**Chapter 5 Performance-Based Option**

5.1\* General

5.1.1 Application

The requirements of this chapter shall apply to facilities designed to the performance-based option permitted by Section 4.3.

5.1.2 Goals and Objectives

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

5.1.3\* Approved Qualifications

The performance-based design shall be prepared by a person with qualifications acceptable to the AHJ.

5.1.4\* Plan Submittal Documentation

When a performance-based design is submitted to the AHJ for review and approval, the owner shall document, in an approved format, each performance objective and applicable scenario, including any calculation methods or models used in establishing the proposed design's fire and life safety performance.

5.1.5\* Independent Review

The AHJ shall be permitted to require an approved, independent third party to review the proposed design and provide an evaluation of the design to the AHJ at the expense of the owner.

5.1.6 Sources of Data

Data sources shall be identified and documented for each input data requirement that is required to be met using a source other than a required design scenario, an assumption, or a facility design specification.

5.1.6.1

The degree of conservatism reflected in such data shall be specified, and a justification for the source shall be provided.

5.1.6.2

Copies of all references relied upon by the performance-based design to support assumptions, design features, or any other part of the design shall be made available to the AHJ if requested.

5.1.7 Final Determination

The AHJ shall make the final determination as to whether the performance objectives have been met.

5.1.8\* Operations and Maintenance Manual

An approved Operations and Maintenance (O&M) Manual shall be provided by the owner to the AHJ and the fire department and shall be maintained at the facility in an approved location.

5.1.9\* Information Transfer to the Fire Service

Where a performance-based design is approved and used, the designer shall ensure that information regarding the operating procedures of the performance-based designed fire protection system is transferred to the owner and to the local fire service for inclusion in the pre-fire plan.

5.1.10\* Design Feature Maintenance

5.1.10.1

The design features required for the facility to meet the performance goals and objectives shall be maintained by the owner and be readily accessible to the AHJ for the life of the facility.

5.1.10.2

The facility shall be maintained in accordance with all documented assumptions and design specifications.

5.1.10.2.1

Any proposed changes or variations from the approved design shall be approved by the AHJ prior to the actual change.

5.1.10.2.2

Any approved changes to the original design shall be maintained in the same manner as the original design.

5.1.11\* Annual Certification

Where a performance-based design is approved and used, the property owner shall annually certify that the design features and systems have been maintained in accordance with the approved original performance-based design and assumptions and any subsequent approved changes or modifications to the original performance-based design.

5.1.12 Hazardous Materials

5.1.12.1

Performance-based designs for facilities containing high hazard contents shall identify the properties of hazardous materials to be stored, used, or handled and shall provide adequate and reliable safeguards to accomplish the following objectives, considering both normal operations and possible abnormal conditions:

Minimize the potential occurrence of unwanted releases, fire, or other emergency incidents resulting from the storage, use, or handling of hazardous materials

Minimize the potential failure of buildings, equipment, or processes involving hazardous materials by ensuring that such buildings, equipment, or processes are reliably designed and are suitable for the hazards present

Minimize the potential exposure of people or property to unsafe conditions or events involving an unintended reaction or release of hazardous materials

Minimize the potential for an unintentional reaction that results in a fire, explosion, or other dangerous condition

Provide a means to contain, treat, neutralize, or otherwise handle plausible releases of hazardous materials to minimize the potential for adverse impacts to persons or property outside of the immediate area of a release

Provide appropriate safeguards to minimize the risk of and limit damage and injury that could result from an explosion involving hazardous materials that present explosion hazards

Detect hazardous levels of gases or vapors that are dangerous to health and alert appropriate persons or mitigate the hazard when the physiological warning properties for such gases or vapors are inadequate to warn of danger prior to personal injury

Maintain power to provide for continued operation of safeguards and important systems that are relied upon to prevent or control an emergency condition involving hazardous materials

Maintain ventilation where ventilation is relied upon to minimize the risk of emergency conditions involving hazardous materials

Minimize the potential for exposing combustible hazardous materials to unintended sources of ignition and for exposing any hazardous material to fire or physical damage that can lead to endangerment of people or property

5.1.12.2

A process hazard analysis and off-site consequence analysis shall be conducted when required by the AHJ to ensure that people and property are satisfactorily protected from potentially dangerous conditions involving hazardous materials. The results of such analyses shall be considered when determining active and passive mitigation measures used in accomplishing the objectives of 4.1.3.3.2 and 4.1.4.2.

5.1.12.3

Written procedures for pre-start-up safety reviews, normal and emergency operations, management of change, emergency response, and accident investigation shall be developed prior to beginning operations at a facility designed in accordance with Section 5.1. Such procedures shall be developed with the participation of employees.

5.1.13 Special Definitions

A list of special terms used in this chapter shall be as follows:

Design Fire Scenario. (See3.4.9.1.)

Design Specification. (See 3.4.5.)

Design Team. (See 3.4.6.)

Exposure Fire. (See 3.4.7.)

Fire Model. (See 3.4.8.)

Fire Scenario. (See 3.4.9.)

Fuel Load. (See 3.4.10.)

Input Data Specification. (See 3.4.12.)

Occupant Characteristics. (See 3.4.13.)

Performance Criteria. (See 3.4.14.)

Proposed Design. (See 3.4.15.)

Safety Factor. (See 3.4.17.)

Safety Margin. (See 3.4.18.)

Sensitivity Analysis. (See 3.4.2.1.)

Stakeholder. (See 3.4.20.)

Uncertainty Analysis. (See 3.4.2.2.)

Verification Method. (See 3.4.22.)

5.2 Performance Criteria

5.2.1 General

A design shall meet the objectives specified in Section 4.1 if, for each required design scenario, assumption, and design specification, the performance criteria of 5.2.2 are met.

5.2.2\* Specific Performance Criteria

5.2.2.1\* Fire Conditions

No occupant who is not intimate with ignition shall be exposed to instantaneous or cumulative untenable conditions.

5.2.2.2\* Explosion Conditions

The facility design shall provide an acceptable level of safety for occupants and for individuals immediately adjacent to the property from the effects of unintentional detonation or deflagration.

5.2.2.3\* Hazardous Materials Exposure

The facility design shall provide an acceptable level of safety for occupants and for individuals immediately adjacent to the property from the effects of an unauthorized release of hazardous materials or the unintentional reaction of hazardous materials.

5.2.2.4\* Property Protection

The facility design shall limit the effects of all required design scenarios from causing an unacceptable level of property damage.

5.2.2.5\* Public Welfare

For facilities that serve a public welfare role as defined in 4.1.5, the facility design shall limit the effects of all required design scenarios from causing an unacceptable interruption of the facility's mission.

5.2.2.6 Occupant Protection From Untenable Conditions

Means shall be provided to evacuate, relocate, or defend in place occupants not intimate with ignition for sufficient time so that they are not exposed to instantaneous or cumulative untenable conditions from smoke, heat, or flames.

5.2.2.7 Emergency Responder Protection

Buildings shall be designed and constructed to reasonably prevent structural failure under fire conditions for sufficient time to enable fire fighters and emergency responders to conduct search and rescue operations.

5.2.2.8\* Occupant Protection From Structural Failure

Buildings shall be designed and constructed to reasonably prevent structural failure under fire conditions for sufficient time to protect the occupants.

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 Electrical Systems

Electrical systems shall comply with applicable NFPA standards for those systems.

5.3.3 General

The design shall comply with the following requirements in addition to the performance criteria of Section 5.2 and the methods of Section 5.4 through Section 5.7:

Fundamental requirements in Section 10.1

Fire drills in Section 10.5

Smoking in Section 10.9

Open flame, candles, open fires, and incinerators in Section 10.10

Fire protection markings in Section 10.11

Seasonal and vacant buildings and premises in Section 10.12

Combustible vegetation in Section 10.13

Safeguards during building construction, alteration, and demolition operations in Chapter 16

5.3.4 Means of Egress

The design shall comply with the following NFPA 101 requirements in addition to the performance criteria of Section 5.2 and the methods of Section 5.4 through Section 5.7:

Changes in level in means of egress: 7.1.7 of NFPA 101

Guards: 7.1.8 of NFPA 101

Door openings: 7.2.1 of NFPA 101

Stairs: 7.2.2 of NFPA 101

Exception: 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 of NFPA 101 shall be exempted.

Ramps: 7.2.5 of NFPA 101

Exception: The provisions of 7.2.5.3.1, 7.2.5.5, and 7.2.5.6.1 of NFPA 101 shall be exempted.

Fire escape ladders: 7.2.9 of NFPA 101

Alternating tread devices: 7.2.11 of NFPA 101

Capacity of means of egress: Section 7.3 of NFPA 101

Exception: The provisions of 7.3.3 and 7.3.4 of NFPA 101 shall be exempted.

Impediments to egress: 7.5.2 of NFPA 101

Illumination of means of egress: Section 7.8 of NFPA 101

Emergency lighting: Section 7.9 of NFPA 101

Marking of means of egress: Section 7.10 of NFPA 101

5.3.5 Equivalency

Equivalent designs for the features covered in the retained prescriptive requirements mandated by 5.3.1 through 5.3.4 shall be addressed in accordance with the equivalency provisions of Section 1.4.

5.4\* Design Scenarios

5.4.1 General

5.4.1.1

The proposed design shall be considered to meet the goals and objectives if it achieves the performance criteria for each required design scenario. The AHJ shall approve the parameters involved with required design scenarios.

5.4.1.2\*

Design scenarios shall be evaluated for each required scenario using a method acceptable to the AHJ and appropriate for the conditions. Each scenario shall be as challenging and realistic as any that could realistically occur in the building.

5.4.1.3\*

Scenarios selected as design scenarios shall include, but not be limited to, those specified in 5.4.2 through 5.4.5.

5.4.1.3.1

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

5.4.1.3.2

Fire Design Scenario 8 (see 5.4.2.8) shall not be required to be applied to fire protection systems or features for which both the level of reliability and the design performance in the absence of the system or feature are acceptable to the AHJ.

5.4.1.4

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

5.4.1.5

Any design 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.

5.4.1.6

Any design 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.

5.4.2 Required Design Scenarios — Fire

5.4.2.1\* Fire Design Scenario 1

Fire Design Scenario 1 involves an occupancy-specific design scenario representative of a typical fire for the occupancy.

5.4.2.1.1

This design scenario shall explicitly account for the following:

Occupant activities

Number and location of occupants

Room size

Furnishings and contents

Fuel properties and ignition sources

Ventilation conditions

5.4.2.1.2

The first item ignited and its location shall be explicitly defined.

5.4.2.2\* Fire Design Scenario 2

Fire Design Scenario 2 involves an ultrafast-developing fire in the primary means of egress with interior doors open at the start of the fire. This design scenario shall address the concern regarding a reduction in the number of available means of egress.

5.4.2.3\* Fire Design Scenario 3

Fire Design Scenario 3 involves a fire that starts in a normally unoccupied room that can potentially endanger a large number of occupants in a large room or other area. This design scenario shall address the concern regarding a fire starting in a normally unoccupied room and migrating into the space that can, potentially, hold the greatest number of occupants in the building.

5.4.2.4\* Fire Design Scenario 4

Fire Design Scenario 4 involves a fire that originates in a concealed wall or ceiling space adjacent to a large occupied room. This design scenario shall address the concern regarding a fire originating in a concealed space that does not have either a detection system or suppression system and then spreading into the room within the building that can, potentially, hold the greatest number of occupants.

5.4.2.5\* Fire Design Scenario 5

Fire Design Scenario 5 involves a slow-developing fire, shielded from fire protection systems, in close proximity to a high occupancy area. This design scenario shall address the concern regarding a relatively small ignition source causing a significant fire.

5.4.2.6\* Fire Design Scenario 6

Fire Design Scenario 6 involves the most severe fire resulting from the largest possible fuel load characteristic of the normal operation of the building. This design scenario shall address the concern regarding a rapidly developing fire with occupants present.

5.4.2.7\* Fire Design Scenario 7

Fire Design Scenario 7 involves an outside exposure fire. This design scenario shall address 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.

5.4.2.8\* Fire Design Scenario 8

Fire Design Scenario 8 involves a fire originating in ordinary combustibles in a room or area with each passive or active fire protection system or feature independently rendered ineffective. This set of design scenarios shall address concerns regarding each fire protection system or fire protection feature, considered individually, being unreliable or becoming unavailable. This scenario shall not be required to be applied to fire protection systems or features for which both the level of reliability and the design performance in the absence of the system are acceptable to the AHJ.

5.4.3 Required Design Scenarios — Explosion

5.4.3.1\* Explosion Design Scenario 1

5.4.3.1.1

Explosion Design Scenario 1 is the detonation or deflagration of explosive materials being manufactured, stored, handled, or used in a facility.

5.4.3.1.2

Explosion Design Scenario 1 shall address the concern regarding safety of individuals not intimate with the explosion and property protection of adjacent properties and buildings.

5.4.4\* Required Design Scenarios — Hazardous Materials

5.4.4.1 Hazardous Materials Design Scenario 1

Hazardous Materials Design Scenario 1 involves an unauthorized release of hazardous materials from a single control area. This design scenario shall address the concern regarding the spread of hazardous conditions from the point of release.

5.4.4.2 Hazardous Materials Design Scenario 2

Hazardous Materials Design Scenario 2 involves an exposure fire on a location where hazardous materials are stored, used, handled, or dispensed. This design scenario shall address the concern regarding how a fire in a facility affects the safe storage, handling, or use of hazardous materials.

5.4.4.3 Hazardous Materials Design Scenario 3

Hazardous Materials Design Scenario 3 involves the application of an external factor to the hazardous material that is likely to result in a fire, explosion, toxic release, or other unsafe condition. This design scenario shall address the concern regarding the initiation of a hazardous materials event by the application of heat, shock, impact, or water onto a hazardous material being stored, used, handled, or dispensed in the facility.

5.4.4.4 Hazardous Materials Design Scenario 4

5.4.4.4.1

Hazardous Materials Design Scenario 4 involves an unauthorized discharge with each protection system independently rendered ineffective. This set of design hazardous materials scenarios shall address concern regarding each protection system or protection feature, considered individually, being unreliable or becoming unavailable.

5.4.4.4.2\*

Hazardous Materials Design Scenario 4 shall not be required to be applied to protection systems or features for which both the level of reliability and the design performance in the absence of the system are acceptable to the AHJ.

5.4.5 Required Design Scenarios — Safety During Building Use

5.4.5.1\* Building Use Design Scenario 1

Building Use Design Scenario 1 involves an event in which the maximum occupant load is in the assembly building and an emergency event occurs blocking the principal exit/entrance to the building. This design scenario shall address the concern of occupants having to take alternative exit routes under crowded conditions.

5.4.5.2 Building Use Design Scenario 2

Building Use Design Scenario 2 involves a fire in an area of a building undergoing construction or demolition while the remainder of the building is occupied. The normal fire suppression system in the area undergoing construction or demolition has been taken out of service. This design scenario shall address the concern regarding the inoperability of certain building fire safety features during construction and demolition in a partially occupied building.

5.5 Evaluation of Proposed Designs

5.5.1 General

5.5.1.1

A proposed design's performance shall be assessed relative to each performance objective in Section 4.1 and each applicable scenario in Section 5.4, with the assessment conducted through the use of appropriate calculation methods.

5.5.1.2

The choice of assessment methods shall require the approval of the AHJ.

5.5.2 Use

The design professional shall use the assessment methods to demonstrate that the proposed design achieves 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.

5.5.3 Input Data

5.5.3.1\* Data

5.5.3.1.1

Input data for computer fire models shall be obtained in accordance with ASTM E1591, Standard Guide for Obtaining Data for Fire Growth Models.

5.5.3.1.2

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.

5.5.3.2 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.

5.5.3.3 Uncertainty and Conservatism of Data

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

5.5.4 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.

5.5.5\* Validity

Evidence shall be provided confirming that the assessment methods are valid and appropriate for the proposed facility, use, and conditions.

5.6\* 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.

5.7 Documentation Requirements

5.7.1\* General

5.7.1.1

All aspects of the design, including those described in 5.7.2 through 5.7.14, shall be documented.

5.7.1.2

The format and content of the documentation shall be acceptable to the AHJ.

5.7.2\* Technical References and Resources

5.7.2.1

The AHJ shall be provided with sufficient documentation to support the validity, accuracy, relevance, and precision of the proposed methods.

5.7.2.2

The engineering standards, calculation methods, and other forms of scientific information provided shall be appropriate for the particular application and methodologies used.

5.7.3 Facility Design Specifications

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

5.7.4 Performance Criteria

Performance criteria, with sources, shall be documented.

5.7.5 Occupant Characteristics

Assumptions about occupant characteristics shall be documented.

5.7.6 Design Scenarios

Descriptions of design hazard scenarios shall be documented.

5.7.7 Input Data

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

5.7.8 Output Data

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

5.7.9 Safety Factors

Safety factors utilized shall be documented.

5.7.10 Prescriptive Requirements

Retained prescriptive requirements shall be documented.

5.7.11\* Modeling Features

5.7.11.1

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

5.7.11.2

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

5.7.12 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.

5.7.13 Performance Evaluation

The performance evaluation summary shall be documented.

5.7.14 Use of Performance-Based Design Option

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

The was as a performance-based design with certain specified design criteria and assumptions.

Any remodeling, modification, renovation, change in use, or change in the established assumptions requires a re-evaluation and reapproval.