Module B – Process
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B10. Performance Based Standards

ASME
Setting the Standard
This submodule will
Introduce the concept of performance based standards
Describe the advantages of such standards
Provide examples of performance based provisions in ASME standards
Describe actions for standards committees
AGENDA

I. Performance Based Standards – What are They?
II. Performance Based Standards – Development Process
III. Our Approach
IV. Performance Based Provisions in Current ASME Standards

Agenda
Performance Based Standards – What are They?
Performance Based Standards – Development Process
Our Approach
Performance Based Provisions in Current ASME Standards
Part I – Performance Based Standards – What are They?
A performance based standard 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. Contrast a prescriptive standard, which typically prescribes materials, design and construction methods frequently without stating 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. Note that performance based standards are also known as objective based standards. Many ASME standards include both prescriptive and performance elements, but most lean heavily towards being prescriptive standards.
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Advantages:

**New Technology** – 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.

**Innovation** – Performance based standards encourage people to find optimum ways to meet performance criteria, which results in building the knowledge base and developing the entrepreneurial spirit, which in turn leads to economic development.

**Barriers to Trade** – Performance based standards permit 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.

**Transparency** – Performance based standards that have clearly stated goals and objectives answer the question of what is to be achieved. For most prescriptive standards, the goals and objectives are implied at best and unknown at worst. For many rules in prescriptive standards, we cannot answer with certainty the question of what end function is to be achieved.

**Efficiency** – The development and maintenance of performance based standards ultimately requires less effort. While initially more difficult to establish goals and objectives, the decision for inclusion or not 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.
PERFORMANCE BASED STANDARDS

Performance Based Example 1:
Preferred Approach 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

Examples:
1. **Performance Based**
   Preferred Approach 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.
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   Disadvantage – testing and calculations are required for proven solutions
   
   More Difficult Approach: 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 – In this example, there is 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 could be very difficult.

2. **Prescriptive** – Bolted flanged joints shall meet the requirements of ASME B16.5, or ASME B&PV Code 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

3. **Prescriptive with Performance Based Alternate** – Bolted flanged joints shall
   Meet the requirements of ASME B16.5, or
   Meet the requirements of ASME B&PV Code 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.
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PERFORMANCE BASED STANDARDS

Performance Based Example 2:

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Part II - Performance Based Standard Development Process
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 hazards 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.

[1] 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 ISO TS 22559-1 - Safety requirements for lifts (elevators) – Part 1: Global essential safety requirements (GESRs).

**Example:** Para. 6.4.9 of ISO TS 22559-1, Change of Speed or Acceleration, states that “Means shall be provided to ensure that any change of speed or acceleration of the [elevator] shall be limited to minimize the risk of injury to the users.”

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 that 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.
III. OUR APPROACH

Part III – Our Approach
The Codes and Standards Board of Directors:
1. Requests that all standards committees develop goals, assumptions and objectives as described in the last paragraph of the performance based standards white paper. 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.

2. Recommends that all standards committees consider making new provisions to existing standards be performance based or have performance based options.

3. Recommends that all standards committees 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 seriously contemplate the advantages of developing performance based standards and performance based provisions in new and existing standards.)
Part IV - Performance Based Provisions in Current ASME Standards
Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 125 psi (B16.33) - this standard is largely performance based and has some prescriptive requirements. Most of the requirements are performance based:

- 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:
  - Gas tightness test
  - Temperature resistance tests
  - Hydrostatic, twist, bending, tensile strength, and turning torque structural tests
  - Flow capacity test

Performance Based Provisions in Current ASME Standards

Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 125 psi (B16.33) This standard is largely performance based and has some prescriptive requirements. 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

Most of the requirements are performance based:

- 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:
  - Gas tightness test
  - Temperature resistance tests
  - Hydrostatic, twist, bending, tensile strength, and turning torque structural tests
  - Flow capacity test
Performance Based Provisions in Current ASME Standards

**Code for the Operation and Maintenance of Nuclear Power Plants (OM-2004)** This code is largely prescriptive and has some performance based requirements. Among the performance based requirements is the

**Check Valve Condition Monitoring Program (Appendix II)** This appendix 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

Valves must have certain identifying markings
Determine bases for establishing groups of check valves
Analyz e 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
Performance Based Provisions in Current ASME Standards

**Safety Code for Elevators and Escalators (A17.1)** This code is largely prescriptive and has some performance based requirements. Among the performance based requirements is

**Rule 206.6 Design of Governor-Rope-Grip Jaws for Type B Safeties**

This Code requires that electric traction elevators having a rated speed in excess of 150 feet/minute be provided with mechanical safety devices (brakes which engage the guide rails, or tracks) which are activated by an overspeed governor, which is a mechanical speed-monitoring device. A continuous governor rope (steel wire rope) is fastened to the safety-actuating mechanism on the elevator, and runs vertically throughout the hoistway, winds over the overspeed governor sheave in the machine room and runs back down the hoistway, running around another sheave in the elevator pit, then back up to the elevator. In order to activate the under-car safety, a force must be imparted to the governor rope to cause it to trip the mechanism on the car, but this force must not be infinitely high, otherwise the rope strength will be exceeded and the governor rope will break. Therefore, the governor rope must be able to slip at the point of application of the force.
Performance Based Provisions in Current ASME Standards

Prior to the ASME A17.1c-1986 Supplement to the ASME A17.1-1984 Safety Code, the predecessor codes had very prescriptive requirements in A17.1 Rule 206.6 which required that the governors be provided with rope gripping jaws only, to the exclusion of all other means of activating the under-car safeties (brakes).

While this conventional design had served the elevator industry well in the US, it nevertheless precluded innovations. Europe, on the other hand, had no such impediment, and as a result, overspeed governors utilizing the principle of traction emerged without the necessity of rope-gripping jaws.

Type B car and counterweight safeties shall be actuated by a speed governor equipped with rope-grip jaws which will permit the governor rope to pull through the jaws. The maximum tension in the governor rope to cause it to slip through the governor jaws shall not exceed one-fifth of the rated ultimate strength of the rope.

Governor jaws shall be of such shape and minimum length that no appreciable damage to or deformation of the rope shall result from the stopping action of the jaws in operating the car or counterweight safety.

Recognizing that US technological leadership in design innovation was coming under serious challenge, we changed the rule to allow for any design which would satisfy the functional objectives of actuating the under-car safeties.
Performance Based Provisions in Current ASME Standards

A17.1c-1986 Rule 206.6 stated the requirements in performance terms as follows:

Type B car and counterweight safeties shall be activated by a speed governor with a governor rope-retarding means conforming to the following:

Most of the requirements are performance based:

Rule 206.6 was changed in A17.1-1986 to state the requirements in performance terms, as follows:

(a) Upon activation at the tripping speeds given by Rule 206.2, the means shall cause sufficient force to be imparted to the governor rope to activate the safety or to trip the governor rope releasing carrier, where used (Rule 205.15).

(b) The means shall be set to allow the governor rope to slip through the speed governor at a rope tension higher than required to activate the safety or to trip the releasing carrier as specified in Rule 205.15. The maximum tension in the rope shall not exceed one-fifth of the rated ultimate strength of the rope.

(c) The means shall be designed to prevent appreciable damage to or deformation of the governor rope resulting from its application (stopping action).

(d) The means shall provide a continuous tension in the governor rope as may be required to operate the safety during the entire stopping interval in accordance with Rule 205.5b.

(e) The governor shall be arranged to be tripped by hand to facilitate the tests specified in Part X.

This performance-based rule has been in effect since 1986 and has allowed the major manufacturers to benefit by the economies of scale due to commonality of designs on a worldwide basis.

Note that a performance based version of A17.1 is under development and is expected to be published soon.
Performance Based Provisions in Current ASME Standards

**Process Piping (B31.3)** 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 says

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.
Summary

I. Performance Based Standards – What are They?
II. Performance Based Standards – Development Process
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REFERENCES

- White Paper on Performance Based Codes and Standards
  - http://cstools.asme.org/csconnect/CommitteePages.cfm?
    Committee=A01000000&Action=7609

References