

2021 Cycle – International Building Code – Section 722.1

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Supplemental Documentation #1

Description of Appendix 4 of ANSI/AISC 360-16

Appendix 4 of ANSI/AISC 360 *Specification for Structural Steel Buildings* provides structural engineers with criteria for designing steel-framed building systems and components for fire conditions. Thermal expansion and progressive decrease in strength and stiffness are the primary structural responses to elevated temperatures that may occur during fires. An assessment of a design of building components and systems based on structural mechanics allows designers to address the fire-induced restrained thermal expansions, deformations, and material degradation at elevated temperatures. This can lead to a more robust structural design for fire conditions.

Compliance with the performance objective can be demonstrated by either component qualification testing or structural analysis. Both of these methods of design for fire conditions are provided in Appendix 4 of ANSI/AISC 360:

1) By Qualification Testing

Design by qualification testing is the prescriptive method specified in most building codes. Traditionally, on most projects where the architect is the prime professional, the architect has been the responsible party to specify and coordinate fire protection requirements.

Fire resistance ratings of building elements are generally determined in accordance with procedures set forth in ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*. Tested building element designs, with their respective fire resistance ratings, may be found in special directories and reports published by testing agencies. Additionally, calculation procedures based on standard test results may be used. Appendix 4 of ANSI/AISC 360-16 points to ASCE 29-05 *Standard Calculation Methods for Structural Fire Protection* for the calculation procedures for steel assemblies.

2) By Analysis. Design by analysis is a relatively newer engineering approach to fire-protection, and analysis methods are used to document the anticipated performance of steel framing when subjected to design-basis fire scenarios. Analysis methods are permitted to be used to demonstrate an equivalency for an alternative material or method, as permitted by the applicable building code. Two such methods are outlined in Appendix 4 for the analysis of steel-framed building systems and components for fire conditions:

- a) *Design by Advanced Methods of Analysis:* Advanced methods are required for the consideration of (i) the overall structural response to fire, (ii) the interaction between structural members and separating elements in fire, or (iii) the residual strength of the structural system following the fire. This method explicitly accounts for behavioral aspects such as loss of strength and stiffness with increasing temperature, effects of thermal expansion, large deformations, time-dependent effects such as creep, etc.
- b) *Design by Simple Methods of Analysis:* Simple methods are permitted to be used for the evaluation of the performance of individual members and structural frames during exposure to a design-basis fire. Engineering judgement is required to select the conservative and appropriate approach for a given structure, loading, and fire scenario.