Fire Resistance Design Guide for Metal Building Systems

MBMA®
METAL BUILDING MANUFACTURERS ASSOCIATION

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1300 Sumner Avenue
Cleveland, Ohio 44115

Preface

This first edition of the *MBMA Fire Resistance Design Guide for Metal Building Systems* incorporates current practices and the results of research undertaken by MBMA, its member companies, and other industry groups through 2009. It was co-sponsored by the American Iron and Steel Institute (AISI). The primary author was Dr. Nestor Iwankiw of Hughes Associates, Inc. in conjunction with MBMA's Committee on Fire Protection and Related Insurance Matters.

Use of the *MBMA Fire Resistance Design Guide* is totally voluntary. Each building manufacturer or designer retains the prerogative to choose its own design and commercial practices and the responsibility to design its building systems to comply with applicable specifications and contract documents.

Although every effort has been made to provide accurate and factual information, Hughes Associates, Inc. and MBMA disclaims all responsibility for errors, omissions, misinterpretations, or oversights resulting from its use. The local building code requirements may not always, or completely, mirror those of the IBC, and their application to any specific project is assessed on a case-by-case basis. Therefore, the fire protection design and regulatory code compliance for the actual construction remain the sole responsibility of the project design professional. It is thereby understood that this Design Guide will be utilized by competent design professionals who assume all responsibility for its use, and that the final construction is subject to the review and acceptance of the local authority having jurisdiction (AHJ).

MBMA expressly disclaims all liabilities for damages of any sort, whether direct, indirect or consequential, arising out of the use, reference to, or reliance on this Guide or any of its content.

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Abbreviations and Acronyms

A/P	Area to Heated Perimeter Ratio
ACI	American Concrete Institute
AHJ	Authority Having Jurisdiction
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASD	Allowable Stress Design
ASTM	American Society for Testing and Materials
AWCI	Association of the Wall and Ceiling Industries
BXUV	UL Guide Information for Fire Resistance Ratings
BXUVC	ULC Guide Information for Fire Resistance Ratings
EFSR	Early Suppression Fast Response
FM	Factory Mutual
GA	Gypsum Association
HOW	Head of Wall
HSS	Hollow Structural Sections
IBC	International Building Code
ICC	International Code Council
ICC-ES	International Code Council Evaluation Service
LRFD	Load and Resistance Factor Design
MBMA	Metal Building Manufacturers Association
NBCC	National Building Code of Canada
NFPA	National Fire Protection Association
SFPE	Society of Fire Protection Engineers
SFRM	Spray-Applied Fire-Resistive Material
UL	Underwriters Laboratories, Inc.
ULC	Underwriters Laboratories of Canada
W/D	Weight to Heated Perimeter Ratio

Glossary

Active Fire Protection: Systems manually or automatically activated for fire suppression, smoke exhaust, emergency warning, and/or other notifications intended to mitigate the fire hazard effects on the building occupants and its property damage. Automatic sprinklers, fire detectors, and alarms are all examples of this type of fire protection.

A/P: Ratio given in inches, where A is the cross-section area of the shape in square inches and P is the shape's heated perimeter in inches, commonly used for steel hollow structural sections (HSS) and pipe products.

ASTM: The American Society for Testing and Materials – a consensus-based standards development organization in the United States for various material, product, and test procedure standards.

ASTM E 119: The longstanding U.S. standard that contains the fire-testing methods and acceptance criteria for development of fire-resistive ratings of construction assemblies (walls, columns, beams, floors and roofs).

Authority Having Jurisdiction (AHJ): The legal party, designated by law, having regulatory responsibility for approval of building plans and construction, also sometimes referred to as the building or fire official.

Fire Resistance: The ability of a construction assembly to control the increase of temperatures, prevent or retard the passage of flames and hot gases, and maintain its structural integrity during the duration of a fire exposure. Usually, fire resistance is referred to within the context of the prescriptive requirements of the building code, and as determined by standard ASTM E 119 fire testing in the US.

Fire-Resistive Rating: The time duration during which an assembly test was performed and successfully met the acceptance criteria of a standard fire test, such as ASTM E 119. This rating is usually expressed in even half hour or full hour increments for which the assembly was qualified by the testing.

Firestopping: Systems consisting of noncombustible infill materials, firecaulks, and sealants, which are intended to prevent the spread of fire and smoke in through-penetrations of horizontal or vertical fire-resistive assemblies. Ratings for firestopping systems are developed in accordance with ASTM E 814.

International Building Code (IBC): Issued and regularly updated by the International Code Council (ICC), which has become the predominant model building code for the United States.

International Code Council -Evaluation Service (ICC-ES): A nonprofit, public-benefit corporation that does technical evaluations of building products, components, methods, and materials.

Metal Building System: An integrated set of components and assemblies, including but not limited to frames that are built-up structural steel members, secondary members that are cold-formed steel or

steel joists, and cladding components, specifically designed to support and transfer loads and provide a complete or partial building shell. These components and assemblies are manufactured in a manner that permits plant and/or field inspection prior to assembly or erection.

Metal Building Manufacturers Association (MBMA): Trade association established in 1956 with the mission to promote the design and construction of metal building systems in the low-rise, non-residential building marketplace. The organization consists of building systems members and associate members who work with the metal building industry.

Passive Fire Protection: The permanent built-in fire protection features of the building that do not require any external activation to function. Such features include limits on the size of buildings (height and area) or their parts; limits on the combustibility of construction, finishes and contents; built-in evacuation routes; fire-fighting access routes; street and yard separations; fire-resistant construction; and other features. Gypsum board, spay-applied materials, concrete, or masonry materials can all be used in applications to protect steel in rated or unrated construction. The term "passive protection" is sometimes used in a narrower sense to only refer to the materials that serve to thermally protect the steel during a fire exposure.

Rated Assembly: An assembly that has been pre-qualified through ASTM E 119, or equivalent fire testing for a certain fire-resistance rating time, also referred to as a fire-resistant assembly.

Spray-Applied Fire-Resistive Material (SFRM): A fire protection material, of various possible types and products, that is spray-applied in the field to construction elements, most often steel.

Standard Fire: Time-temperature curve used for test fire exposure and fire-resistive ratings, usually as defined in a given standard. For conventional buildings in the United States, the standard fire curve is specified in ASTM E 119.

Thermal Barrier: The 2009 IBC, Section 2603.4, defines a thermal barrier as being 0.5-inch gypsum wallboard, or an equivalent product, that will limit the average temperature rise of the unexposed surface to no more than 250°F after a 15-minute exposure to the ASTM E 119 standard fire. Thermal barriers are required for many installations of foam plastic insulation within walls and ceilings.

Underwriters Laboratories, Inc. (UL): An accredited testing laboratory that has regularly conducted standard fire tests of construction assemblies, with many fire-resistance listings contained in its annually updated Fire Resistance Directory.

Unrated Assembly: An assembly that may or may not have some passive fire-protective materials or features but has not otherwise been qualified for any fire-resistive rating.

Unprotected Assembly: An assembly (often of steel or wood) without any fire protection material, sometimes also referred to as being "bare."

W/D: Weight to heated perimeter ratio for a steel member cross-section, in lbs/ft/in. This shape property can be optionally used in many instances to adjust (increase or reduce) the minimum fire protection material thickness for shapes other than the limited few that were tested or explicitly covered in a fire-resistive assembly listing.

In addition, for definitions of these and the many other terms relevant to the fire resistance of building construction, the reader is also referred to the 2009 International Building Code (IBC).

Chapter 1 Introduction

Metal building systems are a popular choice for many low-rise commercial, industrial, assembly, and institutional applications. In today's marketplace, they make up approximately 40 percent of the low-rise, non-residential building market and provide a cost-effective solution for many owners and occupants. Their noncombustible structure consists of primary framing that is constant depth or web-tapered structural steel frames, secondary members that are cold-formed steel or steel joists, a metal panel roof system, and exterior wall cladding. These components and assemblies are manufactured in a manner that permits plant and/or field inspection prior to assembly or erection.

Figure 1.1: Metal Building System Application for a Medical Facility

Today's metal building systems also look much different from their predecessors, as can be seen in the following pictures. Metal buildings are extremely versatile and can incorporate many different architectural finishes to provide the look required for applications such as churches, schools, shopping centers, office buildings, etc. In all of these applications, metal building systems still have significant cost advantages over many other building types, in part due to the speed of construction.

Figure 1.2: Metal Building System Application for a Community Center

The building codes commonly do not require the elements of single-story metal buildings to have structural fire protection for most applications due to their noncombustible steel construction, occupancy types, and limited heights and areas. However, situations may arise in some projects in which portions of the metal building or certain types of elements are required to be protected for fire resistance. These may be due to building design factors such as interior area or occupancy wall separations, multiple story levels, exit distances, and/or building proximity limits to an adjacent property line.

The Metal Building Manufacturers Association (MBMA) is a trade association established in 1956 whose mission is to advance the collective interests of the metal building systems industry. MBMA conducts many ongoing programs in research, publications and information dissemination, education, quality certification, and code development. These activities provide its members and customers with state-of-the-art technical and marketing resources, which enable the final building construction to be economical, of high quality, and in conformance with all applicable codes. To maintain public safety and in response to ever-evolving construction needs and building code issues, structural design and wind loads have

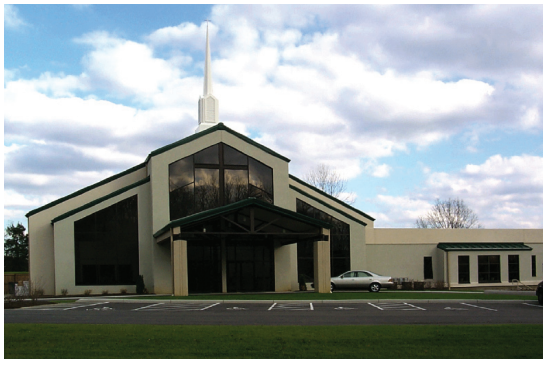

Figure 1.3: Metal Building System Application for a Religious Facility