solutions*

This is one method for incorporating ~~a~~ performance-based requirement~~s~~:

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Advantage *– allows users complete freedom to use any suitable products.*

Disadvantage *– testing and calculations are required for proven solutions.*

PERFORMANCE-BASED REQUIREMENTS EXAMPLE 2

This is an example of performance-based specifications that does not give specific enough requirements:

"The provisions of this standard are not intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety to those prescribed by this Code, provided that there is technical documentation to demonstrate the equivalency of the system, method or device."

Advantage *– allows users the freedom to use suitable innovative approaches*

Disadvantage *–There is insufficient guidance on what equivalency is and how to demonstrate it*

This shows a performance-based specification that does not give specific enough requirements:

"The provisions of this standard are not intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety to those prescribed by this Code, provided that there is technical documentation to demonstrate the equivalency of the system, method or device."

Advantage *–allows users the freedom to use suitable innovative approaches.*

Disadvantage *–insufficient guidance on what equivalency is and how to demonstrate it. Depending on the nature of the departure from the prescriptive requirements, and who is judging equivalency, demonstrating equivalency can be very difficult.*

PRESCRIPTIVE REQUIREMENTS EXAMPLE

Prescriptive requirements, such as the following, are found in many ASME codes and standards:

"Bolted flanged joints shall meet the requirements of
- ASME B16.5, or
- ASME BPVC Section VIII, Division 1, Appendix 2"

Advantage – *gives clear guidance on what is required*

Disadvantage – *does not allow users to use suitable innovative products that may be available*

Prescriptive requirements, such as the following, are commonly found in many ASME codes and standards:

"Bolted flanged joints shall meet the requirements of

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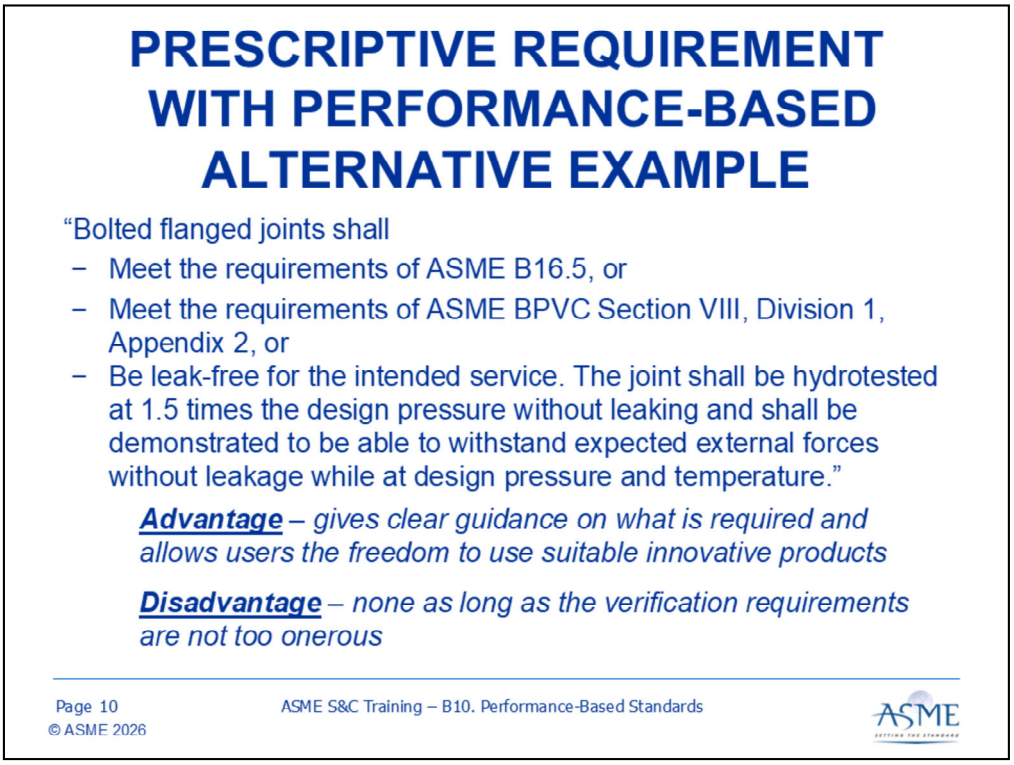


The following example shows how both prescriptive and performance-based specifications can be combined to retain the prescriptive elements, while allowing for performance-based options.

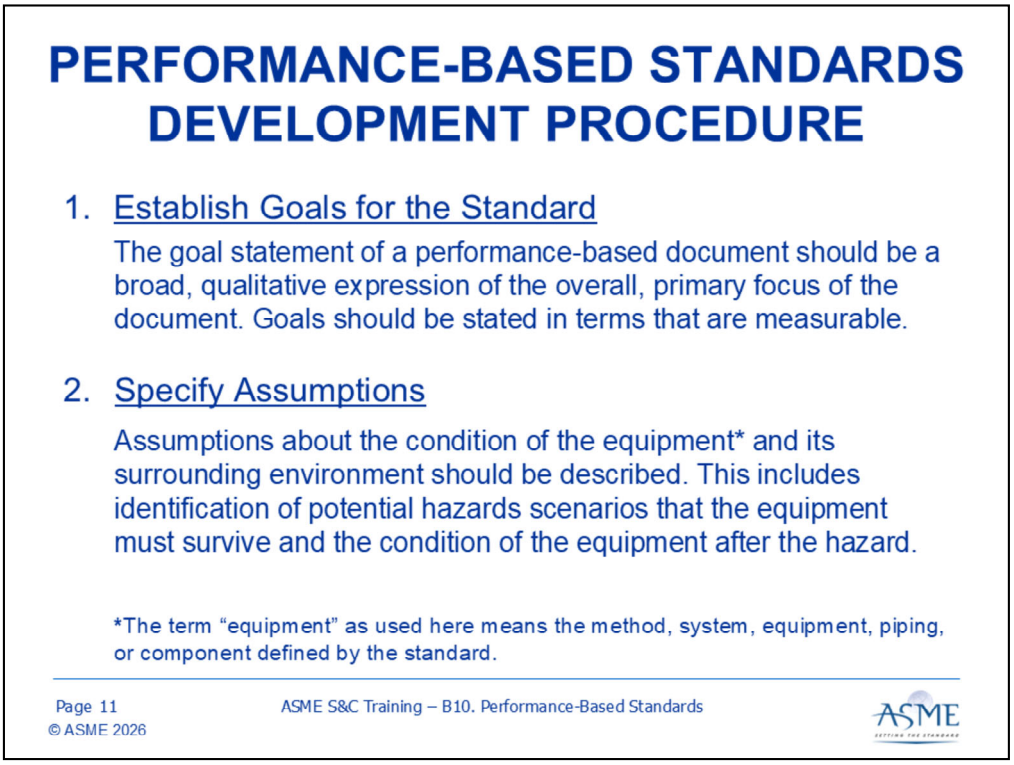
"Bolted flanged joints shall

- Meet the requirements of ASME B16.5, or
- Meet the requirements of ASME BPVC Section VIII, Division 1, Appendix 2, or
- Be leak-free for the intended service. The joint shall be hydrotested at 1.5 times the design pressure without leaking and shall be demonstrated to be able to withstand expected external forces without leakage while at design pressure and temperature."

Advantage *– gives clear guidance on what is required and allows users the freedom to use suitable innovative products.*

Disadvantage *– none as long as the verification requirements are not too onerous.*

The next section will cover how a standards development committee can incorporate these requirements into their code or standard.



There are five basic development steps for creating performance-based standards:

1. **Establish Goals for the Standard**

The goal statement of a performance-based document should be a broad, qualitative expression of the overall, primary concern of the document. Thus, goals may be stated in terms of impact on people, property or the environment, business interruption, or any combination of these. Goals should address the primary concern of the document. Goals should be stated in terms that are potentially measurable, even if the precise measurement scale is not specified.

2. **Specify Assumptions Including Hazard Scenarios**

Assumptions about the condition of the equipment* and its surrounding environment should be described. The hazard scenarios that the equipment must survive and the condition of the equipment after the hazard must also be described. A hazard scenario is a detailed description of the conditions or factors related to any stage of development critical to the results regarding the goals of the standard.

*The term "equipment" as used here means the method, system, equipment, piping, or component defined by the standard.

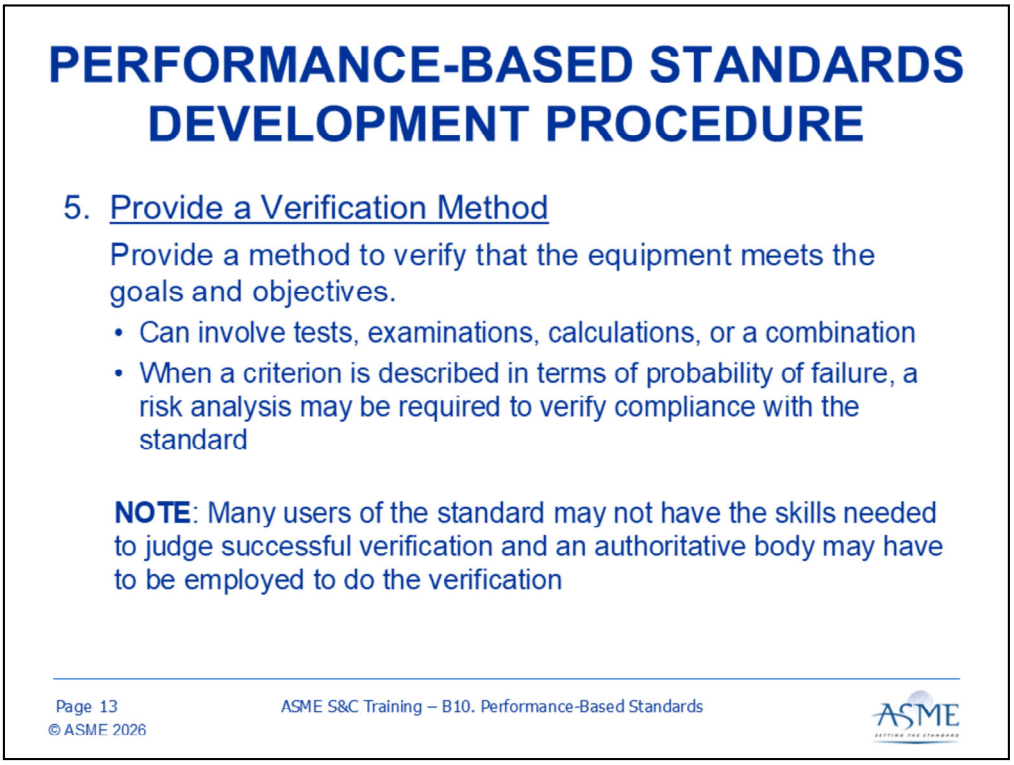
3. Establish Objectives

Performance objectives are those things necessary to meet specified goals. The objectives of performance-based standards are intended to be more specific than goals. In the context of performance-based provisions, objectives provide a greater level of detail than goals. Objectives are stated in more specific terms than goals and are measured on a more quantitative rather than qualitative basis. Objectives are the link between goals and performance criteria. In general, objectives define a series of actions necessary to make the achievement of a goal much more likely. A good example of a set of objectives can be found in A17.7/CSA B44.7, Performance-based safety code for elevators and escalators, Part 3: Global essential safety requirements (GESRs) for Elevators. A detailed example will be covered in a later slide.

4. Performance Criteria

Performance criteria are those things necessary to meet the objectives. Performance criteria tend to be the most specific parts of performance-based documents. Criteria can be thought of as quantified objectives, which state in engineering terms the required level of performance.

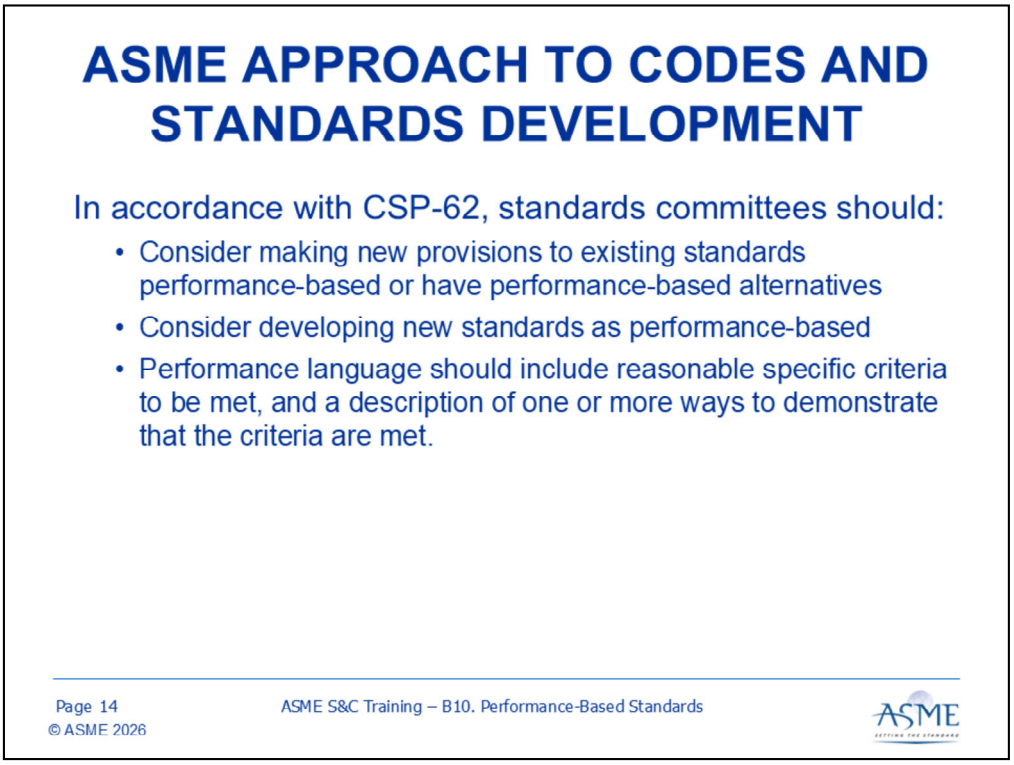
Example: A performance criterion to meet the objective described above might be stated as “The average retardation caused during the emergency stopping of elevators shall not exceed 0.33g.”



5. Verification

Since a performance-based design will frequently involve features that do not comply with prescriptive requirements, it is necessary to verify that the equipment meets the goals and objectives. Verification can involve tests, examinations, calculations or a combination. When a criterion is described in terms of probability of failure of equipment, a risk analysis may be required to verify compliance with the standard.

NOTE: Many users of the standard may not have the skills needed to judge successful verification~~,~~ and an authoritative body may have to be employed to do the verification.

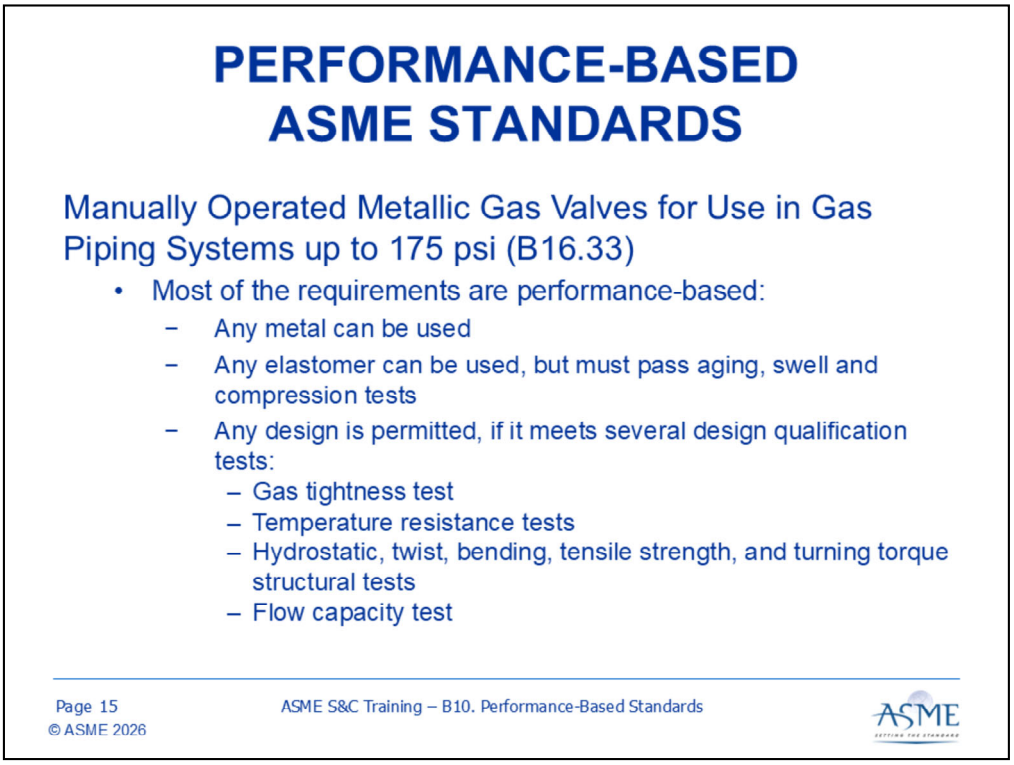


All standards committees should develop goals, assumptions and objectives.

- Note that even for a largely prescriptive standard, developing assumptions, and establishing goals and objectives are extremely useful exercises for any standard developing group.
- The goals, assumptions and objectives should be developed and maintained for each standard as part of the published document or in a separate committee working document.
- Documenting these things will make it easier for the committee to decide whether or not to add certain requirements, and will make inclusion of performance-based requirements much simpler.

ASME Codes and Standards Policy CSP-62 states that:

- standards committees should consider making new provisions to existing standards become performance-based or have performance-based alternatives.
- standards committees should consider making new standards performance-based.
  - It is recognized that the performance-based approach is not appropriate for some standards. The request is that standards committees strongly contemplate the advantages of developing performance-based standards and performance-based provisions in new and existing standards.
  - Performance language should include reasonable specific criteria to be met, and a description of one or more ways to demonstrate that the criteria are met.



Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 125 psi (B16.33) is largely performance-based but does have some prescriptive requirements.

Since most of the requirements are performance-based, that means:

- Any metal can be used
- Any elastomer can be used, but must pass aging, swell and compression tests
- Any design is permitted if it meets several design qualification tests, such as:
  - Gas tightness test
  - Temperature resistance tests
  - Hydrostatic, twist, bending, tensile strength, and turning torque structural tests
  - Flow capacity test

Some examples of the more prescriptive requirements in B16.33 are:

- Ends must be threaded to B1.20.1 or flanged to B16.1 or B16.5
- Valves must have certain identifying markings
- All valves must be leak tested

PERFORMANCE-BASED STANDARDS DEVELOPMENT PROCEDURE

Code for the Operation and Maintenance of Nuclear Power Plants (OM-2022), Section CV-2.4: Check Valve Condition Monitoring Program:

- This Section describes essential requirements for implementing and maintaining a check valve condition monitoring program, but leaves the specifics to the owner. Some of the essential requirements are:
  - Determine bases for establishing groups of check valves
  - Analyze the test and maintenance history that must be done
  - Determine attributes to be monitored and activities needed to monitor
  - Perform the needed activities
  - Retain certain documentation

The Code for the Operation and Maintenance of Nuclear Power Plants (OM-2022) is largely prescriptive and has some performance-based requirements. Among the performance-based requirements is Section CV-2.4, Check Valve Condition Monitoring Program:

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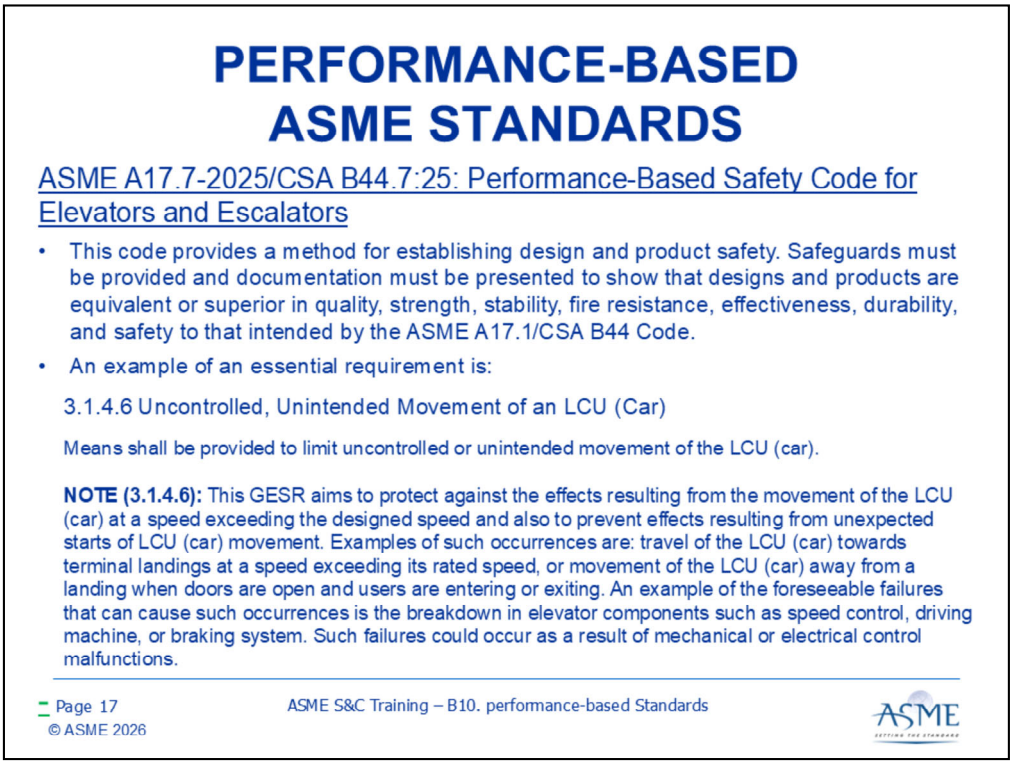

ASME A17.7-2025/CSA B44.7-25: performance-based Safety Code for Elevators and Escalators. This code provides a method for establishing design and product safety. Safeguards must be provided and documentation must be presented to show that designs and products are equivalent or superior in quality, strength, stability, fire resistance, effectiveness, durability, and safety to that intended by the ASME A17.1/CSA B44 Code. An example of an essential requirement is:

“Para. 3.1.4.6 Uncontrolled, Unintended Movement of an LCU (Car)

Means shall be provided to limit uncontrolled or unintended movement of the LCU (car).

NOTE (3.1.4.6): This GESR aims to protect against the effects resulting from the movement of the LCU (car) at a speed exceeding the designed speed and also to prevent effects resulting from unexpected starts of LCU (car) movement. Examples of such occurrences are: travel of the LCU (car) towards terminal landings at a speed exceeding its rated speed, or movement of the LCU (car) away from a landing when doors are open and users are entering or exiting. An example of the foreseeable failures that can cause such occurrences is the breakdown in elevator components such as speed control, driving machine, or braking system. Such failures could occur as a result of mechanical or electrical control malfunctions.

PERFORMANCE-BASED ASME STANDARDS

Process Piping (B31.3-2024)

This code has many prescriptive and many performance-based requirements. Among the performance-based requirements is the permission to use unlisted materials. About unlisted materials, B31.3-2024, Para. 323.1.2 states:

> "Unlisted materials may be used provided they conform to a published specification covering chemistry, physical and mechanical properties, method and process of manufacture, heat treatment, and quality control, and otherwise meet the requirements of this Code. Allowable stresses shall be determined in accordance with the applicable allowable stress basis of this Code or a more conservative basis."

Process Piping (B31.3-2024). This code has many prescriptive and many performance-based requirements. Among the performance-based requirements is the permission to use unlisted materials. An example on unlisted materials in B31.3-2024; Para. 323.1.2 is:

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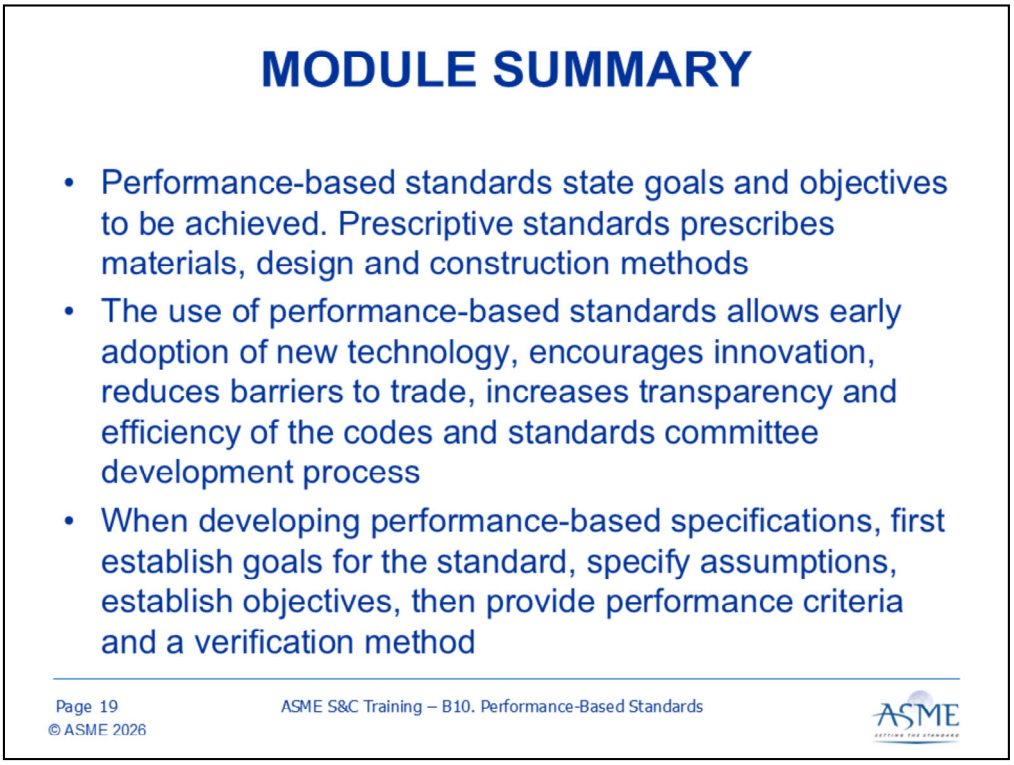

- Performance-based standards state goals and objectives to be achieved. Prescriptive standards prescribes materials, design and construction methods.
- The use of performance-based standards allows early adoption of new technology, encourages innovation, reduces barriers to trade, increases transparency and efficiency of the codes and standards committee development process.
- When developing performance-based specifications, first establish goals for the standard, specify assumptions, establish objectives, then provide performance criteria and a verification method.

REFERENCES

- ASME C&S Polices, Procedures and Guidelines

https://cstools.asme.org/csconnect/CommitteePages.cfm?Committee=100726310&Action=7609

- Examples of Performance Based Provisions

https://cstools.asme.org/csconnect/FileUpload.cfm?View=yes&ID=19679

- Codes and Standards Policy (CSP)

https://cstools.asme.org/csconnect/FileUpload.cfm?View=yes&ID=59993

References