**Chapter 5 Performance-Based Option**

5.1 General Requirements

5.1.1\* Application

The requirements of this chapter shall apply to life safety systems designed to the performance-based option permitted by 4.4.1 and 4.4.3.

5.1.2 Goals and Objectives

The performance-based design shall meet the goals and objectives of this Code in accordance with Sections 4.1 and 4.2.

5.1.3 Qualifications

The performance-based design shall be prepared by a registered design professional.

5.1.4\* Independent Review

The authority having jurisdiction shall be permitted to require an approved, independent third party to review the proposed design and provide an evaluation of the design to the authority having jurisdiction.

5.1.5 Sources of Data

Data sources shall be identified and documented for each input data requirement that must be met using a source other than a design fire scenario, an assumption, or a building design specification. The degree of conservatism reflected in such data shall be specified, and a justification for the source shall be provided.

5.1.6\* Final Determination

The authority having jurisdiction shall make the final determination as to whether the performance objectives have been met.

5.1.7\* Maintenance of Design Features

The design features required for the building to continue to meet the performance goals and objectives of this Code shall be maintained for the life of the building. Such performance goals and objectives shall include complying with all documented assumptions and design specifications. Any variations shall require the approval of the authority having jurisdiction prior to the actual change. (See also 4.6.9.2.)

5.1.8 Definitions

5.1.8.1 General

For definitions, see Chapter 3, Definitions.

5.1.8.2 Special Definitions

A list of special terms used in this chapter follows:

Alternative Calculation Procedure. See 3.3.15.

Data Conversion. See 3.3.53.

Design Fire Scenario. See 3.3.103.1.

Design Specification. See 3.3.260.1.

Design Team. See 3.3.58.

Exposure Fire. See 3.3.86.

Fire Model. See 3.3.99.

Fire Scenario. See 3.3.103.

Fuel Load. See 3.3.162.1.

Incapacitation. See 3.3.146.

Input Data Specification. See 3.3.260.2.

Occupant Characteristics. See 3.3.189.

Performance Criteria. See 3.3.204.

Proposed Design. See 3.3.216.

Safe Location. See 3.3.233.

Safety Factor. See 3.3.234.

Safety Margin. See 3.3.235.

Sensitivity Analysis. See 3.3.17.1.

Stakeholder. See 3.3.265.

Uncertainty Analysis. See 3.3.17.2.

Verification Method. See 3.3.284.

5.2 Performance Criteria

5.2.1 General

A design shall meet the objectives specified in Section 4.2 if, for each design fire scenario, assumption, and design specification, the performance criterion in 5.2.2 is met.

5.2.2\* Performance Criterion

Any occupant who is not intimate with ignition shall not be exposed to instantaneous or cumulative untenable conditions.

5.3 Retained Prescriptive Requirements

5.3.1\* Systems and Features

All fire protection systems and features of the building shall comply with applicable NFPA standards for those systems and features.

5.3.2 Means of Egress

The design shall comply with the following requirements in addition to the performance criteria of Section 5.2 and the methods of Sections 5.4 through 5.8:

Changes in level in means of egress — 7.1.7

Guards — 7.1.8

Doors — 7.2.1

Stairs — 7.2.2, excluding the provisions of 7.2.2.5.1, 7.2.2.5.2, 7.2.2.6.2, 7.2.2.6.3, and 7.2.2.6.4

Ramps — 7.2.5, excluding the provisions of 7.2.5.3.1, 7.2.5.5, and 7.2.5.6.1

Fire escape ladders — 7.2.9

Alternating tread devices — 7.2.11

Capacity of means of egress — Section 7.3, excluding the provisions of 7.3.3 and 7.3.4

Impediments to egress — 7.5.2

Illumination of means of egress — Section 7.8

Emergency lighting — Section 7.9

Marking of means of egress — Section 7.10

5.3.3 Equivalency

Equivalent designs for the features covered in the retained prescriptive requirements mandated by 5.3.2 shall be addressed in accordance with the equivalency provisions of Section 1.4.

5.4 Design Specifications and Other Conditions

5.4.1\* Clear Statement

Design specifications and other conditions used in the performance-based design shall be clearly stated and shown to be realistic and sustainable.

5.4.2 Assumptions and Design Specifications Data

5.4.2.1

Each assumption and design specification used in the design shall be accurately translated into input data specifications, as appropriate for the method or model.

5.4.2.2

Any assumption and design specifications that the design analyses do not explicitly address or incorporate and that are, therefore, omitted from input data specifications shall be identified, and a sensitivity analysis of the consequences of that omission shall be performed.

5.4.2.3

Any assumption and design specifications modified in the input data specifications, because of limitations in test methods or other data-generation procedures, shall be identified, and a sensitivity analysis of the consequences of the modification shall be performed.

5.4.3 Building Characteristics

Characteristics of the building or its contents, equipment, or operations that are not inherent in the design specifications, but that affect occupant behavior or the rate of hazard development, shall be explicitly identified.

5.4.4\* Operational Status and Effectiveness of Building Features and Systems

The performance of fire protection systems, building features, and emergency procedures shall reflect the documented performance and reliability of the components of those systems or features, unless design specifications are incorporated to modify the expected performance.

5.4.5 Occupant Characteristics

5.4.5.1\* General

The selection of occupant characteristics to be used in the design calculations shall be approved by the authority having jurisdiction and shall provide an accurate reflection of the expected population of building users. Occupant characteristics shall represent the normal occupant profile, unless design specifications are used to modify the expected occupant features. Occupant characteristics shall not vary across fire scenarios, except as authorized by the authority having jurisdiction.

5.4.5.2\* Response Characteristics

The basic response characteristics of sensibility, reactivity, mobility, and susceptibility shall be evaluated. Such evaluation shall include the expected distribution of characteristics of a population appropriate to the use of the building. The source of data for these characteristics shall be documented.

5.4.5.3 Location

It shall be assumed that, in every normally occupied room or area, at least one person shall be located at the most remote point from the exits.

5.4.5.4\* Number of Occupants

The design shall be based on the maximum number of people that every occupied room or area is expected to contain. Where the success or failure of the design is contingent on the number of occupants not exceeding a specified maximum, operational controls shall be used to ensure that the maximum number of occupants is not exceeded.

5.4.5.5\* Staff Assistance

The inclusion of trained employees as part of the fire safety system shall be identified and documented.

5.4.6 Emergency Response Personnel

Design characteristics or other conditions related to the availability, speed of response, effectiveness, roles, and other characteristics of emergency response personnel shall be specified, estimated, or characterized sufficiently for evaluation of the design.

5.4.7\* Post-Construction Conditions

Design characteristics or other conditions related to activities during the life of a building that affect the ability of the building to meet the stated goals and objectives shall be specified, estimated, or characterized sufficiently for evaluation of the design.

5.4.8 Off-Site Conditions

Design characteristics or other conditions related to resources or conditions outside the property being designed that affect the ability of the building to meet the stated goals and objectives shall be specified, estimated, or characterized sufficiently for evaluation of the design.

5.4.9\* Consistency of Assumptions

The design shall not include mutually inconsistent assumptions, specifications, or statements of conditions.

5.4.10\* Special Provisions

Additional provisions that are not covered by the design specifications, conditions, estimations, and assumptions provided in Section 5.4, but that are required for the design to comply with the performance objectives, shall be documented.

5.5\* Design Fire Scenarios

5.5.1 Approval of Parameters

The authority having jurisdiction shall approve the parameters involved in design fire scenarios. The proposed design shall be considered to meet the goals and objectives if it achieves the performance criteria for each required design fire scenario. (See 5.5.3.)

5.5.2\* Evaluation

Design fire scenarios shall be evaluated using a method acceptable to the authority having jurisdiction and appropriate for the conditions. Each design fire scenario shall be as challenging as any that could occur in the building, but shall be realistic, with respect to at least one of the following scenario specifications:

Initial fire location

Early rate of growth in fire severity

Smoke generation

5.5.3\* Required Design Fire Scenarios

Design fire scenarios shall comply with the following:

Scenarios selected as design fire scenarios shall include, but shall not be limited to, those specified in 5.5.3.1 through 5.5.3.8.

Design fire scenarios demonstrated by the design team to the satisfaction of the authority having jurisdiction as inappropriate for the building use and conditions shall not be required to be evaluated fully.

5.5.3.1\* Design Fire Scenario 1

Design Fire Scenario 1 shall be described as follows:

It is an occupancy-specific fire representative of a typical fire for the occupancy.

It explicitly accounts for the following:

Occupant activities

Number and location of occupants

Room size

Contents and furnishings

Fuel properties and ignition sources

Ventilation conditions

Identification of the first item ignited and its location

5.5.3.2\* Design Fire Scenario 2

Design Fire Scenario 2 shall be described as follows:

It is an ultrafast-developing fire, in the primary means of egress, with interior doors open at the start of the fire.

It addresses the concern regarding a reduction in the number of available means of egress.

5.5.3.3\* Design Fire Scenario 3

Design Fire Scenario 3 shall be described as follows:

It is a fire that starts in a normally unoccupied room, potentially endangering a large number of occupants in a large room or other area.

It addresses the concern regarding a fire starting in a normally unoccupied room and migrating into the space that potentially holds the greatest number of occupants in the building.

5.5.3.4\* Design Fire Scenario 4

Design Fire Scenario 4 shall be described as follows:

It is a fire that originates in a concealed wall or ceiling space adjacent to a large occupied room.

It addresses the concern regarding a fire originating in a concealed space that does not have either a detection system or a suppression system and then spreading into the room within the building that potentially holds the greatest number of occupants.

5.5.3.5\* Design Fire Scenario 5

Design Fire Scenario 5 shall be described as follows:

It is a slowly developing fire, shielded from fire protection systems, in close proximity to a high occupancy area.

It addresses the concern regarding a relatively small ignition source causing a significant fire.

5.5.3.6\* Design Fire Scenario 6

Design Fire Scenario 6 shall be described as follows:

It is the most severe fire resulting from the largest possible fuel load characteristic of the normal operation of the building.

It addresses the concern regarding a rapidly developing fire with occupants present.

5.5.3.7\* Design Fire Scenario 7

Design Fire Scenario 7 shall be described as follows:

It is an outside exposure fire.

It addresses the concern regarding a fire starting at a location remote from the area of concern and either spreading into the area, blocking escape from the area, or developing untenable conditions within the area.

5.5.3.8\* Design Fire Scenario 8

Design Fire Scenario 8 shall be described as follows:

It is a fire originating in ordinary combustibles in a room or area with each passive or active fire protection system independently rendered ineffective.

It addresses concerns regarding the unreliability or unavailability of each fire protection system or fire protection feature, considered individually.

\*It is not required to be applied to fire protection systems for which both the level of reliability and the design performance in the absence of the system are acceptable to the authority having jurisdiction.

5.5.4 Design Fire Scenarios Data

5.5.4.1

Each design fire scenario used in the performance-based design proposal shall be translated into input data specifications, as appropriate for the calculation method or model.

5.5.4.2

Any design fire scenario specifications that the design analyses do not explicitly address or incorporate and that are, therefore, omitted from input data specifications shall be identified, and a sensitivity analysis of the consequences of that omission shall be performed.

5.5.4.3

Any design fire scenario specifications modified in input data specifications, because of limitations in test methods or other data-generation procedures, shall be identified, and a sensitivity analysis of the consequences of the modification shall be performed.

5.6\* Evaluation of Proposed Designs

5.6.1 General

A proposed design's performance shall be assessed relative to each performance objective in Section 4.2 and each applicable scenario in 5.5.3, with the assessment conducted through the use of appropriate calculation methods. The authority having jurisdiction shall approve the choice of assessment methods.

5.6.2 Use

The design professional shall use the assessment methods to demonstrate that the proposed design will achieve the goals and objectives, as measured by the performance criteria in light of the safety margins and uncertainty analysis, for each scenario, given the assumptions.

5.6.3 Input Data

5.6.3.1 Data

Input data for computer fire models shall be obtained in accordance with ASTM E 1591, Standard Guide for Obtaining Data for Deterministic Fire Models. Data for use in analytical models that are not computer-based fire models shall be obtained using appropriate measurement, recording, and storage techniques to ensure the applicability of the data to the analytical method being used.

5.6.3.2 Data Requirements

A complete listing of input data requirements for all models, engineering methods, and other calculation or verification methods required or proposed as part of the performance-based design shall be provided.

5.6.3.3\* Uncertainty and Conservatism of Data

Uncertainty in input data shall be analyzed and, as determined appropriate by the authority having jurisdiction, addressed through the use of conservative values.

5.6.4\* Output Data

The assessment methods used shall accurately and appropriately produce the required output data from input data, based on the design specifications, assumptions, and scenarios.

5.6.5 Validity

Evidence shall be provided to confirm that the assessment methods are valid and appropriate for the proposed building, use, and conditions.

5.7\* Safety Factors

Approved safety factors shall be included in the design methods and calculations to reflect uncertainty in the assumptions, data, and other factors associated with the performance-based design.

5.8 Documentation Requirements

5.8.1\* General

All aspects of the design, including those described in 5.8.2 through 5.8.14, shall be documented. The format and content of the documentation shall be acceptable to the authority having jurisdiction.

5.8.2\* Technical References and Resources

The authority having jurisdiction shall be provided with sufficient documentation to support the validity, accuracy, relevance, and precision of the proposed methods. The engineering standards, calculation methods, and other forms of scientific information provided shall be appropriate for the particular application and methodologies used.

5.8.3 Building Design Specifications

All details of the proposed building design that affect the ability of the building to meet the stated goals and objectives shall be documented.

5.8.4 Performance Criteria

Performance criteria, with sources, shall be documented.

5.8.5 Occupant Characteristics

Assumptions about occupant characteristics shall be documented.

5.8.6 Design Fire Scenarios

Descriptions of design fire scenarios shall be documented.

5.8.7 Input Data

Input data to models and assessment methods, including sensitivity analyses, shall be documented.

5.8.8 Output Data

Output data from models and assessment methods, including sensitivity analyses, shall be documented.

5.8.9 Safety Factors

The safety factors utilized shall be documented.

5.8.10 Prescriptive Requirements

Retained prescriptive requirements shall be documented.

5.8.11\* Modeling Features

5.8.11.1

Assumptions made by the model user, and descriptions of models and methods used, including known limitations, shall be documented.

5.8.11.2

Documentation shall be provided to verify that the assessment methods have been used validly and appropriately to address the design specifications, assumptions, and scenarios.

5.8.12 Evidence of Modeler Capability

The design team's relevant experience with the models, test methods, databases, and other assessment methods used in the performance-based design proposal shall be documented.

5.8.13 Performance Evaluation

The performance evaluation summary shall be documented.

5.8.14 Use of Performance-Based Design Option

Design proposals shall include documentation that provides anyone involved in the ownership or management of the building with notification of the following:

Approval of the building as a performance-based design with certain specified design criteria and assumptions

Need for required re-evaluation and reapproval in cases of remodeling, modification, renovation, change in use, or change in established assumptions