



Designation: E2813 – 18

Standard Practice for Building Enclosure Commissioning¹

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INTRODUCTION

Building Enclosure Commissioning (BECx) is a process that begins with the establishment of the Owner's Project Requirements (OPR) and endeavors to confirm that the exterior enclosure and those elements intended to provide environmental separation within a building or structure meet or exceed the expectations of the Owner as described in the OPR, and as defined by the contract documents. A fundamental understanding of the most current published edition of ANSI/ASHRAE/IES Standard 202, Commissioning Process for Buildings and Systems and ASTM E2947, Standard Guide for Building Enclosure Commissioning is recommended for optimal use and application of this practice.

1. Scope

1.1 This practice is intended to serve as a concise, authoritative, and technically sound practice for Building Enclosure Commissioning (BECx) that establishes two levels of BECx: *Fundamental* and *Enhanced* (refer also to Section 4).

1.2 The BECx process as defined in this practice includes the following phases and sub-phases:

- 1.2.1 Pre-design,
- 1.2.2 Design,
 - 1.2.2.1 Schematic Design,
 - 1.2.2.2 Design Development,
 - 1.2.2.3 Construction Documentation,
- 1.2.3 Bidding and Negotiation Phase,
- 1.2.4 Construction,
 - 1.2.4.1 Pre-Construction,
 - 1.2.4.2 Construction Administration, and
- 1.2.5 Occupancy and Operations.

1.3 This practice includes a mandatory OPR Development Guideline ([Annex A1](#)) and requires the development of an OPR for both Fundamental and Enhanced BECx that addresses, at a minimum, the performance attributes and metrics included in [Annex A1](#) of this practice.

1.4 This practice includes mandatory BECx Performance Testing Requirements ([Annex A2](#)) approved for use with this practice to evaluate the performance and durability of enclosure materials, components, systems, and assemblies.

¹ This practice is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.55 on Performance of Building Enclosures.

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1.5 This practice mandates independent design review during the Design Phase of both Fundamental and Enhanced BECx.

1.6 This practice recognizes that the OPR for exterior enclosure performance and environmental separation may exceed the baseline requirements of applicable building codes and standards and provides guidance for the development of an OPR based on the following attributes as defined in [Annex A1](#) of this practice:

- 1.6.1 Energy,
- 1.6.2 Environment,
- 1.6.3 Safety,
- 1.6.4 Security,
- 1.6.5 Durability,
- 1.6.6 Sustainability, and
- 1.6.7 Operation.

1.7 The terms “building enclosure” and “enclosure” as they appear in this practice refer collectively to all materials, components, systems, and assemblies intended to provide shelter and environmental separation between interior and exterior, or between two or more environmentally distinct interior spaces in a building or structure.

1.8 This practice establishes that the Building Enclosure Commissioning Provider (BECxP) refers specifically to the individual retained by the Owner to develop, manage, and be in responsible charge of the BECx process, including individual members and technical specialists that may comprise the BECx group (see [4.2](#)).

1.9 The role and responsibilities of the BECxP as defined by this practice are not intended to supersede or otherwise replace the contractual obligations reserved specifically for the parties responsible for the design and construction of a building or

structure, nor the duties that may otherwise be assigned to those parties by applicable regulatory or statutory law.

1.10 This practice is not intended to warrant or otherwise guarantee the as-built or in-service durability, or both, and performance of enclosure materials, components, systems, and assemblies.

1.11 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

1.12 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.13 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

- C423** Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
- C510** Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants
- C522** Test Method for Airflow Resistance of Acoustical Materials
- C724** Test Method for Acid Resistance of Ceramic Decorations on Architectural-Type Glass
- C732** Test Method for Aging Effects of Artificial Weathering on Latex Sealants
- C794** Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants
- C1060** Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings
- C1087** Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems
- C1153** Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging
- C1193-11a** Guide for Use of Joint Sealants
- C1246** Test Method for Effects of Heat Aging on Weight Loss, Cracking, and Chalking of Elastomeric Sealants After Cure
- C1258** Test Method for Elevated Temperature and Humidity Resistance of Vapor Retarders for Insulation
- C1279** Test Method for Non-Destructive Photoelastic Measurement of Edge and Surface Stresses in Annealed, Heat-Strengthened, and Fully Tempered Flat Glass

- C1294** Test Method for Compatibility of Insulating Glass Edge Sealants with Liquid-Applied Glazing Materials
- C1371** Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emis-someters
- C1522** Test Method for Extensibility After Heat Aging of Cold Liquid-Applied Elastomeric Waterproofing Mem-branes
- C1549** Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflec-tometer
- C1601** Test Method for Field Determination of Water Pen-etration of Masonry Wall Surfaces
- C1651** Test Method for Measurement of Roll Wave Optical Distortion in Heat-Treated Flat Glass
- C1652/C1652M** Test Method for Measuring Optical Distor-tion in Flat Glass Products Using Digital Photography of Grids
- D2203** Test Method for Staining from Sealants
- D4541** Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
- D5957** Guide for Flood Testing Horizontal Waterproofing Installations
- E90** Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
- E283** Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
- E330/E330M** Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
- E331** Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uni-form Static Air Pressure Difference
- E336** Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings
- E488/E488M** Test Methods for Strength of Anchors in Concrete Elements
- E492** Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine
- E514/E514M** Test Method for Water Penetration and Leak-age Through Masonry
- E576** Test Method for Frost/Dew Point of Sealed Insulating Glass Units in the Vertical Position
- E596** Test Method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures
- E631** Terminology of Building Constructions
- E779** Test Method for Determining Air Leakage Rate by Fan Pressurization
- E783** Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
- E795** Practices for Mounting Test Specimens During Sound Absorption Tests
- E903** Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- E966** Guide for Field Measurements of Airborne Sound Attenuation of Building Facades and Facade Elements
- E997** Test Method for Evaluating Glass Breakage Probability Under the Influence of Uniform Static Loads by Proof Load Testing
- E1007** Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures
- E1014** Guide for Measurement of Outdoor A-Weighted Sound Levels
- E1050** Test Method for Impedance and Absorption of Acoustical Materials Using a Tube, Two Microphones and a Digital Frequency Analysis System
- E1105** Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference
- E1186** Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
- E1425** Practice for Determining the Acoustical Performance of Windows, Doors, Skylight, and Glazed Wall Systems
- E1503** Test Method for Conducting Outdoor Sound Measurements Using a Digital Statistical Sound Analysis System
- E1827** Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
- E1886** Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
- E1980** Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces
- E1996** Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes
- E2099** Practice for the Specification and Evaluation of Pre-Construction Laboratory Mockups of Exterior Wall Systems
- E2178** Test Method for Air Permeance of Building Materials
- E2179** Test Method for Laboratory Measurement of the Effectiveness of Floor Coverings in Reducing Impact Sound Transmission Through Concrete Floors
- E2249** Test Method for Laboratory Measurement of Airborne Transmission Loss of Building Partitions and Elements Using Sound Intensity
- E2264** Practice for Determining the Effects of Temperature Cycling on Fenestration Products
- E2268** Test Method for Water Penetration of Exterior Windows, Skylights, and Doors by Rapid Pulsed Air Pressure Difference
- E2319** Test Method for Determining Air Flow Through the Face and Sides of Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
- E2353** Test Methods for Performance of Glazing in Permanent Railing Systems, Guards, and Balustrades
- E2357** Test Method for Determining Air Leakage Rate of Air Barrier Assemblies
- E2359/E2359M** Test Method for Field Pull Testing of an In-Place Exterior Insulation and Finish System Clad Wall Assembly
- E2570/E2570M** Test Methods for Evaluating Water-Resistive Barrier (WRB) Coatings Used under Exterior Insulation and Finish Systems (EIFS) or EIFS with Drainage
- E2649** Test Method for Determining Argon Concentration in Sealed Insulating Glass Units Using Spark Emission Spectroscopy
- E2947** Guide for Building Enclosure Commissioning
- F1233** Test Method for Security Glazing Materials And Systems
- F1642/F1642M** Test Method for Glazing and Glazing Systems Subject to Airblast Loadings
- F1869** Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
- F2170** Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes
- F2420** Test Method for Determining Relative Humidity on the Surface of Concrete Floor Slabs Using Relative Humidity Probe Measurement and Insulated Hood (Withdrawn 2014)³
- 2.2 *AAMA Standards*.⁴
- AAMA 501.1** Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure
- AAMA 501.2** Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems
- AAMA 501.4** Recommended Static Test Method for Evaluating Window Wall, Curtain Wall and Storefront Systems Subjected to Seismic and Wind-Induced Inter-Story Drift
- AAMA 501.5** Test Method for Thermal Cycling of Exterior Walls
- AAMA 508-07** Voluntary Test Method and Specification for Pressure Equalized Rain Screen Wall Cladding Systems
- AAMA 1503** Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors, and Glazed Wall Sections
- AAMA 1801** Voluntary Specification for the Acoustical Rating of Exterior Windows, Doors, Skylights and Glazed Wall Sections
- 2.3 *ANSI Standards*.⁵
- ANSI/ASA S12.8** Methods for Determination of Insertion Loss of Outdoor Noise Barriers
- ANSI/ASA S12.60** Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools
- ANSI/ASHRAE/IES 90.1** Energy Standard for Buildings Except Low-Rise Residential Buildings (Map of Climate Zones)

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from American Architectural Manufacturers Association (AAMA), 1827 Walden Office Square, Suite 550, Schaumburg, Illinois 60173-4268, <http://www.aamanet.org>.

⁵ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

ANSI/ASHRAE/IES Standard 101 Application of Infrared Sensing Devices to the Assessment of Building Heat Loss Characteristics

ANSI/ASHRAE/IES Standard 202 Commissioning Process for Buildings and Systems

2.4 *CAN/CGSB Standard*:⁶

CAN/CGSB 149-GP-2MP Manual for Thermographic Analysis of Building Enclosures

2.5 *CEN Standard*:⁷

CEN 1063 Glass in building - Security glazing - Testing and classification of resistance against bullet attack

2.6 *CSA Standard*:⁸

CSA-A123.21 Standard Test Method for the Dynamic Wind Uplift Resistance of Membrane-Roofing Systems

2.7 *CSI Standard*:⁹

Project Resource Manual and Manual of Practice

2.8 *GANA Test Methods*:¹⁰

GANA LD 100-06 Standard Test Method for Ball Drop Impact of Laminated Architectural Flat Glass

GANA TD 101-04 Standard Test Method for Center-Punch Fragmentation of Fully-Tempered Flat Glass

GANA LD 101-08 Standard Specification for Ball Drop Impact Resistance of Laminated Architectural Flat Glazing

2.9 *GSA Standard*:¹¹

GSA-TS01 Standard Test Method for Glazing and Window Systems Subject to Dynamic Overpressure Loadings

2.10 *ICC Publication*:¹²

International Building Code

2.11 *ISO Publication*:¹³

ISO 9000

2.12 *NFRC Standards*:¹⁴

NFRC 100 Procedure for Determining Fenestration Product U-Factors

NFRC 200 Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

NFRC 300 Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems

2.13 *NIJ Standard*:¹⁵

NIJ Std. 0108.01 Ballistic Resistant Protective Materials

2.14 *State Department (SD) Ballistic Standard*:¹⁶

SD-STD-01.01 Forced Entry and Ballistic Resistance of Structural Systems

2.15 *UL Standard*:¹⁷

UL 752 Standard of Safety for Bullet-Resisting Equipment

3. Terminology

3.1 *Definitions*—Refer to the most current edition of the following:¹⁸

3.1.1 **ANSI/ASHRAE/IES Standard 202**, Section 3, Definitions

3.1.2 **Guide E2947**

3.1.3 **Terminology E631**

3.1.4 **AIA Architect’s Handbook of Professional Practice**

3.1.5 **CSI Project Resource Manual and Manual of Practice**

3.2 *Acronyms*:

3.2.1 **AAMA**—American Architectural Manufacturers Association

3.2.2 **A/E**—Architect/Engineer

3.2.3 **AIA**—American Institute of Architects

3.2.4 **ANSI**—American National Standards Institute

3.2.5 **AOR**—Architect-of-Record

3.2.6 **ASCE**—American Society of Civil Engineers

3.2.7 **ASHRAE**—American Society of Heating, Refrigerating and Air Conditioning Engineers

3.2.8 **BCA**—Building Commissioning Association

3.2.9 **BECx**—Building Enclosure Commissioning

3.2.10 **BECxG**—Building Enclosure Commissioning Group

3.2.11 **BECxP**—Building Enclosure Commissioning Provider (aka “Agent” or “Authority”)

3.2.12 **BOD**—Building Enclosure Basis-of-Design

3.2.13 **CAN/CGSB**—Canadian General Standards Board

3.2.14 **CSA**—Canadian Standards Association

3.2.15 **CSI**—Construction Specifications Institute

3.2.16 **Cx**—Commissioning

3.2.17 **CxP**—Commissioning Provider

3.2.18 **EIS**—Energy Information System

3.2.19 **EMCS**—Energy Management and Control System

3.2.20 **EOR**—Engineer-of-Record

3.2.21 **GANA**—Glass Association of North America

¹⁵ Available from National Institute of Justice (NIJ), 810 7th St., NW, Washington, DC 20531, <http://nij.gov>.

¹⁶ Available from U.S. Government Publishing Office (GPO), 732 N. Capitol St., NW, Washington, DC 20401-0001, <http://www.gpo.gov>.

¹⁷ Available from Underwriters Laboratories (UL), 2600 N.W. Lake Rd., Camas, WA 98607-8542, <http://www.ul.com>.

¹⁸ Selection, interpretation, application, and use of the terminology contained in these documents shall be at the sole discretion of the BECxP. Reconciliation of conflicts in terminology or the definition of terms that may exist among or between these documents shall be the sole responsibility of the BECxP, subject to review and final approval by the AOR and Owner.

⁶ Available from Canadian General Standards Board (CGSB), 11 Laurier St., Phase III, Place du Portage, Gatineau, Quebec K1A 0S5, Canada, <http://www.tpsgc-pwgsc.gc.ca/ongc-cgsb/index-eng.html>.

⁷ Available from European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, <http://www.cen.eu>.

⁸ Available from Canadian Standards Association (CSA), 178 Rexdale Blvd., Toronto, ON M9W 1R3, Canada, <http://www.csagroup.org>.

⁹ Available from Construction Specifications Institute (CSI), 110 S. Union Street, Suite 100, Alexandria VA 22314, <http://www.csiresources.org>.

¹⁰ Available from Glass Association of North America (GANA), 800 SW Jackson St., Suite 1500, Topeka, KS 66612-1200, <http://www.glasswebsite.com>.

¹¹ Available from U.S. General Services Administration (GSA), 1800 F Street, NW, Washington, DC 20405, <http://www.gsa.gov>.

¹² Available from International Code Council (ICC), 500 New Jersey Ave., NW, 6th Floor, Washington, DC 20001, <http://www.iccsafe.org>.

¹³ Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.

¹⁴ Available from National Fenestration Rating Council (NFRC), 6305 Ivy Ln., Suite 140, Greenbelt, MD 20770, <http://www.nfrc.org>.

- 3.2.22 *GSA*—United States General Services Administration
- 3.2.23 *HVAC*—Heating, Ventilation, and Air Conditioning
- 3.2.24 *IAQ*—Indoor Air Quality
- 3.2.25 *IEQ*—Indoor Environmental Quality
- 3.2.26 *LEED*—Leadership in Energy and Environmental Design (trademark¹⁹)
- 3.2.27 *NASFA*—National Association of State Facilities Administrators
- 3.2.28 *NEBB*—National Environmental Balancing Bureau
- 3.2.29 *NIBS*—National Institute of Building Sciences
- 3.2.30 *NFRC*—National Fenestration Rating Council
- 3.2.31 *O&M*—Operations and Maintenance
- 3.2.32 *OPR*—Building Enclosure Owner’s Project Requirements
- 3.2.33 *RCx*—Retro-Commissioning
- 3.2.34 *ReCx*—Re-Commissioning
- 3.2.35 *RFI*—Request For Information
- 3.2.36 *USDHS (or DHS)*—U.S. Department of Homeland Security
- 3.2.37 *USDOD (or DOD)*—U.S. Department of Defense
- 3.2.38 *USDOE (or DOE)*—U.S. Department of Energy
- 3.2.39 *USDOS (or DOS)*—U.S. Department of State
- 3.2.40 *USGBC*—U.S. Green Building Council
- 3.2.41 *VA*—U.S. Department of Veterans Affairs

4. Summary of Practice

4.1 This practice establishes two levels of BECx: *Fundamental and Enhanced*.

4.1.1 *Fundamental BECx*—Architecture or engineering-related technical services, or both, performed on behalf of the Owner by the BECxP and associated group members and summarized as follows:

4.1.1.1 BECxP engagement during the *Design Phase* of the BECx process, but no later than commencement of the Design Development sub-phase;²⁰

4.1.1.2 Review and documentation of the preliminary OPR developed during the Pre-Design Phase of the BECx process;²¹

4.1.1.3 Identification of the scope and recommended budget for the BECx process and development of a preliminary BECx Plan;²²

4.1.1.4 Technical assistance and documentation during the development of the BOD, contract documents, project-specific BECx specification section, and final OPR during the Design Phase of the BECx process, including completion of a mini-

imum of one independent design review of enclosure-related construction document drawings and specifications in a manner that will allow for timely review and consideration by the AOR prior to solicitation and contract award. The project-specific BECx specification section establishes the roles and responsibilities of the contractor and individual members of the construction team in the context of the BECx process, including a summary of required pre-construction laboratory and field performance test standards and methodology for enclosure-related materials, components, systems, and assemblies required by **Annex A2** of this practice and further defined by the AOR in the construction documents;

4.1.1.5 Document a final BECx Plan that includes an outline of the BECx process, BECx roles and responsibilities of the BECxP, individual members of the BECx group,²³ the Design Team, the Construction Team, and the methodology established to verify and document compliance of the as-built construction with the requirements of the approved contract documents. The BECx Plan shall be developed to align with the requirements of the BECx section of the project specifications;

4.1.1.6 Direct and substantive participation²⁴ by the BECxP during the Bidding and Negotiation, Pre-Construction, Construction Administration, and Occupancy & Operations phases of the BECx process, including pre-construction laboratory and field performance testing as required in **Annex A2** for *Fundamental BECx*.

4.1.2 *Enhanced BECx*—Architecture or engineering-related technical services, or both, performed on behalf of the Owner by the BECxP and associated BECx group members in accordance with the requirements of *Fundamental BECx*, but with the following additional requirements:

4.1.2.1 BECxP engagement during the *Pre-Design Phase* of the BECx process, but no later than commencement of the Schematic Design sub-phase;

4.1.2.2 Technical assistance and documentation during the development of the preliminary OPR;

4.1.2.3 Technical assistance and documentation during the development of the BOD, contract documents, including the project-specific BECx specification section, and final OPR during the Design Phase of the BECx process, including completion of a minimum of three independent design reviews²² of enclosure-related construction document drawings and specifications in a manner that will allow for timely review and consideration by the AOR prior to solicitation and contract award, and;

4.1.2.4 Direct and substantive participation²⁵ (see **4.2**) by the BECxP and BECxG during the Bidding and Negotiation,

¹⁹ LEED is a trademark held by the U.S. Green Building Council.
²⁰ Typically characterized by the AOR as “50 %” completion of the Construction Documents, subject to review and concurrence by the Owner and BECxP.
²¹ Including retroactive development of a written OPR in circumstances where a formal OPR may not exist or otherwise was not fully developed during the Pre-Design Phase of the BECx process as defined by ANSI/ASHRAE/IES Standard 202 and Guide **E2947**.
²² The BECx Plan shall be as defined by ANSI/ASHRAE/IES Standard 202 and Guide **E2947**.

²³ Though it is recognized that all parties participating in the design and construction of the building are part of the BECx process, for the purposes of this practice, the BECx group (BECxG) is defined as the group of individuals, working under direct supervision of the BECxP. This group may be comprised of a single person or may include multiple subject matter specialists and administrative staff. It is the responsibility of the BECxP to perform each required task or to delegate the appropriate task to the appropriate Group member.
²⁴ As outlined in ANSI/ASHRAE/IES Standard 202 and Guide **E2947**, unless otherwise defined in this practice.
²⁵ As defined in ANSI/ASHRAE/IES Standard 202 and Guide **E2947**.

Pre-Construction, Construction Administration, and Occupancy and Operations phases of the BECx process, including pre-construction laboratory and field performance testing as required in **Annex A2** for *Enhanced BECx*.

4.2 This practice establishes that the BECxP shall assemble a group (BECxG) that, at a minimum, demonstrates a level of proficiency in the core competencies listed below that meets or exceeds the requirements of building codes, standards, guidelines, and regulations applicable to or otherwise voluntarily adopted by the Owner to govern enclosure-related design, construction, and performance. Determination of the qualification of the BECxP and BECxG will be at the discretion of the Owner:

4.2.1 *BECxG Core Competencies:*

4.2.1.1 *Building and Materials Science*, including, at a minimum, demonstrated knowledge of the:

(1) Principles associated with heat transfer via conduction, convection, radiation, and air infiltration/exfiltration;

(2) Principles associated with moisture storage and transport via gravity, diffusion, convection, capillary action, absorbed flow, and osmosis; and

(3) Characteristics and behavior of enclosure-related materials, components, systems, and assemblies when specified for a given application, geographic region, location, exposure, or climate, and corresponding influence on workability, durability, serviceability, performance, and anticipated service-life.

(4) Principles of structural loading and structural capacity of enclosure-related materials, components, systems, and assemblies for specified loads including: wind, earthquake, projectile, differential volume change, and kinetic energy and differential pressure conditions.

4.2.1.2 *Procurement and Project Delivery*, including, at a minimum, demonstrated knowledge of the:

(1) Influence of the project delivery method²⁶ selected by the Owner on the scope, adaptation, implementation, and cost of the BECx process as defined in this practice;

(2) Influence of the number and type of contracts²⁷ established between the Owner and the design and construction teams on the role and responsibilities of the BECxP and individual members of the BECx group;

(3) Influence of design and construction scheduling, phasing, and sequencing of the work on the scope, adaptation, implementation, and cost of the BECx process as defined in this practice;

(4) Influence of the experience, qualifications, technical depth, and commitment of the design and construction teams to the BECx process on the role and responsibilities of the BECxP, the range and technical depth required of the BECx group, and the anticipated scope and cost of the BECx process.

²⁶ Including, but not limited to: Design-Build; Design-Bid-Build; Design-Negotiate-Build; Construction Management, and; Owner-Build as defined by CSI Project Resource Manual and Manual of Practice.

²⁷ Including, but not limited to Single-Prime Contract and Multiple-Prime Contracts, with basis-of-payment provisions that may include: Stipulated/Lump Sum; Cost-Plus Fee; Fixed Fee, and; Guaranteed Maximum Price, with penalties, bonuses, and incentives for early completion of the work and liquidated damages for any delays in substantial or final completion of the project.

4.2.1.3 *Contract Documents and Construction Administration*, including, at a minimum, demonstrated knowledge of the:

(1) Interrelationship and commonly understood hierarchy that exists between Procurement Documents, Contract Documents, Contract Drawings and Specifications²⁸ developed during the Design Phase of the BECx process, as well as submittals and legally binding Instruments of Change²⁸ issued during the Pre-Construction (Procurement) and Construction Phases of the BECx process, including but not limited to: Addenda; Submittals; Architect's Supplemental Instructions and Field Directives; Construction Change Directives, and; Change Orders;

(2) Influence of enclosure-related design, detailing, and integration²⁹ on total building performance, including at a minimum consideration of the performance attributes listed in **1.5** and **Annex A1** of this practice;

(3) Influence of product selection, allowable construction tolerances, and dimensional requirements to accommodate environmental and service loads on detailing at interface conditions between enclosure-related materials, components, systems, and assemblies, and; the corresponding influence on sequencing, phasing, and coordination of trades during the Construction Phase of the BECx process;

(4) Importance of material compatibility and continuity of primary heat, air, and moisture control layers throughout the building enclosure on total building performance and the appropriate mitigation of risks associated with improperly managed heat, air, and moisture transport across the building enclosure;

(5) Importance of the timely preparation and distribution of subject-direct, technically sound, and actionable documentation and feedback to the Owner, design, and construction teams throughout the Construction Phase of the BECx process.

4.2.1.4 *Performance Test Standards and Methodology*, including, at a minimum, demonstrated knowledge of the:

(1) Pre-construction laboratory and field-applied test standards and methodology referenced in this practice (see **Annex A2**) and their intended use and application³⁰ in evaluating the durability, performance, constructability, and anticipated service-life of enclosure-related materials, components, systems, and assemblies;

(2) Importance of establishing appropriate and quantifiable thresholds of performance and clear and unambiguous definitions of failure³¹ for enclosure-related materials, components, systems, and to allow for proper enforcement of the contract documents;

(3) Influence of modifications to the intended use and application of pre-construction laboratory and field test standards and methodology on the appropriate interpretation of test results and their relevance to the requirements of the contract documents;

²⁸ As defined by the Construction Specifications Institute (CSI).

²⁹ Including, but not limited to integration with base building structural and environmental control systems.

³⁰ Including the limitations associated with each test standard.

³¹ Including remedial action required in the event of failure and the nature and extent of re-testing necessary to evaluate compliance of the repair(s) with the requirements of the contract documents.