

## Performance Based Codes and Standards

The movement towards performance based codes and standards<sup>1</sup> has become a world wide effort, especially in the standards developed for reference in building codes. The use of such standards offers significant advantages. The purpose of this paper is to briefly describe what a performance based standard is and explain why we should move ASME's standards development effort in that direction.

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.

What are the advantages of performance based standards? Performance based standards allow users flexibility in choosing materials, design and construction to meet the standards' goals and objectives. Advantages include:

- **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 encourages 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.

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<sup>1</sup> Codes and standards are referred to as “standard” elsewhere for simplicity.

Different Approaches – The degree to which a standard can be effectively performance based rather than prescriptive depends on the ease of judging whether or not products or services meet its goals and objectives. When performance based requirements lead to costly and complicated testing procedures, prescriptive requirements should be considered, possibly with alternate performance based requirements. Different approaches are described below using a pressurized bolted flanged joint as an example. (Note that the specific requirements are not intended to be complete or comprehensive; they are intended to be illustrative of the types of requirements that would be described for each approach.)

## Comparative Example

### 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.

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

*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.

*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*

Performance based standard development process elements – This section was adapted from a NFPA report<sup>2</sup> and a NFPA guide<sup>3</sup>. NFPA has done extensive work on fire safety standards for the last decade or so. Other building code developers have also adopted the performance based approach.

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<sup>4</sup> 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.
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

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<sup>2</sup> “NFPA’s Future in Performance-Based Codes and Standards”, Report of the NFPA In-House Task Force, July, 1995, <http://www.nfpa.org/PDF/PBreport.pdf?src=nfpa>

<sup>3</sup> “Performance-Based Primer, Codes and Standards Preparation”, NFPA, December 16, 1999, <http://www.nfpa.org/PDF/PBPrimerCombined.pdf?src=nfpa>

<sup>4</sup> The term “equipment” as used here means the method, system, equipment, piping, or component defined by the standard.

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.

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. Note that some of these things may be described in the standard’s foreword, introduction, and scope, but typically not at the level of detail needed. 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.