U.S. Building Enclosure Resource Guide

An Alphabetical Listing of References with Which to Be Familiar

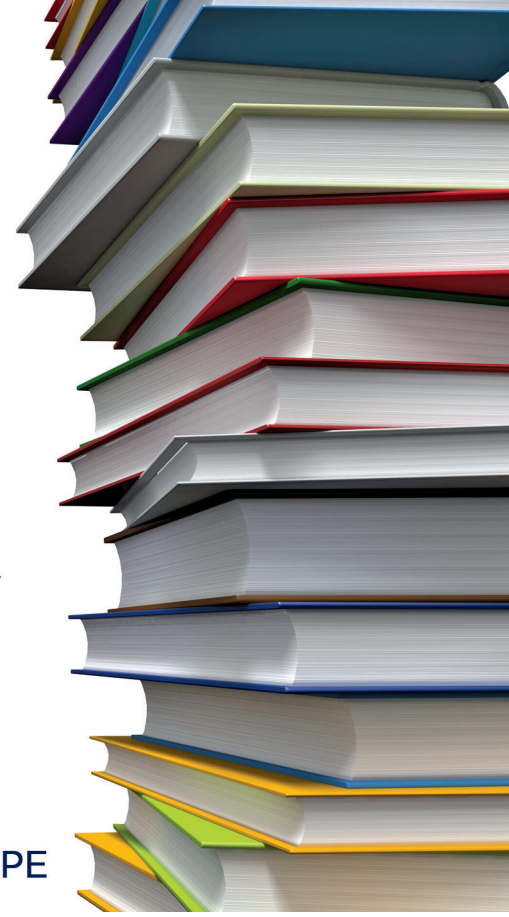

Photo Credit: © Can Stock Photo / 4774344sean

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Walter J. Rossiter, F-IIBEC, PhD; and John Wylie, REWC, PE

Section 107.2.4 of the 2018 *International Building Code* (*IBC*) requires a design professional to include exterior wall envelope information on every set of construction documents as follows:

> *Construction documents for all buildings shall describe the exterior wall envelope in sufficient detail to determine compliance with this code. The construction documents shall provide details of the exterior wall envelope as required, including flashing, intersections with dissimilar materials, corners, end details, control joints, intersections at roof, eaves or parapets, means of drainage, water-resistive membrane and details around openings.*

The same code defines construction documents as:

> *Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building permit.*

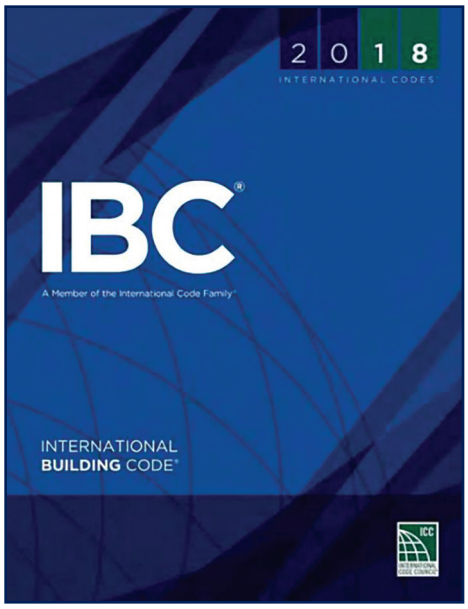
The code commentary for this definition indicates:

> *To determine whether proposed construction is in compliance with code requirements, it is necessary that sufficient information is submitted to the building official for review. This typically consists of drawings (such as floor plans, elevations, sections and details), specifications and product information describing proposed work.*

Because it would be difficult to include all of the required information on the project plans, it is important for design professionals (as well as all others involved in the construction process) to be familiar with available resources that may be referenced to supplement project plans, while also serving to meet the intent of the code, as described previously.

This article provides a snapshot of various resources available in the construction industry that—if consulted, understood, and followed by the various contractors executing the work—would generally be expected to result in a reasonably safe and durable building. Much of the information cited in this article is not referenced nor required by current building codes. Following the minimum requirements of the building code is intended to meet the same intent of safety and durability. However, it is the experience of the authors that an absence of "best practices," as depicted in many of the resources referenced by this article, serves to reduce the effective service life of building components, such that safety and durability are often compromised.

The following table and descriptions represent a general summary of the references that are most often cited by design



Ref. #	Organization	Reference(s) Name/Title/#	Subject(s): R=Roofing EC=Ext. Cladding F=Fenestration WP=Waterproofing S=Structural	2018 IRC/IBC Reference	Keyword(s): D=Design I=Installation S=Specifications T=Testing E=Evaluation
1	ABAA	The Air Barrier System Specification	R, EC	None	D, I, S
2	AAMA	Training Manual	F, WP, S	None	D, I, S, T, E
		711-16	F, WP	IBC 1404.4	S, T, E
		714-15	F, WP	IBC 1404.4	S, T, E
3	ACI	318-14	S	IBC (multiple)	D, I, S, T, E
		524R-16	EC	None	D, I, S
4	AIA	Architectural Graphic Standards	R, EC, F, WP, S	None	D, I, S
5	APA	Residential Design Guide	EC, S	IBC/IRC (multiple)	D, I, S, T
		Siding and Trim Attachment	EC	None	D, I, S
6	ANSI	4435-ES-1-11	R	IBC 1504.5	D, I, S, T
7	ARMA	Roofing Manual	R	None	D, I, S, T, E
8	ASCE	30-14	R, EC, F, WP, S	None	D, I, S, T, E
		7-16	R, EC, S	IBC/IRC (multiple)	D, S
9	ASHRAE	90.1 - 2016	R, EC, F, WP	None	D, S, T, E
10	ASTM	E2112	F	None	D, I, S, T, E
		E2128	R, EC, F, WP	None	T, E
11	BIA	Tech Notes	EC, WP, S	None	D, I, S, T, E
12	CSI	Cast Stone Technical Manual	EC	None	D, I, S
13	CSI	Project Manual	R, EC, F, WP, S	None	S, T, E
14	CSSB	Roof Manual	R	IBC Tables 1507.8.5 and 1507.9.6 IRC R702.6 and 703.6	D, I, S
		Wall Manual	EC	None	D, I, S
15	EIMA	Guide Specifications	EC	None	D, I, S, T
16	FEMA	Coastal Construction Manual	R, EC, F, WP, S	None	D, I, S
		TB-11-01 Crawlspace Construction	WP	IBC 1805.1.2 IRC R408.7	D, S, E
17	FRSA	Concrete and Clay Tile Installation Manual	R	None	D, I, S, T
18	FM	Data Sheets	R	None	D, I, S, T, E
19	IBHS	Fortified Standards	R, EC, F	None	D, I, S
20	ICC	IRC and IBC	R, EC, F, WP, S	N/A	D, I, S, T
21	IGMA	TM-3000-90(04)	F	None	T
		TM-4100-03	F	None	E
		TM-4000-02(07)	F	None	S
22	IIBEC	Manual of Practice	R, EC, F, WP, S	None	D, S, T, E
23	ILI	Indiana Limestone Handbook	EC	None	D, I, S
24	JLC	A Manual of Best Practices	R, EC, F, WP, S	None	D, I
25	MBMA	Low Rise Building Manual	R, EC, S	None	D, I, S, T
		Roofing Design Manual	R	None	D, I, S, T, E

26	MVMA	Installation Guide	EC	None	D, I, S, T
27	NAAMM	EMLA 920-09	EC	None	D, I, S
28	NCMA	TEK Manual	EC, S, WP	IBC Table 721.1(2) (TEK 5 only)	D, I, S, T, E
29	NRCA	Roofing and Waterproofing Manual	R, WP	None	D, I, S, T
30	NSA	Slate Installation and Design Manual	R	None	D, I, S, T
31	PCA	Plaster/Stucco Manual	EC	None	D, I, S, T
		PCA 100-12 Concrete Wall Design	S	IRC (multiple)	D, I, S, E
32	Revere Copper	Copper and Common Sense	R, EC	None	D, I, S
33	SBCA	BCSI – 2013	S	IRC R502.11.2 and R802.10.3	D, I, S, E
34	SDI	SDI RD-2017 Standard for Steel Roof Deck	S	IBC 2210.1.1.2	D, I, S
35	SJI	SJI 100-15	S	IBC 1604.3.3 2203.2 2207.1	D, I, S
36	SMACNA	Architectural Sheet Metal Manual	R, EC	None	D, S
37	SPFA	SPFA-130 - Spray Polyurethane Foam Roofing	R	None	D, I, S
38	SPRI	RP-4-13	R	IBC 1504.4	D, I
39	SWRI	Technical Bulletins	EC, WP	None	D, I, S, T
40	TCNA	Handbook for Ceramic, Glass, and Stone Tile Installation	EC, WP	None	D, I, S
41	TMS	402-16 Building Code Requirements and Specifications for Masonry Structures	EC, S	IBC/IRC (multiple)	D, I, S, T
42	TPI	TPI 1-2014	S	IBC 2303.4.6 and 2306.1 IRC R502.11.1 and R802.10.2	D, I, S, T
43	TRI/WSRC	Concrete and Clay Roof Tile Installation Manual	R	None	D, I, S
44	UL	55A-04 Built-up Roof Coverings	R	IBC 1507.10.2	D, S, T
		Rated Assemblies	R, EC	None	D, I, S, T, E
45	VSI	2017 Vinyl Siding Installation Manual	EC	None	D, I, S, E
46	WDMA	101/I.S.2/A440	F	IBC 1709.5.1 and 2405.5 IRC R308.6.9, R609.3 and N1102.4.3	S, T
		I.S. 11-18 DP Rating	F, S	IRC R308.6.9.1 and R609.3.1	D, S, E

Table 1

professionals. While there are certainly other relevant references within the industry, these references are most familiar to the authors. This list has not been expanded to include references specific to Canada, or other countries beyond the U.S. However, the information provided in most of these references is not sensitive to geographic location. Users of these references should become familiar with the applicability of a reference on a case-by-case basis. For forensic work, it is important to select the publication date that is applicable to your project. For new construction, the latest versions should be used.

Much of the information regarding each organization, and the referenced documents, were collected from current websites. The web address for each organization is provided for quick access to this information, as well as the download or ordering instructions for the referenced documents.

1. ABAA (AIR BARRIER ASSOCIATION OF AMERICA)

www.airbarrier.org

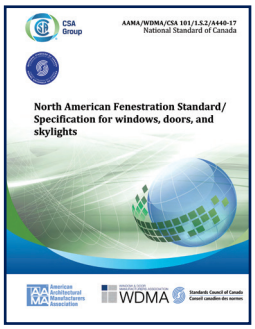
The Air Barrier Association of America (ABAA) was founded as a trade association in 2001 as the building enclosure community was increasingly advocating for control of air movement through enclosures to conserve energy, among other reasons. The association provides education and outreach, research, technical resources, standards development, building code participation, and quality assurance for the air barrier industry. This is summed up in its mission statement: "To work together with our membership, industry, and trade to be the recognized voice for Air Barrier [*sic*] knowledge." Its membership includes manufacturers, architects, engineers, trade contractors, researchers, testing and audit agencies, consultants, and building owners. Among the benefits provided are:

- Availability of air barrier assembly details and model specifications.
- Technical assistance on the design and construction of air barrier assemblies.
- Technical bulletins and newsletters highlighting innovations in air barrier technology and industry advancements.
- Education and technology transfer programs on building enclosure design, construction, and maintenance.
- Access to industry research and best-practice guides for air barrier materials, assemblies, systems, and installation.
- Availability of a quality assurance program providing training, certification, product evaluations, contractor accreditation, and site quality control audits of air barrier installations.

2. AAMA (ARCHITECTURAL ALUMINUM MANUFACTURERS ASSOCIATION)

www.aama.org

The Architectural Aluminum Manufacturers Association (AAMA) is the group that sponsors the testing certification program for fenestration products such as windows and doors. The *Installation Training Manual* was first published in 2000; a second edition was released in 2008. It was originally developed simultaneously with ASTM E2112, *Standard Practice for Installation of Exterior Windows, Doors and Skylights*, but the training manual was published first. The AAMA manual is a contractor-friendly document used to train contractors regarding proper installation details as part of the AAMA "Installation Masters" program.



Two code-referenced standards have recently been published by AAMA that address flashing/waterproofing products to be installed in the rough opening for a window or door. These standards (711 and 714) provide performance and durability requirements for self-adhering and liquid-applied flashing products, respectively.

3. ACI (AMERICAN CONCRETE INSTITUTE)

www.concrete.org

The American Concrete Institute's (ACI's) *Building Code Requirements for Structural Concrete* (ACI 318-14) has been referenced by the building codes for decades. This is a go-to document for concrete design and construction details. This standard was first referenced by the building code in 1941.

ACI 524R-16, *Guide to Portland Cement-Based Plaster,* appears to have been first published in 1993. The current version is dated 2016. This guide is intended for use by architects, engineers, designers, specification writers, contractors, plasterers, laboratory personnel, and public authorities for familiarization with the plastering processes and as an aid in specification writing.

4. AIA (AMERICAN INSTITUTE OF ARCHITECTS)

www.aia.org

Marketed as the "Architect's Bible," the *Architectural Graphic Standards* was first introduced in 1932. It is currently in its 12th edition. This reference is filled with drawings that depict various types of building enclosure assemblies. The current book includes three sections that address design and documentation, materials, and building elements. The latest edition also includes information regarding building enclosure resiliency, fundamentals of design and construction documentation, and material performance.

5. APA (APA – THE ENGINEERED WOOD ASSOCIATION)

www.apawood.org

Portions of the *APA Residential Design Guide* have been referenced by the building codes for decades. This guide includes relevant design and installation information for wood panels (OSB and plywood) used to create structural diaphragms for roofs, walls, and floors. This document includes a recommendation (not a requirement) for sloping exterior walkways and balconies that utilize wood framing. This portion of the document was not previously referenced by the building codes. However, this common-sense recommendation recently became a requirement with the "positive slope" provision introduced in the 2018 IBC.

The *Nail-Base Sheathing for Siding and Trim Attachment* guide was issued in June 2015. This guide provides an easy method for determining the type and spacing of siding fasteners to satisfy building code requirements when using wood structural panel sheathing as a nail base. This document allows for siding and trim attachment into structural panels only when certain conditions are met. The information is consistent with "real-world" conditions that may deviate from specific, prescriptive code requirements described by the *International Residential Code* (*IRC*), or siding manufacturer installation instructions.

6. ANSI (AMERICAN NATIONAL STANDARDS INSTITUTE)

www.ansi.org

The American National Standards Institute (ANSI), founded in October 1918, is a private, not-for-profit organization dedicated to supporting the U.S. voluntary standards and conformity assessment system. ANSI does not itself develop standards, but rather, it supports their development. To this end, ANSI provides an unbiased framework through its regulations for developing objective, consensus standards and conformity assessment systems. It has over 200,000 individual standards for sale. Most are developed in partnership with U.S. entities that include industry, other standards developing organizations, trade associations, professional and technical societies, government, labor, and consumer groups. Such entities are called ANSI-accredited standards developers (ASD). Approval of these joint standards requires ANSI verification that the principles of openness and due process have been followed and that


ANSI/SPRI/FM 4435/ES-1 2017
Test Standard for Edge Systems Used with Low Slope Roofing Systems
Approved January 24, 2017
Table of Contents
1.0 Introduction ... 2
1.1 Scope ... 2
1.2 Definitions ... 2
2.0 Background Information ... 4
2.1 Wind Related Roofing Damage ... 4
3.0 Membrane Termination ... 4
3.1 Dependently Terminated Systems ... 4
3.2 Independently Terminated Systems ... 4
4.0 Edge System Resistance ... 4
4.1 Dependently Terminated Systems ... 4
4.2 Edge Flashing, Gravel Stops ... 4
4.3 Copings ... 5
5.0 Packaging and Identification ... 5
6.0 Installation Instructions ... 5
7.0 References ... 5
Appendix A—Roof Edge System Testing ... 6
Appendix B—Commentary ... 12
Disclaimer
This standard is for use by architects, engineers, roofing contractors, manufacturers, testing agencies, and owners of low slope roofing systems. SPRI, its members and employees do not warrant that this standard is proper and applicable under all conditions

a consensus of those directly and materially affected by the standard has been achieved.

Many organizations serving the building enclosure community have teamed with ANSI and have issued documents often referred to as ANSI/industry standards. Notable examples of organizations partnering with ANSI to issue standards of utility to the building enclosure community include AAMA, FM Approvals, SPRI, and UL (for examples, see individual sections). ANSI is also the official U.S. representative to the International Organization for Standardization (ISO). For purposes of this summary, one of the most notable standards is the code-referenced ANSI/SPRI ES-1, *Test Standard for Edge Systems Used with Low Slope Roofing Systems*, that deals with edge metal on roofs.

7. ARMA (ASPHALT ROOFING MANUFACTURERS ASSOCIATION)

www.asphaltroofing.org

The Asphalt Roofing Manufacturers Association (ARMA) is a trade association representing North America's asphalt roofing manufacturing companies and their raw material suppliers. The association includes the majority of North American manufacturers of asphalt shingles and asphalt low-slope roof membrane systems. Information that ARMA gathers on modern asphalt roofing materials and practices is provided to building and code officials, as well as regulatory agencies and allied trade groups. The *ARMA Asphalt Roofing Residential Manual* was first published in 1984. The current version, *Residential Asphalt Roofing Manual – Design and Application Methods*, was published in 2014. This manual provides information regarding project estimating, specifications, and installation details.

8. ASCE (AMERICAN SOCIETY OF CIVIL ENGINEERS)

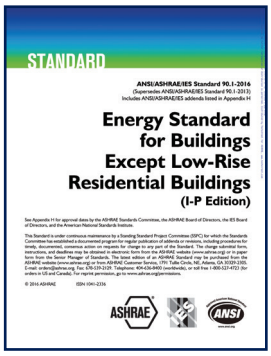
www.asce.org

The American Society of Civil Engineers' (ASCE's) *Guideline for Condition Assessment of the Building Envelope* (ASCE 30-14) includes protocols to be followed by industry professionals that perform condition assessments of building envelopes, as well as identifying problematic and dysfunctional elements. The adaptive reuse, rehabilitation, and improvement of existing buildings include an accurate assessment of the building enclosure. Failures of the building enclosure can result not only in structural damage but also in safety or health problems. ASCE 30-14 serves structural engineers, design professionals, code officials, and building owners in evaluating the enclosure systems of existing buildings.

ASCE 7-16, *Minimum Design Loads for Buildings and Other Structures*, is a long-standing code reference that is used by engineers to determine the code-prescribed loads associated with specific buildings. The most common use of this standard for building enclosure consulting is calculating the design wind pressures for roof and wall assemblies.

9. ASHRAE (AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS)

www.ashrae.org



The ANSI/ASHRAE/IES Standard 90.1-2016, *Energy Standard for Buildings Except Low-Rise Residential Buildings*, provides the minimum requirements for energy-efficient design of most buildings, except low-rise residential buildings. It offers, in detail, the minimum energy-efficient requirements for design and construction of new buildings and their systems, new portions of buildings and their systems, and new systems and equipment in existing buildings, as well as criteria for determining compliance with these requirements. It is an indispensable reference for engineers and other professionals involved in design of buildings and building systems.

10. ASTM INTERNATIONAL (FORMERLY THE AMERICAN SOCIETY FOR TESTING AND MATERIALS)

www.astm.org

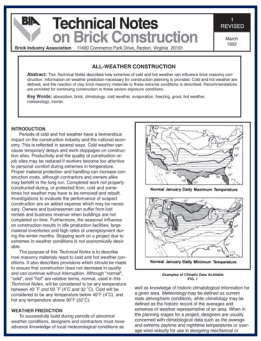
There are over 2,500 ASTM standards referenced by the building code. However, there are several standards that seem to be regularly discussed by (and should be familiar to) building enclosure consultants. While numerous standards could be discussed, a brief list of ASTM "highlights" is provided below.

- ASTM C926 and ASTM C1063 are the code-referenced stucco standards.
- ASTM E1105 is the standard for testing water penetration resistance of windows and doors.
- ASTM E2112 is the standard for the installation of windows and doors.
- ASTM E2128 is the standard for evaluating water intrusion at an existing building.

There are too many ASTM standards to list that may be relevant to building enclosure issues. The standards described previously represent a small sample of those that are most commonly referenced.

11. BIA (BRICK INDUSTRY ASSOCIATION)

www.gobrick.com



The Brick Industry Association's (BIA's) *Technical Notes on Brick Construction* date back to the 1960s. These are free bulletins that contain design, detailing, and construction information based on the latest technical developments in brick masonry. Drawings, photographs, tables, and charts illustrate appropriate topics. *Technical Notes on Brick Construction* are recommendations on the use of fired clay brick.

Technical Notes are available individually online or may be ordered as a set through the online BIA bookstore.

12. CSI (CAST STONE INSTITUTE)

www.caststone.org

The Cast Stone Institute (CSI) was incorporated in 1927. The publication date of the first edition of its *Technical Manual* has been lost in time. The current edition, published in 2020, includes numerous design details, as well as design tips provided in the form of case studies.

CSI considers that appropriate and accurate specification, fabrication, and installation of cast stone is essential. Consequently, CSI worked through The Masonry Society (TMS) to create new consensus-based standards for architectural cast stone design, fabrication, and installation in October 2016. These architectural cast stone standards were adopted by the International Code Council (ICC) into the 2018 version of the *International Building Code* (*IBC*).

13. CSI (CONSTRUCTION SPECIFICATIONS INSTITUTE)

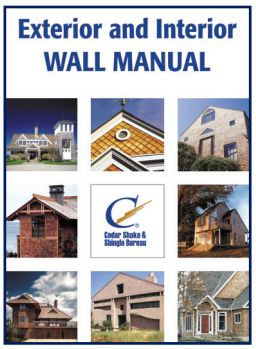
www.csiresources.org

The Construction Specifications Institute (CSI) is a national association that includes industry professionals who are experts in building construction and materials. The work of CSI is currently focused in three areas: standards and publications, construction industry professional certifications, and continuing education for construction professionals.

First published in 1967, *The Project Resource Manual: CSI Manual of Practice* has been recognized as the standard for project manual preparation and administration. It is the authoritative resource for the organization, preparation, use, and interpretation of construction documents encompassing the entire life cycle of a facility. The fifth edition expands the scope of the manual to meet the requirements of all participants involved in a construction project in a stage-by-stage progression, including owners, design professionals, design-builders, contractors, construction managers, product representatives, financial institutions, regulatory authorities, attorneys, and facility managers. It promotes a team model for successful implementation.

14. CSSB (CEDAR SHAKE AND SHINGLE BUREAU)

www.cedarbureau.org



Founded in 1915, the Cedar Shake and Shingle Bureau (CSSB) is a nonprofit trade association that promotes cedar roofing and sidewall products. Over the years, the CSSB has become recognized as a leading source on the design, selection, and installation of cedar shake and shingle systems. A major association goal is the education of the public and building code officials on the acceptable use of these products through advocacy, publications, and seminars. CSSB publishes quality standards (grade rules) and ensures that the member mills producing shakes and shingles meet these standards through periodic third-party inspection. Publications include technical bulletins and articles, newsletters, manuals, and installation details. Manuals include the *New Roof Construction Manual*, most recently published in 2020, and the *Exterior and Interior Wall Manual*, most recently published in 2020.

15. EIMA (EIFS INDUSTRY MEMBERS ASSOCIATION)

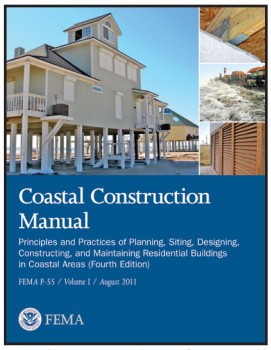
www.eima.com

The EIFS Industry Members Association is a not-for-profit trade association committed to the advancement and growth of the demand for exterior insulation and finish systems (EIFS) by accomplishing objectives which either cannot be achieved by individual members, or those which are more efficiently carried out collectively. Specifically, EIMA supports the industry by developing consensus technical, training, installation, and design standards for use by architects, designers, code bodies, officials, and other technical associations.

ANSI/EIMA 99A-2017, *Standard for Exterior Insulation and Finish Systems* (EIFS) *and EIFS with Drainage,* embodies the minimum requirements for specifying and installing EIFS and EIFS with drainage. The generic materials, details, and design considerations for EIFS and EIFS with drainage are described in this standard. In addition, care has been taken to incorporate the reference documents that constitute provisions of this American national standard. The annex contained in this standard is considered part of the standard.

16. FEMA (FEDERAL EMERGENCY MANAGEMENT AGENCY)

www.fema.gov

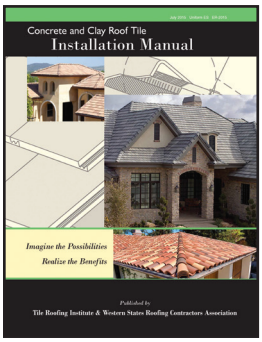


The Federal Emergency Management Agency (FEMA) coordinates the federal government's role in preparing for, preventing, mitigating the effects of, responding to, and recovering from all domestic disasters, whether natural or man-made. Its mission statement is straightforward: helping people before, during, and after disasters. Since Hurricane Andrew struck south Florida in 1992, FEMA has coordinated the development of Mitigation Assessment Team (MAT) Reports. These reports, freely available on FEMA's website, summarize the performance of buildings during storms, providing observations of the problems experienced and recommendations and technical guidance for their avoidance. Since 1992, over one dozen MAT reports have been issued.

Another important FEMA document for hurricane-prone construction areas is FEMA P-55, *Coastal Construction Manual: Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining Residential Buildings in Coastal Areas* (Fourth Edition), published in 2011. This is a two-volume set that provides a comprehensive approach to planning, siting, designing, constructing, and maintaining homes in the coastal environment. It has been described by many users as the go-to document for residential coastal construction. Volume I provides information about hazard identification, siting decisions, regulatory requirements, economic implications, and risk management. Volume II contains in-depth descriptions of design, construction, and maintenance practices that, when followed, will increase the durability of residential buildings in the harsh coastal environment and reduce economic losses associated with coastal natural disasters.

17. FRSA (FLORIDA ROOFING AND SHEET METAL CONTRACTORS ASSOCIATION)

www.floridaroof.com



In January, 1987, the Roof Tile Committee of the Florida Roofing and Sheet Metal Contractors Association (FRSA) and the National Tile Roofing Manufacturers Association (NTRMA) was commissioned to develop and write consensus standards for the installation of concrete and clay roof tiles. The NTRMA later changed its name to the Tile Roofing Institute, and then recently (in 2019) the Tile Roofing Industry Alliance. The *Concrete and Clay Tile Installation Manual* was later revised to be the *Florida High Wind Concrete and Clay Tile Installation Manual.* While the design and installation details are intended for high-wind environments, most of the information is relevant to roof installations elsewhere.

18. FM

www.fmglobal.com

FM Global (formerly Factory Mutual) is an insurance carrier that focuses on property loss prevention and safety. Guided by the tenet that most losses can be prevented, mitigating risk is an FM Global major service. FM Global focuses on reducing property loss due to fire, weather, and/or equipment failure. Integral to these efforts, it has developed FM Global Property Loss Prevention Data Sheets that provide general guidance and recommendations regarding factors such as the proper design, selection installation, and maintenance of building components and systems. FM Global states that they "incorporate nearly 200 years of property loss experience, research, and engineering results, as well as input from consensus standards committees, equipment manufacturers, and others." More than 40 construction-oriented Property Loss Prevention Data Sheets have been developed. Examples are:

- Data Sheet 1-4: *Fire Tests*
- Data Sheet 1-15: *Roof-Mounted Solar Photovoltaic Panels*
- Data Sheet 1-28: *Wind Design*
- Data Sheet 1-30: *Repair of Wind-Damaged Single- And Multi-Ply Roof Systems*
- Data Sheet 1-34: *Hail Damage*

Affiliated with FM Global is FM Approvals, an independent testing laboratory that conducts research and develops standards associated with buildings and property loss prevention. FM Approvals tests products and services used in commercial and industrial facilities to verify they meet loss prevention standards of quality, technical integrity, and performance. As part of the process, FM Approvals develops Approval Standards that provide the requirements (and procedures for conformance) that must be met for FM acceptance. Examples of such standards are:

- FM 4470: *Approval Standard for Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction*;
- FM 4473: *Specification Test Standard for Impact Resistance Testing of Rigid Roofing Materials by Impacting with Freezer Ice Balls*; and,
- ANSI FM 4474-2004 (R2010): *American National Standard for Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures.*

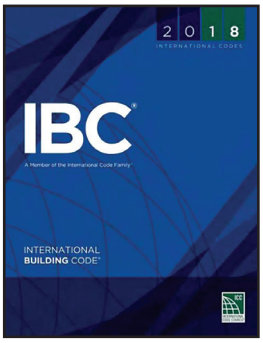
19. IBHS (INSTITUTE OF BUILDING AND HOME SAFETY)

www.ibhs.org

The Institute of Building and Home Safety is funded by insurance companies that have an interest in reducing risks. The FORTIFIED standards serve to minimize risks of light to medium peril. FORTIFIED standards go beyond typical building codes to deliver superior performance during severe weather (such as hurricanes, strong thunderstorms, and lower-level tornadoes). FORTIFIED is a nationally recognized building method based on more than 20 years of scientific research and real-world testing by IBHS. The FORTIFIED standards now include residential and commercial construction, as well as roofing.

20. ICC (INTERNATIONAL CODE COUNCIL)

www.iccsafe.org



The International Code Council (ICC) publishes the *International Building Code* (IBC) and the *International Residential Code* (IRC), along with the companion codes for Mechanical (IMC), Electrical (IEC), Plumbing (IPC), Energy Conservation (IECC), Existing Buildings (IEBC), Property Maintenance (IPMC), Swimming Pools and Spas (ISPSC), Fire (IFC), and Fuel Gas (IFGC). Products used in building enclosure assemblies typically gain code acceptance via the code evaluation process. Code evaluation reports are provided to confirm that products used in construction meet the intent of the building code requirements. Building consultants should be familiar with these reports that outline the testing/evaluation performed, the specific code requirements that are satisfied, along with installation information and product limitations.

21. IGMA (INSULATING GLASS MANUFACTURERS ALLIANCE)

www.igmaonline.org

As of January 1, 2020, the American Architectural Manufacturers Association (AAMA) and the Insulating Glass Manufacturers Alliance (IGMA) unified to form the Fenestration and Glazing Industry Alliance (FGIA). The combined organization has been developing product performance standards for glass, window, door, skylight, curtainwall, and storefront products for decades and supports certification programs for finished fenestration products and components as well as insulating glass units. FGIA also engages in technical and market research projects and continuing education. The mission of FGIA is to improve home and building performance through better glass, window, door, and skylight technologies and standards. FGIA is the source for performance standards, product certification, and educational programs for the fenestration and glazing industry. Some of the relevant manuals that are available include:

- TM-3000-90(04), *North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use*;
- TM-4100-04, *Preventing Insulating Glass Failures*; and,
- TM-4000-02(07), *Insulating Glass Manufacturing Quality Procedures.*

22. IIBEC (INTERNATIONAL INSTITUTE OF BUILDING ENCLOSURE CONSULTANTS)

www.iibec.org

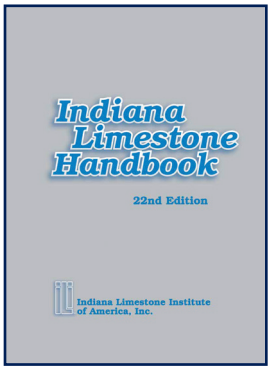
As *IIBEC Interface* readers are aware, the International Institute of Building Enclosure Consultants, or IIBEC (founded in 1983 as the Roof Consultants Institute, then renamed RCI) is an international association of professional consultants, designers, and quality assurance observers who specialize in the specification, design, installation and observation of roofing, waterproofing, and exterior wall systems. Its members serve a variety of clients in the construction industry, including architects, engineers, and building owners. They also offer a wide range of beneficial services, such as unbiased specification and design, condition assessment, construction contract administration, repair planning, quality assurance observation, forensics, legal testimony, and general asset management services. To serve these clients well and perform their duties successfully, qualified building enclosure consultants must

be knowledgeable regarding all technical and practical factors that impact the successful performance of building enclosure materials and systems.

In 2006, RCI published Volume III of the first edition of its *Manual of Practice*, which was originally intended to be a three-volume set. The second edition was issued in 2010, titled *Manual of Practice: Roof, Exterior Wall, and Waterproofing Consulting and Quality Assurance Observation.* A revised third edition was released in 2020 retitled *Manual of Practice: Roof, Waterproofing, and Exterior Wall Consulting and Quality Assurance Observation.* This manual presents the standard of practice for building enclosure consultants and quality assurance observers, as they interact not only with their clients, but with the public in general. In brief, the manual describes the role that IIBEC consultants and observers play and what they do in the building enclosure arena.

23. ILI (INDIANA LIMESTONE INSTITUTE OF AMERICA, INC.)

www.iliai.com



The *Indiana Limestone Handbook,* first published in 1954 and now in its 22nd edition, which was issued in 2007, is generally recognized as the most respected book of its kind in the masonry industry. The handbook includes a history of limestone, specifications, design, and installation information, as well as case histories. Dating back many years, the book combines the knowledge from the pioneers of the Indiana limestone industry with that of today's generation and the intervening years. The publication is made possible in no small part by the efforts of the ILI technical committee, which is comprised of engineers, design specialists, and other interested industry personnel. This committee evaluates technical inquiries regarding Indiana limestone and conducts an ongoing review of the handbook and other ILI publications. ILI offers the publication free of charge for downloading from their website, and welcomes comments and questions about its content.

24. JLC (JOURNAL OF LIGHT CONSTRUCTION)

www.jlconline.com

First published in 2003, the *JLC Field Guide to Residential Construction, Volume 1: A Manual of Best Practice* provides best practices for residential construction. Following the principles, materials, and methods detailed in this book is intended to improve the safety and durability of structures. The *JLC Field Guide* is a visual guide to building a sound structure and durable exterior shell. It includes details and proven techniques that have been successfully developed by leading builders, remodelers, subcontractors, engineers, and architects. This volume is a visual guide to every stage of constructing a durable, high-quality shell on a firm foundation. It also features over 440 detailed technical drawings and concise instructions on the fundamental principles, proven techniques, and practical rules of thumb for builders and remodelers.

25. MBMA (METAL BUILDING MANUFACTURERS ASSOCIATION)

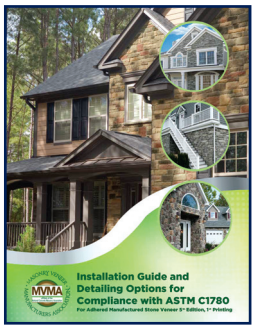
www.mbma.com

For over 60 years, the Metal Building Manufacturers Association (MBMA) and its manufacturing members have worked together as partners to further its mission: to conduct research, to help advance building codes and standards, and to educate the construction community.

The two most relevant documents from the MBMA include: 1) the *Low-Rise Building Manual*, and 2) the *Metal Roofing Systems Design Manual.* The *Low-Rise Building Manual* includes essential information about the design and construction of pre-engineered metal buildings. The roofing design manual includes specific information about various types of metal roofing systems, including both architectural and structural panels.

26. MVMA (MASONRY VENEER MANUFACTURERS ASSOCIATION)

www.ncma.org



The Masonry Veneer Manufacturers Association (MVMA) is part of the National Concrete Masonry Association (NCMA). The NCMA published the fifth edition of the *Installation Guide and Detailing Options for Compliance with ASTM C1780 for Adhered Manufactured Stone Veneer* in 2017. This guide provides information on design and construction of adhered manufactured stone veneer systems. Use of these recommendations, which are coordinated with requirements in the 2018 *International Building Code*, help to ensure structural integrity of the adhered veneer system. The guide is used throughout the construction industry, is considered the authority on proper installation of adhered manufactured stone veneer systems, and is available for free download at the NCMA website.

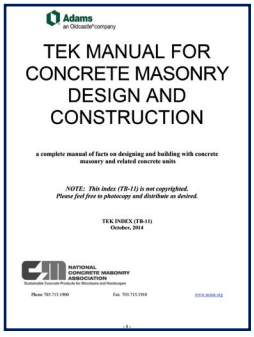
27. NAAMM (NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS)

www.naamm.org

EMLA 920-09, *Guide Specifications for Expanded Metal Lathing and Furring,* was first published in 1981; this standard is now in its fifth edition, published in 2009. This standard was discovered when dealing with "stucco bucket" conditions on stucco-clad beams located below balconies. The stucco bucket condition describes locations where proper drainage provisions are not provided at the base of vertical, stucco-clad wall areas. The absence of drainage provisions can result in significant damage where the water is trapped and unable to exit. This standard identifies this issue and provides recommended installation details to facilitate adequate drainage. According to the NAAMM website, "This standard is no longer being revised or updated."

28. NCMA (NATIONAL CONCRETE MASONRY ASSOCIATION)

www.ncma.org



The National Concrete Masonry Association (NCMA) TEK manual is a complete manual of facts on designing and building with concrete masonry. The manual consists of an informational series of "TEK Notes." TEK Notes are regularly updated by NCMA and offer a broad range of technical information and best practices. The *TEK Manual for Concrete Masonry Design and Construction*

is a must-have reference for those in the construction industry who design or build with concrete masonry units (CMUs). The current list of TEK Notes on the NCMA website includes 152 entries that cover a broad range of topics from codes/standards to flashing and waterproofing details.

29. NRCA (NATIONAL ROOFING CONTRACTORS ASSOCIATION)

www.nrca.net

The National Roofing Contractors Association (NRCA) is one of the oldest associations in the construction industry, having been initiated in 1886. Its purpose is to preserve and promote the art of roofing application. NRCA advocates for integrity and professionalism in roof contracting, including contractors' dealings with clients and their own employees through appropriate training and education. Promotion of successful, high-quality roofing practices through activities such as publications, including manuals and its trade journal, *Professional Roofing*, seminars, conferences, and education programs, are an integral part of its history.

The NRCA's foremost publication is the *NRCA Roofing Manual*. Presently available as a four-volume set, it provides extensive information about the design, materials, and installation techniques applicable to most types of roof systems. The manual was first published in 1970 as *A Manual of Roofing Practice*. As time passed, it was updated, and in 1981, it appeared as the *NRCA Roofing and Waterproofing Manual*. The four-volume set was first completed in 2010 with the title reverting to *The NRCA Roofing Manual*. As of 2020, the individual volumes along with the dates published are:

- *The NRCA Roofing Manual: Metal Panel and SPF Roof Systems*—2020
- *The NRCA Roofing Manual: Membrane Roof Systems*—2019
- *The NRCA Roofing Manual: Architectural Metal Flashing and Condensation and Air Leakage Control*—2018
- *The NRCA Roofing Manual: Steep-Slope Roof Systems*—2017

Waterproofing information is currently provided in a separate publication titled *The NRCA Waterproofing Manual*.

30. NSA (NATIONAL SLATE ASSOCIATION)

www.slateassociation.org

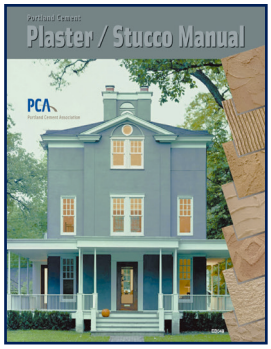
The 2010 *Slate Roofs: Design and Installation Manual* is a comprehensive document that includes relevant information for design professionals, contractors, and property owners who deal with slate roofs. Eighty-four years after the original *Slate Roofs*, the National Slate Association (NSA) published this completely new guide to slate roofing. This complete, in–depth manual, consisting of 250 pages of text and detailed drawings, has undergone extensive peer review by respected members of the slate roofing industry.

31. PCA (PORTLAND CEMENT ASSOCIATION)

www.cement.org

The Portland Cement Association (PCA), founded in 1916, is the premier policy, research, education, and market intelligence organization serving America's cement manufacturers. The *Portland Cement Plaster/Stucco Manual* was last published in 2003. There were four previous editions. This manual includes a history of stucco,

a discussion of applicable codes and standards, design information, installation details, and a troubleshooting guide for the most common issues.



32. REVERE COPPER PRODUCTS
www.reverecopper.com

Revere Copper Products, founded in 1801, is one of the oldest manufacturing companies in the United States. Known for its role in copper roofing and wall cladding, Revere is also a leading supplier of copper-based products for various other markets, including electrical, telecommunications, air conditioning, and industrial machinery and equipment. Over the years, to advance the copper segment of the roofing industry, it has furnished quality products and technical assistance, including publications, research results, and training seminars. In 1945, Revere released the first edition of its manual, *Copper and Common Sense*. The manual is now in its eighth edition, which was published in 2005. Many practitioners consider this manual to be the most widely referenced sheet copper design guide, and a must-have reference source for anyone working with copper roofing. The manual addresses the complete gamut of factors to be pursued in the construction of acceptable copper roofs and accessories, including basic principles, mechanical properties, design, installation procedures, storage, handling, specifications, and detailed drawings. In addition, results of research studies on copper sheet products sponsored by Revere have been included in the text.

33. SBCA (STRUCTURAL BUILDING COMPONENTS ASSOCIATION)
www.sbcindustry.com

The Structural Building Components Association (SBCA) is considered to be the only international trade association representing manufacturers of structural building components. Founded in 1983, SBCA has published several best practice and technical resources for such components as metal-plate-connected wood trusses, conventionally framed roofs, deck ledger attachments, fire-resistance-rated truss assemblies, floor vibrations, and microbial growth on structural building components.

34. SDI (STEEL DECK INSTITUTE)
www.sdi.org

The Steel Deck Institute (SDI) has been providing information with regard to the design, engineering, manufacturing, and installation of steel decks since 1939. The SDI provides standards in reference to roof decks, floor decks, and diaphragms that are incorporated into the *International Building Code* and NFPA 5000. The SDI works with industry organizations to perform research and develop standards.

35. SJI (STEEL JOIST INSTITUTE)
www.steeljoist.org

Founded in 1928, the Steel Joist Institute (SJI) is an organization comprised of manufacturers and companies developing standards for steel joist construction. SJI provides several technical references and standards with regard to the specification, design, and installation of steel joist components, including the *Standard Specifications: Load Tables and Weight Tables for Steel Joists and Joist Girders.*

36. SMACNA (SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION)
www.smacna.org

The Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) is an international trade association that provides technical resources relevant to the sheet metal and air conditioning industry. The *Architectural Sheet Metal Manual,* published by SMACNA, contains recommended practices for the design and installation of fabricated architectural sheet metal, which includes, but is not limited to, roof drainage systems for scuppers, gutters, and downspouts. Additionally, this manual provides methods for design with reference to the climatic conditions and rainfall rates.

37. SPFA (SPRAY POLYURETHANE FOAM ALLIANCE)
www.sprayfoam.org

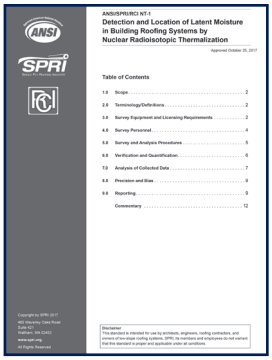
The Spray Polyurethane Foam Alliance (SPFA) is a trade association dedicated to the advancement of spray polyurethane foam (SPF) used in construction. As the technical voice of the SPF industry, SPFA advocates on its behalf to educate and influence the construction industry on the benefits of SPF roofing, insulation, coatings, and specialty installations. Its members include contractors, manufacturers, and distributors of polyurethane foam and related equipment, and others who provide protective coatings, inspections, surface preparations, and other related products. SPFA services provided on behalf of its customers and members include certification programs, technical literature and guidelines, research, and governmental advocacy. Two types of technical literature are available, designated by SPFA, as "TechTips" and "TechDocs."

Within the roofing arena, a major "TechDoc" is SPFA-130, *Spray Polyurethane Foam Roofing: The High Performance, Cost Effective, Weather Resistant Solution for Commercial, Industrial & Residential Structures.* Originally published in the 1990s as the association's first roofing brochure, designated AY-130, it was recently updated and republished. It provides general pointers on the selection, use, and installation of SPF roofing. A companion document on SPF roof maintenance is SPFA-127, *Maintenance Manual for Spray Polyurethane Foam Roof Systems.* This manual was first published in 2005, with the most recent version being issued in 2016. With SPF insulation being increasingly used in home constructions, SPF has made available a brochure, SPFA-154, *A Homeowner's Guide to Spray Polyurethane Foam.*

38. SPRI (SINGLE-PLY ROOFING INDUSTRY)
www.spri.org

The Single-Ply Roofing Industry (SPRI) is a commercial roofing association whose members provide for discussion, education, and innovation within the industry. It is the leading advocate for single-ply roofing in North America, focusing on the performance of flexible, thermoset, thermoplastic, and polymer-modified bitumen membrane systems. Its main members are the manufacturers and marketers of these systems. Associate members include suppliers of raw materials, components, accessories, tools,

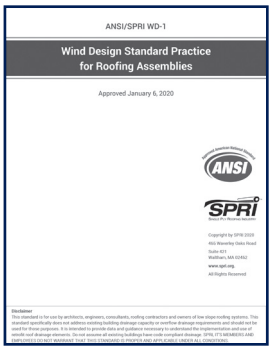
or equipment used in conjunction with them. Affiliate members are associated with use of the systems, including professional roof consultants, architectural and engineering firms, specifiers, product distributors, sales representatives, testing agencies, building owners, contractors, and research agencies.


ANSI/SPRI/RCI NT-1

Detection and Location of Latent Moisture in Building Roofing Systems by Nuclear Radioisotopic Thermalization

Approved October 25, 2017

Table of Contents


ANSI/SPRI WD-1

Wind Design Standard Practice for Roofing Assemblies

Approved January 6, 2020

SPRI provides essential technical support and resources to the single-ply user community. Chief among these resources are publications, standards, and other documents that range from generic technical guidelines for design and application to general information about roof maintenance and emergency repairs. SPRI also advocates for codes and standards pertinent to the acceptable performance of single-ply systems. Working through ANSI, SPRI has developed a dozen, complimentary-available, ANSI/SPRI standards. Examples (followed by the publication date of the latest edition) are:

- ANSI/SPRI/FM 4435/ES-1, *Test Standard for Edge Systems Used with Low Slope Roofing Systems*—2017
- ANSI/SPRI FX-1, *Standard Field Test Procedure for Determining the Withdrawal Resistance of Roofing Fasteners*—2016
- ANSI/SPRI/RCI NT-1, *Detection and Location of Latent Moisture in Building Roofing Systems by Nuclear Radioisotopic Thermalization*—2012 (R2017)
- ANSI/SPRI RP-4, *Wind Design Standard for Ballasted Single-ply Roofing Systems*—2019
- ANSI/SPRI WD-1, *Wind Design Standard Practice for Roofing Assemblies*—2020

Note that NT-1 was developed in affiliation with RCI (now IIBEC). The basis for the NT-1 standard was the original-published RCI industry standard having the same title. It was subsequently published in the RCI 2010 *Manual of Practice*.

39. SWR INSTITUTE (SEALANT, WATERPROOFING, & RESTORATION INSTITUTE)

www.swrionline.org

The Sealant, Waterproofing, & Restoration Institute (SWR Institute) is an international trade association that represents the commercial sealant, waterproofing, and restoration construction industry. SWR Institute members include experienced and qualified contractors, manufacturers, and design professionals who constantly strive to advance the industry and the quality of work that is performed. The SWR Institute Technical Bulletins cover a variety of topics, including elastomeric wall coatings, exterior stone restoration, mortar joint removal, repointing mortar joints, clear water repellents for masonry, and other topics.

40. TCNA (TILE COUNCIL OF NORTH AMERICA)

www.tcnatile.com

The Tile Council of North America (TCNA) is a trade association representing North American manufacturers of ceramic tile, tile installation materials, tile equipment, raw materials, and other tile-related products. Since 1945, the TCNA has had a leadership role in facilitating the development of North American and international industry quality standards that benefit tile consumers. The 2018 *TCNA Handbook* provides guidelines and industry standards that give helpful information to anyone handling or dealing with tile.

41. TMS (THE MASONRY SOCIETY)

www.masonrysociety.org

The Masonry Society (TMS) publishes TMS 402, which was first referenced by the 1994 *Standard Building Code* under the designation of ACI 530/ASCE 5/TMS-402-92. The current designation is TMS 402/602-16, *Building Code Requirements and Specification for Masonry Structures*. This document includes structural design information as well as general requirements for installation, including attachment and water management details for adhered and anchored masonry veneer.

42. TPI (TRUSS PLATE INSTITUTE)

www.tpinst.org

The Truss Plate Institute (TPI) opened in 1961 with the goal of supporting the emerging market of metal-plate-connected wood trusses. Since then, TPI has been using its resources and dedicated members to support the market and uphold the institute's mission "to maintain the truss industry on a sound engineering basis" TPI continues to support the industry by publishing ANSI-approved industry guidelines. The code-referenced ANSI/TPI 1-2014 standard, *National Design Standard for Metal Plate Connected Wood Truss Construction*, includes design and installation information related to the fabrication and erection of metal-plate-connected wood trusses.

43. TRI/WSRCA (TILE ROOFING INSTITUTE/WESTERN STATES ROOFING CONTRACTORS ASSOCIATION)

www.tileroofing.org

The Tile Roofing Institute (TRI) and Western States Roofing Contractors Association's (WSRCA's) *Concrete and Clay Roof Tile Installation Manual* provides information regarding the design and installation of concrete and clay tile roof systems. TRI partnered with WSRCA in 1991 to develop the first manual. The current edition was published in 2015 and addresses proper installation practices, industry standards, and code requirements. The manual was reviewed by the International Association of Plumbing and Mechanical Officials, who issued a Uniform ES Evaluation Report, ER-2015, which serves to formalize the practices and recommendations included in the manual.

44. UL (UNDERWRITERS LABORATORIES)

www.ul.org

Underwriters Laboratories (UL) is a nonprofit organization that is dedicated to furthering scientific research in the areas of battery safety, chemical insights, data science, education and outreach, fire safety, and standards. Within these areas, UL conducts rigorous independent research to gather and analyze safety data to create a safer world and workplace for people within the industry. UL fire-rated assemblies for walls and roofs are commonly depicted and/or referenced by construction drawings and specifications.

45. VSI (VINYL SIDING INSTITUTE)

www.vinylsiding.org

The Vinyl Siding Institute (VSI) and its members engage in product stewardship and outreach activities in the interest of enhancing the image of the vinyl siding

industry. The VSI provides and publishes information gathered from industry professionals that acts as a guide for remodelers, builders, planners, designers, architects, elected officials, building code officials, distributors, homeowners, and other exterior cladding decision-makers on the facts about vinyl siding. The VSI *Vinyl Siding Installation Manual* provides recommendations to contractors regarding installation details.

46. WDMA (WINDOW & DOOR MANUFACTURERS ASSOCIATION)

www.wdma.com

Since 1927, The Window & Door Manufacturers Association (WDMA) has defined the standards of excellence in the residential and commercial window, door, and skylight industry and continues to advance these standards among industry members while providing resources, education, and professional programs designed to advance industry businesses and provide greater value for their customers. The two code-referenced documents that are currently published by WDMA include:

- AAMA/WDMA/CSA 101/I.S.2/A440, *North American Fenestration Standard/Specification for Windows, Doors, and Skylights*; and,
- WDMA I.S. 11-18, *Industry Standard for Analytical Method for Design Pressure (DP) Ratings of Fenestration Products.* IIBEC

Derek A. Hodgin

Derek A. Hodgin, of Construction Science and Engineering (CSE) in Westminster, SC, has over 25 years of experience as an engineering consultant. He is responsible for facility condition inspections, failure analysis, damage assessments, and forensic engineering investigations of all types of structures. A large part of his projects have included analysis of deficient construction cases, including roofs, exterior walls, windows, doors, structural framing, civil site work, and building code review.

Walter J. Rossiter, F-IIBEC, PhD

Walter J. Rossiter, PhD, F-IIBEC, is IIBEC's Director of Technical Services. In addition to being on IIBEC staff, he is an Honorary member. Rossiter has been on the RCI-IIBEC Foundation board of directors for well over a decade. He has also served as staff liaison to the Advocacy Committee, and the Building Enclosure Symposium Committee. Rossiter is currently the staff liaison to the Technical Advisory Committee, helping craft the Technical Advisories that are shared on IIBEC's website for the benefit of the industry.

John C. Wylie

John C. Wylie, with CSE, has 11 years of experience as a licensed engineer and consultant—primarily in the areas of deficient construction, structural analysis, and collapse/damage investigations. He is responsible for the inspection and structural analysis of a wide variety of building enclosure and framing systems, including roof, wall, and guardrail systems that have been subjected to damage caused by hurricanes, floods, tornados, hail, wind, ice, and fire.

Public Works Building Uses Roads as Design Motif

Bexar County's Public Works Department's office building. Photo from Marmon Mok LLP.

A public works department in Bexar County, San Antonio, TX, has a unique approach to the design of various aspects of their new building. They've created a motif using "an abstracted map of the major county roads," which is repeated in various locations throughout the building. The motif appears on a perforated screen on the front of the building, which is illuminated at night. It also occurs as a wall mural, window decoration, and as carpet tiles. The 35,000-sq.-ft. project includes solid and perforated metal panels, stainless steel mesh, composite wood panels, and stone. The designing architect on this project was Marmon Mok LLP.

— Metal Construction News