JBED
Journal of Building Enclosure Design
An official publication of the Building Enclosure Technology and Environment Council (BETEC) of the National Institute of Building Sciences (NIBS)
Winter 2008

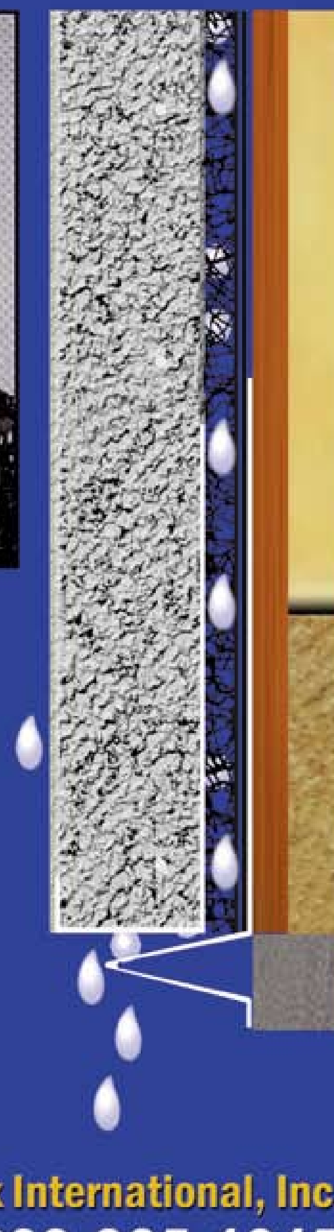
# Commissioning the Whole Building Enclosure

# WATERWAY PLUS

## Side-Wall Rainscreen Drainage Mats

**WaterWay™ Plus** is a revolutionary Patent Pending technology in **Vertical Wall Rainscreen Drainage Mats**. The product consists of a polymer matrix of tangled monofilaments. The monofilaments are laminated to a breathable filter fabric on one side and Dow WeatherMate Plus™ on the other side. This product creates a one step code compliant weather resistive barrier **(NER-640) or (CCMC – 13012-R)** and Side-Wall Rainscreen in a single application. WaterWay Plus is designed to create a cavity/space for water drainage and ventilation.

Equally effective for all side-wall products including manufactured stone, stucco, EIFS, fiber-cement, wood sidings, masonry, metal and other cladding materials.



- Code Complainant WRB (NER-640 / CCMC-13012-R).
- Code Compliant Air Infiltration Barrier.
- Filter fabric assures cavity remains clear of stucco or mortar.
- Non-chambered cavity unlike strapping or furring.
- Outstanding resistance to moisture penetration.
- Class "A" Fire Rated.
- Continuous ventilation.
- Simple detailing to interface with adjacent materials.
- Exceeds AC-24 drainage criteria for EIFS.
- No special training or skills.
- Extremely competitive vs furring systems.
- 26 Million feet in service.

**Stuc-O-Flex International, Inc.**
**1-800-305-1045**
**www.stucoflex.com**

# Contents


JBED

Published For:
NIBS / BETEC
1090 Vermont Avenue, NW, Suite 700
Washington, DC 20005-4905
Phone: (202) 289-7800
Fax: (202) 289-1092
nibs@nibs.org
www.nibs.org

Published by:
MATRIX GROUP PUBLISHING
Please return all undeliverable addresses to:
16516 El Camino Real
Suite 413, Houston, TX 77062
Phone: (866) 999-1299
Fax: (866) 244-2544

PRESIDENT & CEO
Jack Andress

SENIOR PUBLISHER
Maurice P. LaBorde

PUBLISHER & DIRECTOR OF SALES
Joe Strazzullo
jstrazzullo@matrixgroupinc.net

EDITOR-IN-CHIEF
Shannon Lutter
shannonl@matrixgroupinc.net

EDITOR
Jon Waldman

FINANCE/ACCOUNTING & ADMINISTRATION
Shoshana Weinberg, Pat Andress, Nathan Redekop
accounting@matrixgroupinc.net

DIRECTOR OF MARKETING & CIRCULATION
Jim Hamilton

SALES MANAGER
Neil Gottfred

MATRIX GROUP PUBLISHING ACCOUNT EXECUTIVES
Travis Bevan, Albert Brydges, Lewis Daigle, Rick Kuzie, Miles Meagher, Ken Percival, Peter Schulz, Vicki Sutton

ADVERTISING DESIGN
James Robinson

LAYOUT & DESIGN
J. Peters




## Features:



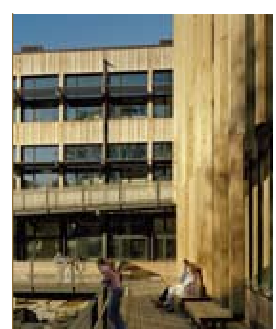



## Messages:

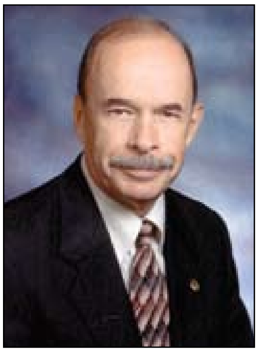


## Industry Updates:





On the cover: The Sidwell Friends Middle School, located in Washington, DC, is the first LEED Platinum rated school in the United States. Read more about the process used to commission the majority of the facade on page 10. Photo courtesy of Halkin Photography.



*David A. Harris, FAIA*

WELCOME TO THE FIFTH EDITION of the Journal of Building Enclosure Design. In my more than 27 years at the National Institute of Building Sciences, I've seen many "opportunities" promise a revolution and, more often, an evolution of the U.S. building process. While many have advanced the performance of buildings, few have been "revolutionary." We are now presented with two new opportunities: building information modeling (BIM) and high performance building standards. We are in the early stages of the use of BIM, while the development of standards for high performance buildings is a new initiative, sponsored by Section 914 of the 2005 Energy Policy Act. Again the claims are high, but I believe the potential of each may well match, or even exceed, expectations. More importantly, to achieve the potential of these opportunities, our fragmented industry must work more cooperatively than it has in the past.

For the design of better performing building envelopes, a system that endures more complex and varied stresses than perhaps any other building system, the combination of high performance standards and BIM hold great promise.

As the building process transitions to BIM, the application of high performance criteria for design of higher performing buildings and building systems, including building envelopes, will become easier. By advancing beyond today's standards, which have been driven, at least in part, by minimum requirements for regulation, we have the opportunity to offer high performance buildings to owners and users. This will allow us to move beyond poorly or non-quantified performance measures, largely dependent on manufacturers' claims and warrantees, which address building performance in many different and non-standardized ways.

In the future, industry agreed upon metrics applied through the use of BIM, will greatly increase our ability to analyze the life-cycle value of many more design alternatives and options, far better manage costs, and virtually eliminate much of the waste, error, and inefficiency inherent in today's facility delivery and O&M processes. For the design of better performing building envelopes, a system that endures more complex and varied stresses than perhaps any other building system, the combination of high performance standards and BIM hold great promise.

Through building information modeling, which is far more advanced, comprehensive and useful than 3D CAD, we will be able to integrate high performance standards and the metrics through which to apply them into future design and analysis software. Thus, the move to establish metrics for high performance levels will be facilitated by our ability to virtually test models of design solutions. This will give us the ability to assess applications and success in virtual buildings before actually constructing them. For example, the recently completed BIM module for architectural precast concrete sponsored by the Pankow Foundation will be an essential tool for future design and construction professionals.

To illustrate the complexity of fully applying BIM, look at the number of parts that comprise buildings. There are about ten thousand different generic building products, from screws to cooling towers. Integrating the performance analysis of the building systems and components constructed from these "parts" into software products is a daunting challenge, especially if we are to assess all links in the process to make sure the performance of the weakest link is not unacceptable. But, through well designed and interoperable software, this is possible and within reach.

BIM provides us with the capability to test materials and components for intended and unintended performance and also to determine how all parts will work together. As an example of complexity, with BIM we can test a precast concrete wall system and the building structural system under normal use, as well as under uncommon stresses from forces such as earthquake, flood, and high wind events.

The evolution/revolution we are now becoming a part of is exciting, it will be a challenge, but it will likely transition us from our 100 year-old facility delivery process into one that promises dramatically better immediate and long-term facility performance. I urge you to become part of the solution by joining with other NIBS volunteers to help us with this transition.

David A. Harris, FAIA
President
National Institute of Building Sciences

*Wagdy Anis, FAIA, LEED AP*

IT IS WITH GREAT SADNESS that I must announce that BETEC's vice president Barry Hardman passed away on February 7th, 2008. His wife Jacqueline "Jackie" Beaulac Hardman was at his side at all BETEC events, and was with him at the end, as were son and daughters Barry G. Hardman II, Susan Jean Grass, Jackie Lynne Hardman, Marjorie B. Hardman, and Carolyn J. Hardman. They all had a chance to express their love and gratitude to him and to pray with him and hold his hands through his final moments. Recalling Barry's window contracting career, Barry II said, "God was looking around heaven and needed some better windows, so he called the best man for the job!" Barry's energy and long service to BETEC will be sorely missed.

On December 7, 2007 BETEC held its board meeting at the Sheraton Sand Key Resort in Clearwater Beach, FL, in conjunction with the Buildings X Conference, a forum focused on building enclosure science, research and applications. The conference was sponsored by BETEC and organized by Oak Ridge National Laboratories of the DOE. The conference was a huge success, drawing more attendees than ever before in its 30 year history. Attendees and presenters came from all over the world to attend this conference. Notably, however, there were too few architects in attendance, much to my disappointment. A very important possibility was discussed at the BETEC board meeting, namely the collaboration of Canadian and United States' BECs into one big North American family. A Memorandum of Understanding has been drafted; more on that as we progress. BETEC also celebrated its 25th anniversary with a beachside dinner complete with a mariachi band.

BETEC will continue a new tradition by holding its next committee and board meetings in conjunction with the BEST I Conference in Minneapolis in June, 2008. If you have not yet found out about the Building Enclosure Science and Technology I Conference (BEST 1), be sure to look into this event, for it promises to be a great forum for learning. There will be tracks on energy efficiency and sustainable design practices, with a sub-focus on fenestration. The second track is focused on indoor air quality, moisture and durability. BEST I is a BETEC conference hosted by BEC-Minneapolis and AIA Minneapolis. Go to www.thebestconference.org for more information.

This edition of JBED is primarily focused on the commissioning of building enclosures. Although the commissioning of a building enclosure has been offered as a service by specialist firms, often in bits and pieces, it is a relatively new and systematic process of providing building projects with high levels of excellence in building enclosure design, construction, and operation. With this issue, we bring you great articles focused on different aspects of commissioning the enclosure, including design and construction, as well as on specific techniques the authors have used to produce high quality projects. We also bring you a summary of NIBS Guideline 3-2006, "Exterior Enclosure Technical Requirements for the Commissioning Process."

We hope you enjoy what I believe is another excellent edition of JBED, and we would appreciate your feedback.

Wagdy Anis, LEED AP, FAIA,
Principal, Wiss, Janney, Elstner Associates, Inc.
Chairman of BETEC
Chairman of the Editorial Board of JBED

**BETEC LOSES INSTRUMENTAL MAN**

As mentioned, it is with great sadness that BETEC says goodbye to Barry G. Hardman, vice chairman of BETEC. Not only did Barry run a thriving business, National Building Science Corporation in Temecula, CA, he also found the time to better the industry. Barry was the force behind developing the ASTM fenestration installation standard ASTM E 2112 and the AAMA window installation training and certification program at AAMA. He also developed and conducted a number of mold educational sessions for five consecutive years for BETEC.

Barry also organized all the workshops for the international conference Whole Buildings X held December 2007, and for years organized all the WUFI hygrothermal educational programs for Oak Ridge National Labs (ORNL) of the department of energy. Barry was also a key player in a major ORNL research study on the energy efficiency of exterior enclosures conducted in Charleston, SC.

His excitement and energy will be sorely missed by BETEC. Our sympathy goes out to his family.

**Congratulations to BEC-Los Angeles on the formation of the newest Building Enclosure Council. BEC–LA is the 19th BEC in the U.S. Welcome to the BEC family!**

# Sidwell Friends Middle School: Building Enclosure Panel System Commissioning

**By Paul E. Totten,** PE, Simpson Gumpertz & Heger Inc. and
**Richard Hodge,** AIA, LEED, Kieran Timberlake Associates

THIS ARTICLE WILL DISCUSS THE process used to commission the majority of the facade and its interface with other building elements at Sidwell Friends Middle School, located in Washington, DC. An award winning building designed by Kieran Timberlake Associates (KTA), the building is the first LEED Platinum rated school in the United States and first Platinum building in Washington, DC.

The majority of the facade is comprised of factory-built, two-story panels, each typically with two inset punched windows **(Figure 1)**. The justification for off-site fabrication of the enclosure system is examined, including schedule, quality control and cost.

The panels consist of an open wood screen, a drainage cavity with a UV-stable air barrier and water resistant barrier (WRB) over exterior sheathing, insulation, and another layer of sheathing attached to a steel stud structural frame. Thermal bridging discovered in the initial design of the panel system including elements such as sun shade devices attached through the panels; the effects of these issues were significantly mitigated due to a combination of insulation strategies, which we will briefly discuss.

The commissioning process for this structure involved peer review, shop drawing review, technical consultation, factory visits and visits at the job-site during the erection and tie-in of the panels to the rest of the building. We will describe the process used for panel system commissioning, based on the current *National Institute of Building Sciences (NIBS) Guideline 3* for commissioning building enclosures. In addition, we will discuss some of the issues encountered during construction and their resolution.

## PROJECT DESCRIPTION

The Sidwell Friends Middle School project was completed in September 2006, in time for the start of the academic year. The project involved a 39,000 square foot addition and a comprehensive renovation of the existing 33,500 square foot building. The addition and renovation of the school was planned as a LEED-certified Platinum building, incorporating many innovative and sustainable technologies.

The building employs mechanically assisted, natural ventilation

*Figure 1.*

to minimize the need for artificial cooling. Classrooms are designed to optimize natural lighting as the primary daytime illumination source. Photovoltaic panels further reduce energy consumption. A constructed wetland at the campus-side entry forecourt to the Middle School treats and recycles all building wastewater for grey water use within the building. The building houses a central plant, which will serve the entire campus, allow greater control of energy resources, and demonstrates responsible energy use to students. A vegetated roof filters rainwater, which is collected in a biology pond used in the science curriculum. Recycled and reclaimed materials are used throughout the building, including reclaimed lumber on the facade. See **Figure 2** for an overall view of the school.

### PANEL SYSTEM DESIGN AND CONSTRUCTION CONSIDERATIONS

The panel system at Sidwell School as constructed consists of the following building elements, from the outside to the inside:

- Reclaimed red cedar open wood screen, secured to horizontal and vertical pressure treated wood furring;
- UV-stable air and water barrier;
- 5/8 inch (16 millimeter) glass-mat faced exterior grade gypsum sheathing;
- 1/2 inch (13 millimeter) rigid insulation;
- 3/4 inch (19 millimeter) plywood);
- 8 inch (20 millimeter) steel stud framing with unfaced fiberglass batt insulation between studs and at panel to panel joints;
- “Smart” variable permeance vapor retarder;
- 1 inch (25 millimeter) air space;
- 2.5 inch (63 millimeter) steel studs to secure interior drywall finishes with fiberglass batt insulation between studs; and
- 5/8 inch (16 millimeter) interior gypsum sheathing with two coats of latex paint.

In addition, most of the panels also contain two window systems within the field of the panel. The panels form the majority of the facade of the second and third floors of the addition and the renovated middle school. They were factory built, shipped to the site and erected by the contractor, and joint treatments between panels and closure at the top and the bottom of the panels are field fabricated **(Figure 3)**.

Numerous considerations went into the decision to factory-build the panels versus site construction. These included efficiency, cost, schedule and the higher level of quality control the architect felt factory building would provide. In addition, as the footprint for on-site storage was quite small, it allowed the construction team the ability to stage other portions of the construction prior to erecting the panels. The contractor for the project debated and originally proposed site building the wall system.

The most significant driver of the prefabrication decision was the compressed schedule. The academic calendar limited the renovation portion of the work to three months. This included the demolition of portions of the existing exterior and replacement with the new exterior wall assembly. About 440 linear feet of one story (eighteen feet high/5.4864 meters) and two stories (thirty-two feet high/9.7536 meters) of exterior wall was to be constructed on the existing portion of the project. After reviewing schedule and site constraints, it was determined that factory building the facade offered the best solution.

KTA examined several wall system options before finalizing their design, all based on the concept of using factory built panels. A hybrid factory/site built panel was discussed where the support for the screen would be factory built but the screen itself would be field installed. To minimize thermal bridging caused by insulating between steel stud framing, the initial design had a drained EIFS system installed outboard of the panel sheathing with 2 inches (5.08 centimeters) of expanded polystyrene insulation. However, due to

*Figure 2.*

*Figure 3.*

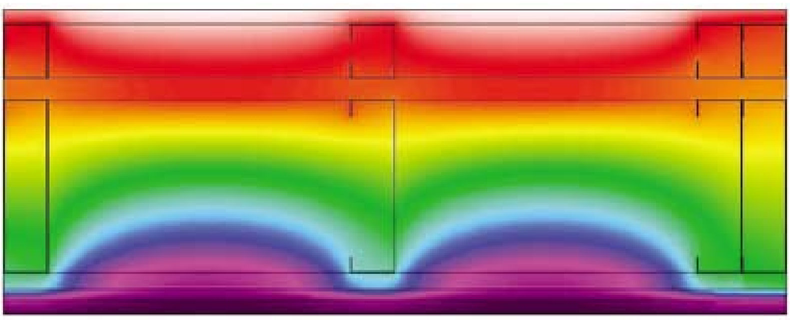


*Figure 4 – Outside, cladding not shown.*

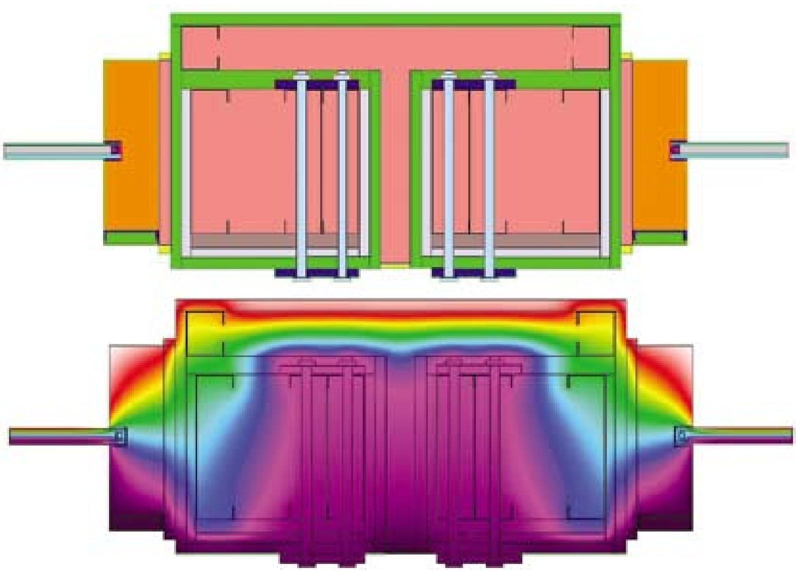


*Figure 5.*

structural constraints of attaching the screen, this thickness of insulation could not be accommodated economically.

Initially the design assumed staggered studs in a single track; 4 inch (101 millimeter) studs supporting the exterior sheathing assembly, and 4 inch (10.16 centimeter) studs supporting the interior finish assembly. In order to further minimize the thermal bridges caused by the studs, a wall system was developed in consultation with the building enclosure commissioning agent that offered a very similar level of performance. A 1/2 inch (13 millimeter) layer of rigid foam was sandwiched between the exterior sheathing layers, and an independent, interior finish wall was field fabricated with 2.5 inch (63.5 millimeter) studs, mostly offset from the 8 inch (203.2 millimeter) panel studs. An air gap was placed between the exterior and interior studs to avoid any incidental direct contact. The overall effect allowed thermal bridging to be minimized, with limited risk for condensation through the panel system **(Figure 4)**.

In addition to the thermal efficiency of the panels, additional care needed to be taken in installing the windows. The commissioning agent and the window manufacturer both recommended that the windows be site installed to minimize risk of glass breakage and window damage during transportation. In addition, both parties raised concerns regarding additional stresses on the window connections due to transportation loads that are not part of the manufacturer's design.

However, the panel fabricator indicated that they could install and properly brace the system for transportation with limited risk of damage to the windows. The window installation instructions were established for a site built system in a vertical wall rather than installation on a horizontal system as was completed by the panel fabricator. The manufacturer reiterated its concerns with respect to stress on the window connections that were not intended for transportation loads, but only for in-service loads within a wall assembly. The panel fabricator responded by providing means and methods in the factory, including the installation of additional temporary bracing at windows, to ensure the installation met the manufacturer's technical requirements and addressed their concerns.

## BUILDING ENCLOSURE COMMISSIONING PROGRAM

A commissioning program is typically comprised of the following elements:

- Peer review and consultation on the enclosure, typically at schematic design, design development and the construction document phases;
- Hygrothermal and thermal analysis of the building enclosure, in particular through the field of the wall, roof or below grade elements and at fenestration

to wall and roof element interfaces, as well as analysis of unique elements such as sun shades;

- Shop drawing review;
- Submittal review of any material substitutions;
- On-site review of the construction of the building enclosure;
- On-going building technology and building science consultation; and
- Project closeout services.

For Sidwell School, because of budget constraints, the panel system and its interfaces with fenestration and the first floor facade and the roof were the primary commissioned elements rather than a full program to commission the entire building enclosure. This reduced scope, however, covered most of the critical interface conditions.

As many changes occurred to the drawings and specifications for the wall system during considerations to factory or site build the wall system at the wood screen, the most critical set of drawings for construction of the system to verify they met design intent was the panel and window system shop drawings. We will discuss the shop drawing review process for the panels by the commissioning agent, their analysis of the panel system, the coordinated factory and field site visits, some of the consultation during construction, and project closeout services.

## SHOP DRAWING REVIEW

The panel system shop drawings were reviewed for consistency with the design set, interface conditions, information on factory and site built components and for completeness. After initial review and written comments and recommendations were forwarded to the architect and contractor, the panel fabricator and commissioning agent met to discuss the comments. Key elements that were not clearly shown on the original shop drawings from the fabricator included the air barrier system, and water management system interface conditions and flashings. In completing the initial meeting at the fabricators, additional discussion on the design and design concepts with the fabricators personnel provided them key information regarding the intent of an air barrier system.

In addition, the flashing system details provided were typically in two-dimensions, similar to some of the design drawings. As such, all of the elements needed to complete the detail in three dimensions were not clear to the fabricator. Further discussion of the sequence they intended to use and each of the elements needed to complete some of these critical interfaces provided the information needed to better understand the elements required to properly complete the panel fabrication. The initial visits to the factory during mock-up construction provided additional opportunity to work out the details provided in the shop drawings by the fabricator.

## HYGROTHERMAL AND THERMAL ANALYSIS

Hygrothermal and thermal analysis was completed on the panel system, and the window-to-wall interface of each panel. In addition, sun shade and light shelves were examined to determine how to best reduce the bridging effects. KTA used the same theory presented by the panel commissioning agent to reduce bridging in the field of the panels to create a similar effect at sun shades and light shelves. A layer of insulation was placed between the light shelve and sun shade location to minimize the thermal communication between the two elements. At locations where only the sun shades were installed (south elevation of the original school, where renovated

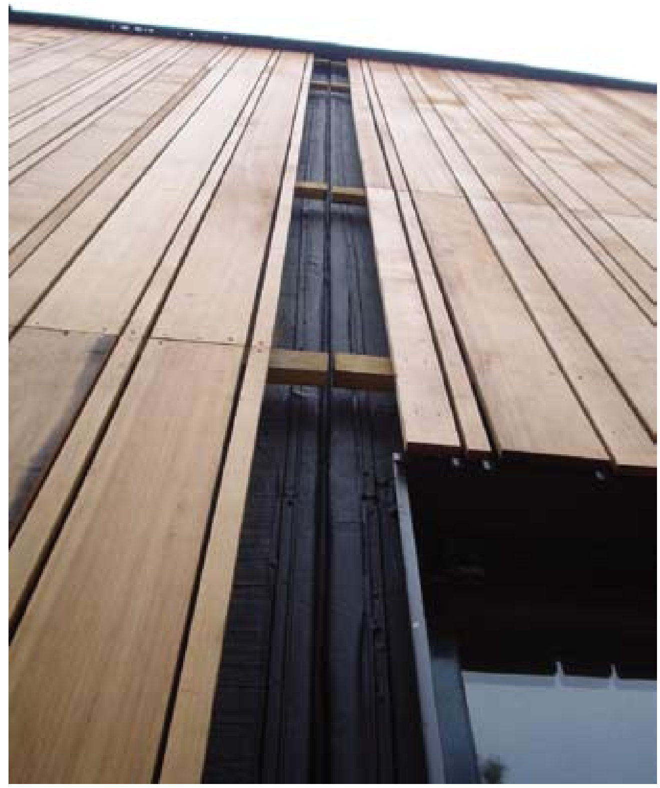


*Figure 6.*

with the new panels), the offset and installation of new interior walls with a continuous band of insulation inboard of the sun shade also reduced the effects of bridging **(Figure 5)**.

Hygrothermal analysis used throughout the design phases verified that the wall system is at minimal risk for condensation within the wall, and provides a robust wall that easily dries. Semi permeable combinations of materials at the outboard side provide summer time vapor drive control (outside to inside drive direction). The use of a variable "smart" vapor retarder at the inboard side of the wall system provides winter time vapor drive control (inside to outside).

The use of the analysis tools provided the necessary information to the architect to allow them to complete the design with confidence that their unique design will perform in the climate it is constructed in. Additional instrumentation of the walls and the building and analysis of data from the instrumentation is currently in progress. Results from the instruments will be compared to the information shown in the models to verify the tools predictions for performance.

## SITE AND FACTORY VISITS TO REVIEW WALL CONSTRUCTION

The panel commissioning agent made numerous site and factory visits to review the construction of the panel system. Factory visits were critical, as early deficiencies and difficulties encountered at the factory with the installation of the air and water barrier system resulted in visits and training of factory personnel by manufacturer technical representatives. The plant quality assurance personnel then modified their procedures to provide the proper oversight to reduce the number of deficiencies. The quality of workmanship on the panels made immediate drastic improvements, thereby preventing large scale rework that may have been needed had the factory visits not been completed. The majority of the issues were related to the coating thickness in application and adequate cure time prior to shipping. Some minor recoating in the field was still required to areas damaged in shipping.

The initial panels that were shipped did not reach full cure for some of the coatings that were applied too thick. The commissioning agent arranged a field visit with the manufacturer's technical representative, the architect and the contractor to discuss the proper techniques for correcting the issues in the field. In addition, the method for joint treatment was discussed—and based on final recommendations made by the commissioning agent, with discussions with the manufacturer—a refined method of treating panel joints was developed. The joints are stripped in with self-adhering membrane secured with termination bar at each panel joint. The backer for the self-adhering membrane is left in place across the center of the joint (it is removed at the edges of the self adhering below the termination bar) and additional material "bellied" into each joint to allow for any thermal movement **(Figure 6)**. The membrane is then coated over with the UV-stable air/water barrier. This detail is used at all panel-to-panel and panel-to-other building element interfaces.

At some of the building interfaces additional details were required and installed due to the configuration of each unique detail. Items noted by the commissioning agent during site visits were discussed with the architect and contractor at the conclusion of each visit and documented in field reports, with a list of follow-up action items. This list became a rolling punch list; in addition, many of the issues noted that may have turned into a systemic problem were addressed immediately and corrected not only at the locations already installed, but procedures changed and altered appropriately for the additional installations to come.

The commissioning agent and the contractor both made several site visits in the midst of actual rain events after large portions of the building enclosure were completed. Incidental leakage and the potential cause (roof leak, work yet to be completed, etc.) were documented and corrective action was identified and eventually completed.

The field and factory visits provided the project a higher level of quality assurance/control than if a commissioning process was not undertaken.

## BUILDING TECHNOLOGY AND BUILDING SCIENCE CONSULTATION

Throughout the process of construction and during periodic job site progress meetings, the commissioning agent provided valuable insight on several detailing issues and compatibility between material questions. In addition, information on the performance of the building for heat, air and moisture control were discussed. These sessions of consultation with the commissioning agent helped work out a number of key details. The advantage of utilizing a commissioning agent for the building enclosure with extensive in-house knowledge and resources provides any construction team the opportunity to more efficiently work through these issues with minimal impact to the overall project schedule.

## PROJECT CLOSEOUT

At the conclusion of the panel construction, the architect, contractor and the commissioning agent made a few more site visits to complete a punch list for the panels and the enclosure tie-ins. The punch list items were noted by location on a set of architectural elevations and distributed. The contractor then scheduled the appropriate subcontractors with rework in order to correct the issues noted.

## CONCLUSION

The use of a commissioning program and building enclosure and building science consultation on the Sidwell project provided a better end product to an innovative design. The use of a commissioning program for the building enclosure will provide any project, regardless of its complexity, a higher level of quality and a reduced risk for systemic problems with respect to the water and air tightness of the enclosure and overall thermal efficiency. ■

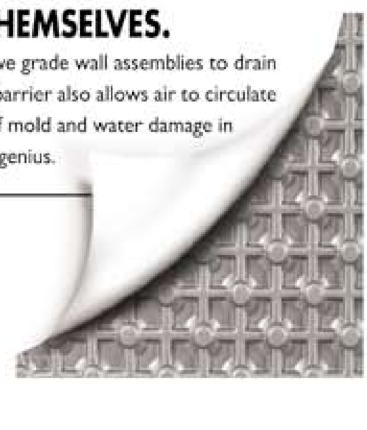
---

*Paul E. Totten is a Senior Staff Engineer in the Washington, DC office of Simpson Gumpertz & Heger Inc. He has over 10 years of experience in the fields of structural engineering, building technology and building science. He has concentrated his expertise on the evaluation and analysis of heat, air, and moisture transfer, and the cumulative effect these elements have on building components and building operation.*

*Richard Hodge, AIA, LEED, is a project manager with KieranTimberlake Associates.Hodge is a member of the American Institute of Architects and is a LEED accredited professional. He participates in conferences and symposia on sustainable design and building information modeling.*


COSELLA DORKEN
DELTA-DRY
DELTA-DRY





# NIBS Guideline 3: Exterior Enclosure Technical Requirements for the Commissioning Process

The National Institute of Building Sciences completed the 2006 NIBS Guideline 3, Exterior Enclosure Technical Requirements For the Commissioning Process; it is a new guide that includes a template for commissioning the enclosure, following ASHRAE Guideline 0, The Commissioning Process. Extensive information was produced by a variety of experts in different areas of the envelope for the first time. Annexes with copious examples, case studies and templates, additional information and interactions of systems with the envelope were created, as were sample commissioning specifications. This paper will help bring an understanding of the benefits of using Guideline 3 in commissioning the enclosure to achieve more durable, energy-efficient high-performance buildings.

By **Wagdy Anis**, LEED AP, FAIA

## INTRODUCTION

The commissioning process, which is outlined in ASHRAE Guideline 0-2005: The Commissioning Process. Guideline 3, along with its Technical Support guidelines, provides specific information related to the building exterior enclosure. The commissioning process:

- Is a quality-oriented process for achieving, verifying and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria.
- Assumes that owners, programmers, designers, contractors, commissioning team members, and operations and maintenance entities are fully accountable for the quality of their work.
- Uses methods and tools to verify that the project is achieving the owner's project requirements throughout the delivery of the project.
- Begins at project inception (during the predesign phase) and continues for the life of the facility (through the occupancy and operations phase).
- Includes specific tasks to be conducted during each phase in order to verify that design, construction and training meet the owner's project requirements.

The National Institute of Building Sciences' (NIBS) Guideline 3 2006 focuses upon the implementation of this process to building exterior enclosure systems and describes the specific tasks necessary to that implementation. It can be applied to both new construction and renovation projects. The commissioning process structures the design and construction process to increase quality. It does not require the owner to employ a specific outside expert as the commissioning authority and nothing would prevent the owner from selecting the project design or construction firm to perform commissioning, if the commissioning authority is properly qualified and is sufficiently independent by being positioned outside the specific project team within the firm.

For a given project, the commissioning role might be performed by a number of players—owner, program manager, construction manager (CM), third party commissioning authority hired by the owner, LEED-required commissioning authority, general contractor, the MEP contractor, etc. For a project, each player will have a mixed set of characteristics including independence, expertise and project-related knowledge. Whoever hires the commissioning authority (CxA) is doing so in order to provide the project with an independent set of eyes that verify and assure the required performance of the building. This required performance should be defined and found in the project documents and specifications. The level of effort of the commissioning process and size of the commissioning team for a given building can be strongly influenced by such factors as the owner's preferred level of building quality, the level of risk the owner will accept, as well as building size, type and complexity. Thus, it is difficult to develop general estimates of the level of effort required by the commissioning authority and other members of the commissioning team.

## TOTAL BUILDING COMMISSIONING

The Total Building Commissioning series of guidelines is a family of guidelines following Guideline 0's recommended structure. Figure 1 shows the relationship of Guideline 3 and other guidelines to Guideline 0.

**Purpose**

The purpose of Guideline 3 2006 is to describe the technical requirements for the application of the commissioning process described in ASHRAE Guideline 0-2005 that will verify that the building exterior enclosure systems achieve the owner's project requirements (OPR) It includes requirements for:

- Exterior enclosure systems to fully support the commissioning process activities;
- Verification during each phase of the commissioning process;
- Acceptance during each phase;
- Documentation during each phase; and
- A Systems Manual, and training for

operations and maintenance personnel and occupants.

The primary focus is on new buildings. The procedures, methods, and documentation requirements apply to new construction and to on-going commissioning process activities or requirements of buildings and facilities, or portions thereof. They also can be applied to rehabilitation projects, retro-commissioning, or re-commissioning projects.

### MILESTONES

**Pre-design phase:** Pre-design commissioning overview for exterior enclosure system. Pre-design is a preparatory phase of the project delivery process in which the owner's project requirements are developed and defined. General information about the overall project is gathered, including: (a) Program requirements (e.g., facility interior conditions), (b) Community context (e.g., reflectance limits on glazing), (c) Codes, regulations, standards and guidelines (d) Site and climate (e.g., outdoor air design conditions) (e) Facility functions (f) Construction budget (g) Building delivery schedule (h) Training requirements (i) Documentation requirements, and (j) Operational and maintenance budgets. Information for the exterior enclosure system is gathered as part of this process and documented as the enclosure portion of the owner's project requirements.

**Objectives of the pre-design phase:** Commissioning process objectives relative to building exterior enclosure systems include the following:

- Developing the owner's project requirements (OPR);
- Identifying a scope and budget for the commissioning process;
- Developing the initial commissioning plan; and
- Acceptance of pre-design phase commissioning process activities.

**Design phase:** During the design phase of the project delivery process the owner's project requirements (OPR) are translated into a design intent and represented in construction documents. The design phase is typically broken into three sub-phases:

1. **Schematic design.** Early in the schematic design phase, rough concepts of building massing, internal layout, appearance and materials are developed and tested against the OPR to arrive at a solution that best fulfills all criteria. Analysis of conceptual solutions should include impact of inter-related systems. During this phase, a document called the Basis of Design (BOD) is created that clearly conveys the assumptions made in developing a design solution that fulfills the intent and criteria in the Owner's Project Requirements document. During schematic design, the OPR is evaluated and updated to balance scope, budget and quality. Narrative descriptions of building exterior enclosure systems (e.g., roof, exterior walls, floors, windows, skylights, atria, thermal mass, etc.) are developed and included in the BOD and the commissioning plan is expanded to include more details of construction phase and occupancy and operations phase activities.
2. **Design development.** In this phase more detailed drawings, typically largescale wall sections, elevations and plan details, and preliminary specifications for the exterior enclosure systems are developed in support of the solution represented in the BOD. Commissioning procedures are established by the commissioning team for incorporation into the construction documents. The CxA should verify that the design team agrees upon these procedures. The OPR and BOD are updated to reflect ongoing decisions, and the design development documents are verified against them.
3. **Construction documentation.** The construction documents indicate the scope of work, the required level of quality and all other administrative and procedural requirements of the contractor. Construction documents must also include requirements for the contractor to implement commissioning activities. Ideally, all significant decisions were made during the design development phase, but the OPR and BOD should be updated if changes have been made. Commissioning process objectives specific to the exterior enclosure includes verifying that each exterior enclosure system documented in the basis of design fulfills the requirements within the OPR document

**Basis of design documentation:** The BOD is developed during the schematic design phase and includes the following as a minimum:

- A description of each system option considered, such as the type of building exterior enclosure systems, sub-systems, materials and components, and the interaction of the building exterior enclosure system with the heating, cooling, mechanical and natural ventilation, lighting, building interior, and other systems. Describe how the designer intends to meet the building exterior enclosure-related OPR. For appropriate exterior enclosure systems or components, provide an outline sequence of operations, for example:
  - o Automatically controlled shading devices; and
  - o Operation of sensing devices that provide feedback to occupants about daylighting, security, natural ventilation, or glare control elements of the building exterior enclosure system.
- The reasoning for the selection of the final building exterior enclosure system, including supporting information describing fulfillment of criteria in the OPR.
- The inter-relationship of each exterior enclosure system with other systems, e.g. stiffness/deflection of supporting structure, daylighting versus artificial lighting, impact of skin thermal performance on mechanical systems.
- Operational assumptions for any operating

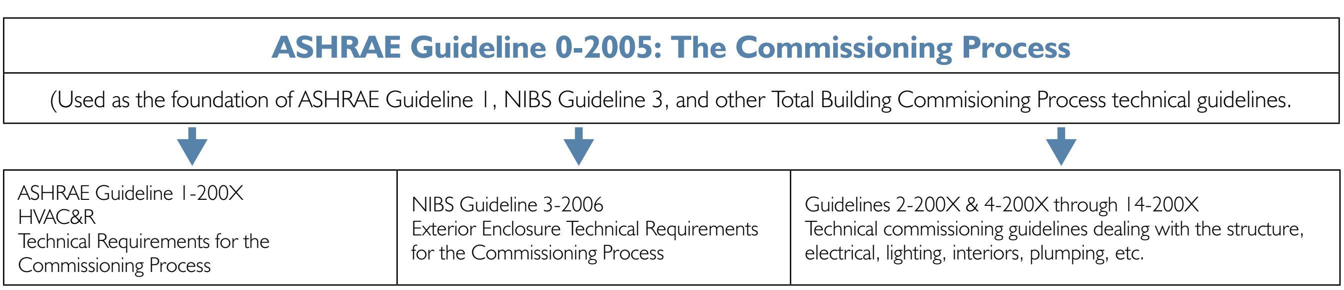



*Figure 1 – Total Building Commissioning Series.*

portions of the exterior enclosure system that are either manually or automatically controlled, including facility and space usage, schedules (occupancy and operational), diversity, and annual operation and maintenance budget and personnel capabilities.

- Calculations including the electronic inputs and outputs of modeling programs or copies of manual calculations to show the progression from assumption to calculation to the construction documents.
- If not included in the OPR, list facility, system and assembly performance assumptions for calculations for exterior enclosure loads on systems, and for exterior enclosure interactions with other building systems at design day conditions and at part load conditions over time.
- If not included in the OPR, list analytical procedures and tools used during design, including manual and software (including version) analysis and simulation models (heat gain, heat loss, cooling and heating loads, impacts on energy usage and comfort conditions, control strategies, such as window management strategies and assumptions).
- If not included in the OPR, list environmental conditions including, exterior/interior pressure relationships, airflow and velocity.
- If not included in the OPR, list codes, standards, guidelines, regulations, and other references that influenced the design of building exterior enclosure systems.
- If not included in the OPR, list Owner guidelines and directives that influenced the design of building exterior enclosure systems.

Commissioning process requirements for the construction documents phase: Requirements specific to the exterior enclosure include:

- Systems to be documented and tested.
- A schedule of building exterior enclosure-related commissioning process activities for:
  - o The construction phase; and
  - o The occupancy and operations phase. The schedule should identify critical times for witnessing testing activities, building exterior enclosure systems and equipment accessibility for maintenance and commissioning, completion of construction checklists, and activities relative to substantial completion/project closeout.
- Integrate specific component performance documentation requirements and use of construction checklists into the relevant building exterior enclosure specification sections (and others as appropriate), with appropriate cross-references.
- Integrate building exterior enclosure commissioning process activities into the relevant building exterior enclosure specification Sections as required.

**Commissioning authority checklists:** To verify that delivered materials conform to specifications, that substrates and supporting structures have been inspected and approved for overlying construction, and that all components of the assembly are being properly completed.

**Systems manual:** A systems manual is developed for each major building exterior enclosure system.

## COMMISSIONING-FOCUSED REVIEW OF DESIGN DOCUMENTS

**General quality review:** A general quality review for building exterior enclosure systems should focus on completeness, organization and readability of drawings and specifications with attention to details, schedules, controls, phasing, legends, etc.

**Coordination review:** Key system elements and random samples (10 to 20 percent) of other portions of the building exterior enclosure systems are reviewed to evaluate the coordination accomplished within and among disciplines. This includes reviewing for interfaces among disciplines and checking the design against the owner's project requirements. The intent of this review is to determine if there are systematic errors, not to fully check the drawings. The responsibility for complete checking of the drawings for coordination and accuracy remains with the design team.

**Building exterior enclosure system-specific review:** The commissioning authority should verify that, within the areas selected for review, the design complies with the OPR. The intent of this review is to determine if there are systematic errors for exterior enclosure materials and interface coordination, not to fully check the drawings. The responsibility for complete checking of the drawings for coordination, appropriateness, and accuracy remains with the design team.

**Building exterior enclosure specification review:** The commissioning authority should ensure that a review of the specifications is performed to determine completeness and applicability to the project. A review of 10 to 20 percent of the building exterior enclosure specification is performed in detail for verification of compliance with the owner's project requirements. Items checked include applicability of the section to the project, commissioning process requirements, submittal requirements, applicability of sub-systems and materials, training requirements, coordination with other sections, and coordination with the drawings.

**Schematic design documents:** Review approximately 20 percent of the BOD to verify that it provides an acceptable design solution to fulfill the OPR requirements, both for exterior enclosure requirements and requirements for integrating the exterior enclosure with other building systems.

**Design development documents:** Review approximately 20 percent of the systems documented to verify that the design solutions are in conformance with the BOD and will fulfill the requirement of the OPR. Review the documented solutions for coordination of integrated systems required for performance.

**Construction documents:** Review approximately 20 percent of the systems documented to verify that the design solutions are in conformance with the BOD and will fulfill the requirement of the OPR. Review specifications for inclusion of commissioning process requirements, including submittal requirements, training requirements, requirements for systems manual, testing requirements, inspection requirements, mock-ups, performance requirements, contractors quality assurance requirements, etc.

## CONSTRUCTION PHASE

Commissioning process activities described in this section to be performed by the various members of the construction-phase commissioning team are described in ASHRAE Guideline 0-2005 (Section 7.2). Additional requirements pertaining to building exterior enclosure may include but are not limited to:

- Assistance with detail development during the construction phase for elements not addressed or co-coordinated during the design phase.
- Additional field-testing. The commissioning team may confer with the design team/contractor about the possible need for detail alterations if failures occur during either the laboratory mock up or the field air and water leakage tests performed during the construction phase.
- Field review of aesthetic and functional

mock-up(s) and review of both the unique interface conditions and the general interface conditions to verify that they meet the design intent and will provide the level of water and air tightness of the exterior enclosure as specified in the OPR. Mock-ups, construction and testing should be scheduled with adequate time allowed for the remediation of unforeseen issues by way of iterative repair submittals and testing prior to actual construction.

- Thorough review of submittals including shop drawing(s), mockups, sample constructions, project schedule and sequencing, and all building exterior enclosure components allowing for revisions as necessary to provide the level of water and air tightness in the exterior enclosure as specified in the OPR.
- Review of the contractor's and subcontractors' site-specific quality plans for the building exterior enclosure.
- Pre-bid conference which is held including Cx team, owner, all consultants and building exterior enclosure specialists to discuss design intent, construction sequencing, constructability, and other issues pertaining to the co-ordination and construction of the building exterior enclosure.
- Aesthetic and functional review(s) of mock up shop drawings, and accompanying submittals for all laboratory testing and field testing.
- Periodic construction monitoring—quality assurance, particularly increased during critical events, such as roof transition and roof termination installation, initial installation of sealants, and the specific project interfacing conditions, such as below grade waterproofing, and the differing material interfaces, e.g., masonry, metal panels, EIFS, stucco, stone, GFRC, windows, curtain wall, fenestration expansion joints, plaza deck waterproofing, green roofs.
- Inspection, testing and witnessing, including field-testing specific to the project and detailed documentation.
- Establishment of a training program for the owner's personnel for O & M of the building exterior enclosure.

## OCCUPANCY AND OPERATIONS PHASE

"The occupancy and operations phase of the commissioning process begins at substantial completion. As a minimum, the commissioning process activities begun at this point should continue through the end of the contractual warranty/correction period and ideally continue throughout the life of the facility. During the occupancy and operations phase, the on-going operation, maintenance, and modification of the facility systems and assemblies, and their associated documentation, are verified against the updated owner's project requirements." Excerpt from Guideline 0-2005, Section 8.1.1.

**Continuous commissioning:** A program of continuous commissioning is recommended for the exterior enclosure systems in order to ensure that the required level of performance is maintained by monitoring the acceptable performance of key components and assemblies.

At this phase, the commissioning authority's involvement is primarily to verify the accuracy of the documentation record and manuals relative to the performance of the completed exterior enclosure including:

- Operations and maintenance manuals;
- Manufacturers conformance records;
- Functional performance test records;
- Record drawings;
- Systems manual;
- Commissioning report;
- Documentation review;
- Exterior envelope preventative maintenance program including cyclical verification of exterior enclosure components to the original manufacturer's maintenance recommendations and performance specifications with consideration for warranty enforcement; and
- Additional documentation and verification as specified in owner's project requirements.

**Retro-commissioning:** The activities described below assume that the commissioning process has progressed through the activities defined for the pre-design, design, and construction phases. A commissioning process that begins during the occupancy and operations phase is termed "retro-commissioning" and is substantially different from the process described herein. The retro-commissioning process is not within the scope of this Guideline.

**Occupancy and operations phase commissioning process activities for exterior enclosure systems:** These are based on owners project requirements. See ASHRAE Guideline 0-2005, Section 8.2.1, plus the additional items listed below:

- Verification of pre-design cost benefit analysis to actual performance of completed processes accepted by the owner;
- Sustainability analysis verification;
- IAQ performance using relevant ASHRAE standards;
- Guarantee/warranty enforcement matrix;
- Comfort performance verification (using ASHRAE Standard 55-2004) for all types of space uses, based on the owners project requirements;
- Conformance to standards and codes references in construction documents and systems manual;
- Documentation that the completed process meets the level of quality established in the OPR.
    - o Call-back of contractors. See ASHRAE Guideline 0-2005, Section 8.2.2.
    - o Performance verification. See ASHRAE Guideline 0-2005, Section 8.2.3. In addition, the commissioning authority should ascertain that the performance verification being conducted for the exterior enclosure systems meet the owners project requirements as updated during the construction.
    - o Training. See ASHRAE Guideline 0-2005, Section 8.2.4, and Section 8.5 below in this guideline for the exterior enclosure.
    - o Final Project Commissioning Process Report. See ASHRAE Guideline 0-2005, Section 8.2.5.
    - o Final Project Systems Manual. See ASHRAE Guideline 0-2005, Section 8.2.6.

**Migration of performance levels:** All types of exterior enclosure systems will migrate from performance levels established at the time of final acceptance. Materials used in construction have varied lifecycles and preventative maintenance requirements.

**Training during occupancy and operations phase.** This training should be to the level defined in the OPR as implemented at the time of significant completion. As a minimum the occupancy and operations phase training sequence should contain a role and responsibilities matrix based on information contained in the O&M manuals.

## CONCLUSIONS

NIBS Guideline 3 2006 has infinitely more detail and guidance than summarized above—it is a 350 page document including extensive annexes that provide sample example documents and case studies, and is an extremely rich resource for use in the total commissioning process. It is anticipated that its use will result in a rigorous process of commissioning the building enclosure that should result in more durable building enclosures and higher performance buildings. Guideline 3 may very well establish a new standard of care for the building enclosure in the design and construction industries.

Credit is due to the project development team:

Joseph Deringer, Committee Chair
Don Acker
Fiona Aldous
David Altenhofen, Design Chair
Wagdy Anis, Pre-Design Chair
Dave Bailey
Bill Brodt
Paul Brosnahan
Brad Carpenter
Tim Corbett, Occupancy/Operations Chair
David Eakin
H. Jay Enck
Walter Grondzik
K. Quinn Hart
Marc LaFrance
Dan Lemieux
William R. Nash, Construction Chair
Andrew Persily
Nik Vigener
Paul Totten
Paul Tseng
Thomas Smith
Richard Walker
Mohammed Ettouney, Liaison, ASCE
Charles E. Dorgan, Liaison, NIBS/ASHRAE Guideline 1
Dagmar Epsten/Larry Ross, Liaison, BCA
Earle Kennett, Vice-president NIBS ■

## REFERENCES:

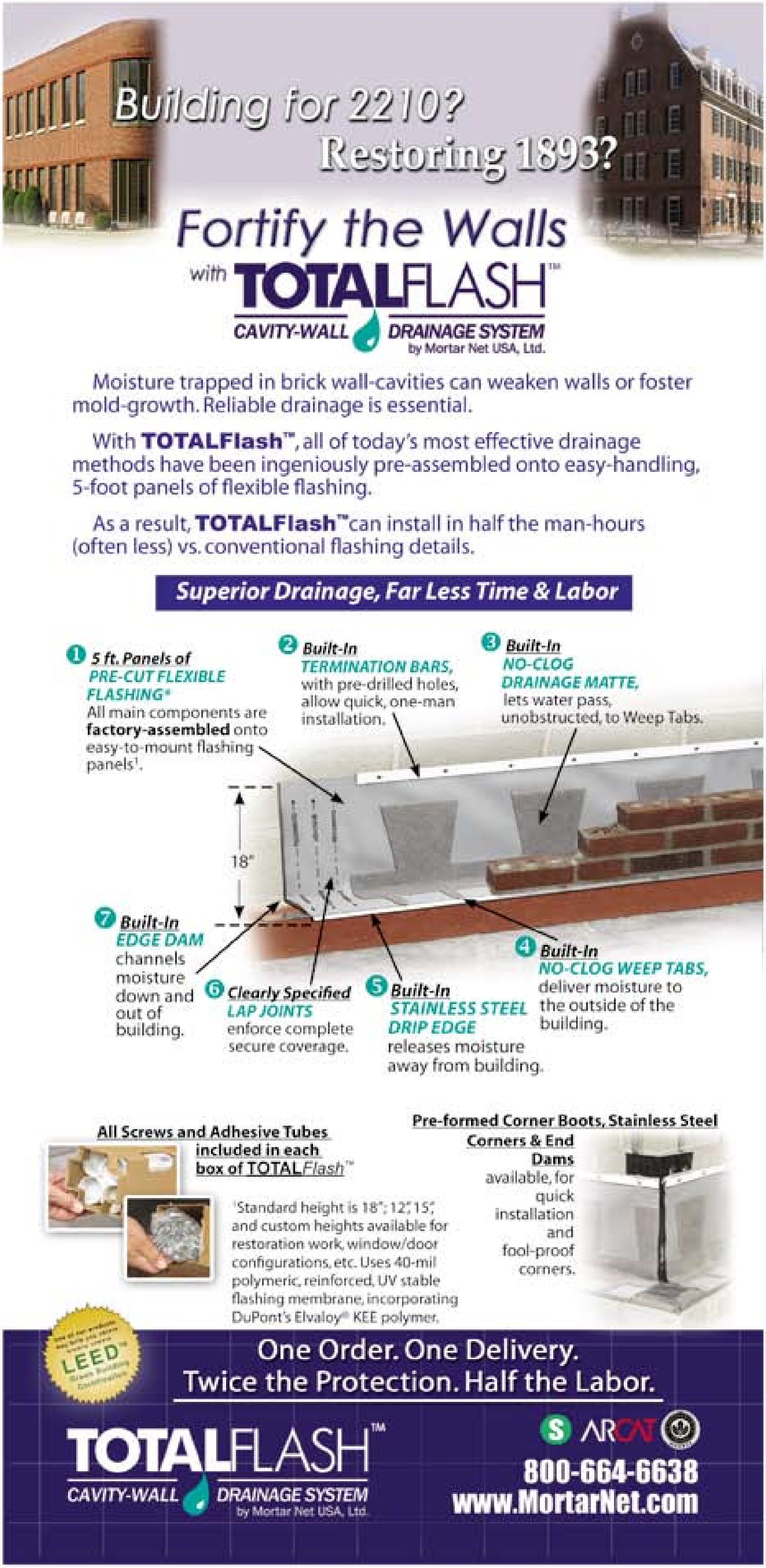

ASHRAE Guideline 0 2006 The Commissioning Process.

ASHRAE Guideline 1 200X HVAC & R.

NIBS Guideline 3 2006 Exterior Enclosure Technical Requirements for the Commissioning Process.


---


*Wagdy Anis, LEED AP, FAIA is a principal with Wiss, Janney, Elstner Associates, Inc. Architects Engineers and Material Scientists working out of the Cambridge, MA office. Anis is Chairman of the Building Enclosure Technology and Environment Council, Board member of BEC Boston, ABAA, and chairman of the energy advisory committee in MA. He is a member of ASHRAE 90.1, TC 4.4 and committee member of ASHRAE's SP 200, Advanced Indoor Air Quality Design Guideline; Anis provides building enclosure consulting services.*

# Quality Assurance for Your Wall Air Barrier

By **Ryan Dalgleish**, bpc Building Professionals Consortium

WITH THE EXPANDED USE OF air barrier materials and assemblies in buildings to reduce energy and assist with moisture management, the issue of on-site installation is something that needs to be taken into consideration. As with any product or assembly used in a building, the ultimate long-term performance of that product or assembly is directly related to how well (or not) it is installed.

In the case of air barriers in a wall assembly, these materials and assemblies are for the most part installed between the exterior cladding and structure of a building. As such, once the exterior cladding is installed, the air barrier becomes a non-maintainable component of the wall assembly that needs to perform for the life of the wall assembly. Ultimately, this means that the installation must be done right the first time in order to minimize the risk of expensive repairs in the future.

To deal with this issue and to foster a professional industry, the Air Barrier Association of America has adopted a pro-active, systematic program to increase the quality of the air barrier installation for the building owner. The intent of the program is to take a 3-Dimensional approach to improving quality through a number of initiatives and base it upon the principles of the International Organization for Standardization (ISO). Continuous improvement is then built into the program acknowledging that it will change as we learn more and the construction industry changes or new technologies and techniques are developed.

## WHAT IS "QUALITY ASSURANCE"?

The term "quality assurance" is a term that often is not fully understood. The whole concept of quality assurance often gets confused with quality control or inspections. In discussing the program with individuals, there seems to be a lack of understanding of quality assurance vs. quality control, the fundamental differences between the two and what function each brings to the table.

To start off, an understanding of these terms is required and we need to know how they are defined. The American Society of Quality™ (ASQ) is noted as being one of the world's leading authorities on quality and is an excellent resource that helps define these terms. The ASQ goes onto define these terms as follows:

**Assurance:** The act of giving confidence, the state of being certain or the act of making certain.

**Quality assurance:** The planned and systematic activities implemented in a quality system so that quality requirements for a product or service will be fulfilled.

**Control:** An evaluation to indicate needed corrective responses; the act of guiding a process in which variability is attributable to a constant system of chance causes.

**Quality control:** The observation techniques and activities used to fulfill requirements for quality.

Quality assurance is the prevention of quality problems through planned and systematic activities—or simply put, the quality is "built in". This process allows you to build quality into your building project at the front end rather than trying to build in quality at the back end of the project simply by doing some inspections. So rather than treating the cause, is it not better to treat the symptom? Is not prevention a much better form and effective way of ensuring quality on a building project than correction or repair?

To summarize, quality assurance:

- Provides a documented process by which quality commitments are met;
- Establishes a benchmark;
- Is systematic and reproducible; and
- Provides a means for continuous improvement.

## WHAT MAKES UP THE AIR BARRIER QUALITY ASSURANCE PROGRAM?

The Air Barrier Quality Assurance Program is made up of the following items:

*ABAA specified project. Milford Hospital project in Milford, MA.*

*ABAA Installer Training in Maryland, DC. Both theory and hands-on information.*

- Research;
- Standards and specifications;
- Product validation;
- Contractor accreditation;
- Training;
- 3rd Party Certification for installers and auditors;
- Trade testing and inspection;
- Documentation;
- 3rd party auditing; and
- Conflict resolution.

A quick summary of each of the items provides further insight:

**Research:** In-field and laboratory testing of materials, components, assemblies and systems by credible research bodies such as Oak Ridge National Laboratories (ORNL) and industry help provide reliable and credible answers to questions the industry may have with regards to material performance, design or installation issues and real life performance. As research is completed, it can be disseminated to the field.

**Standards and specifications:** The Air Barrier Association of America (ABAA) is very active in developing guide specifications for architects on how to properly specify various types of air barrier materials, and working with groups such as ASTM in developing a number of standards for testing materials, assemblies, installation, inspections, durability and so forth. Currently two air barrier standards exist for testing the air permeance of a material (ASTM E2170 and the air permeance of an assembly (ASTM E2357). A number of other work items are in progress at ASTM. These provide the "benchmark" to the quality assurance program.

**Product validation:** ABAA has developed performance criteria for various air barrier materials through their technical committee. A manufacturer can apply to have its material evaluated against a set of performance criteria and have the product validated as meeting the predefined criteria. This provides a tool for designers to rely on when choosing a material, as no evaluation criteria currently exists in the US market, such as the ICC evaluation services.

**Contractor accreditation:** ABAA Accredited Contractors must meet minimum requirements for insurance, bonding, employ certified installers, possess the necessary equipment to install and test their work, be trained in the Quality Assurance Program and sign a licensing agreement dictating professional conduct and the right to terminate their accreditation should they not meet the requirements of the program.

**Education:** Education is a very important component to ensuring quality. ABAA has taken a wide range approach to providing education to all involved in the construction process. First and foremost, education and training is provided to the installer of the air barrier of how to properly install the material, as he/she can have the single largest impact on the quality of the installation. ABAA also provides training programs for designers, general contractors, inspectors and others involved in the construction process to provide industry best practice and consistent information.

**3rd Party Certification for installers and auditors:** Certification is provided for the individual installers and auditors. Certification criteria is defined and individuals can be eligible to receive certification after **proving** they have the knowledge. The certification program provides the benchmark for installation qualifications and knowledge and holds the individuals to meeting standards of professional conduct on an on-going basis in order to maintain their certification.

**Trade testing and inspection:** Certified installers, on a daily basis, will perform various forms of inspection and testing on the application of air barrier materials. This self testing program provides a mental checklist for the installer to conduct daily and provides a form of quality control.

**Project installation documentation:** The certified installer is required to document the entire installation process on "daily work sheets". These forms also allow the installer to document corrective action taken as part of their quality control program.

**3rd party audits:** On every project that is specified with the ABAA QAP program, an ABAA audit is conducted by a 3rd party. The number of audits performed on a specific project is determined on the contract value of the project.

**Conflict resolution:** If there is a concern on a project by the design professional or owner, a dispute resolution system is in place to deal with any problems to make sure things are done right.

All of these initiatives and programs work together on an on-going basis and success is only achieved when this holistic approach is implemented as a system. Although each of the initiatives has merit in itself, the integration of all of them is what distinguishes this quality assurance program from other developed in the industry. Each item is intertwined with the next and each item feeds into each other. For instance, as research is conducted and new techniques

*ABAA on-site audit in progress. Children's Hospital, Wauwatosa, WI.*

*ABAA Certified Installers Daily Quality Control. Thickness testing of a liquid applied air barrier.*

are established, this may impact what training is needed, how to inspect completed work, and so forth.

### HOW CAN I GET AIR BARRIER QUALITY ASSURANCE ON MY PROJECT?

As a voluntary program, the ABAA QAP only comes into effect when specified in the project contract documents for the air barrier sub-trade. There are no building code requirements, nor industry standards that will automatically provide the owner or designer with a form of quality assurance.

### WHAT IS THE COST?

So, how much will incorporating the air barrier QAP program add to the bottom line? Not much, based on the value of the program! As the entire program is a voluntary program, the additional costs for incorporating the program in a project is about 2.75 percent of the air barrier contract value. For instance, if the cost to supply and install the air barrier is $50,000, it would add around $1,500, as an estimate. This cost, for this case, would cover the cost of one site audit by an ABAA auditor and the management and administration fees of the program.

### CONCLUSION

The ABAA Quality Assurance Program has been designed to raise the professionalism of the industry and benefit all parties involved. It takes a holistic approach to long-term quality and raising the standards within the industry. This program will help raise the bar to ensuring the long-term durability of our buildings, ensuring the energy efficiency benefits of an air barrier are achieved and to foster a mindset of continuous improvement. ■

---

*Ryan Dalgleish is the Vice-President of the bpc Building Professional Consortium. BPC is a full service quality consulting and management firm that works with associations and industry across North America involved in energy efficiency and green buildings in both the residential and commercial industries. Dalgleish has been involved in the building envelope, building science and building performance areas of construction in for 10 years. He currently serves as the president of his local building envelope council (MBEC) and as president of the national building envelope council (NBEC).*

# Managing Quality

## It's about the people, not the paper!

By David W. Altenhofen, AIA, RMJM Hillier

IF YOU'RE LOOKING FOR AN article which lays out a simple method to check some drawings and then end up with high-quality documents, well, you might as well stop here. If checklists, audits, peer reviews, office standards or anything similar could ensure even a minimum level of quality, let alone excellence, then these tricks already used widely by the industry, would be sufficient. The fact is, managing the design process to deliver high quality services, documents and in the end, the actual building is more of an art than a science. Central to delivering high quality service is the people involved and their skills, motivation, training and empowerment. Any design firm striving for quality, innovation and design excellence must focus on its staff.

### DEFINING QUALITY

What is quality? One of the more significant problems with any quality program is that defining quality is extremely difficult. Dealing with quality professional services versus a more tangible product creates many difficulties in assessing quality. When speaking about architecture, with many aspects inherently unquantifiable, then defining quality is nearly impossible. For this article "quality" shall be defined as the level of design, innovation, service and project execution established by an individual design firm to serve its own needs and the needs of its clients.

### MOTIVATION IN A DESIGN FIRM

Absolutely essential for any firm to deliver quality is for the individual members of that firm to be highly motivated to do so. Of course they must have the requisite intelligence, knowledge and time but even with these things, if not motivated, mediocrity is likely. For the sake of this article, I will be talking about motivating architects but there are parallels for engineers, construction managers and other service professionals in the construction industry.

Central to delivering high quality service is the people involved and their skills, motivation, training and empowerment. Any design firm striving for quality, innovation and design excellence must focus on its staff.

Architects are motivated by the desire to see a great idea turned into an actual building. Although we sometimes focus on the drawings, any architect who has practiced long will inevitably talk about the indefinable but unmistakable feeling of fulfillment one gets visiting a job site for which you were part of the design team. So, while architects need good pay, job security and benefits, what really makes them tick is to be able to work on "cool" projects and be recognized for their contribution. By tapping into that desire an architectural firm can count on team members who are deeply, passionately committed to the quality of a project. If you can feed this committed staff with knowledge, empowerment, recognition and guidance, they will make the project better than anyone's expectations.

The key to managing quality in an architectural office is to walk the fine line between giving staff the knowledge to do the right thing within their own design solution versus simply telling them the solution. An architect who takes ownership of a design solution will always do higher quality work.

### THREE HELPFUL TOOLS

Several well recognized quality management systems can help organize and manage a quality program. However, these programs lack an emphasis on the individual team members. Instead, they either focus on verifying that a prescribed process is carefully followed, without extensive checking of the content, or they attempt to thoroughly check a set of documents at a nearly complete state to find errors and omissions.

Perhaps the most well known quality program is the ISO 9000 system*. The International Organization for Standardization publishes documents which can guide the set up and administration of a quality program. The system is not dedicated to design or even service firms and in fact may be a better fit for manufacturing. The strength of the ISO 9000 program is that it forces the organization to put into writing the specific steps they themselves believe necessary to deliver quality. Behind this is the idea that if each step necessary for quality is followed, then quality itself will follow. The ISO program can ultimately result in ISO 9001 certification which requires outside auditing of the process. ISO Certification is more common in the U.S. for manufacturing firms but certification of design firms is not unusual in Europe. For design firms, it is possible to carefully follow the prescribed steps, but if the individuals on the team are not really up to the task, quality will suffer.

Another quality system is "commissioning" such as put forth by ASHRAE in Guideline 0-2005, *The Commissioning Process***. The core tenets of commissioning is defining the owner's project requirements (OPR),developing and documenting a design solution answering those requirements in a Basis of Design (BOD), and then checking off all future documentation and construction activities against the OPR and BOD.

The emphasis of commissioning on first understanding the owner's needs and then checking back is an excellent process to meet technical criteria (how many rooms, how big, what temperature, etc.) but provides little for aesthetic issues. Also, the commissioning process as written places a large emphasis on an outside commissioning agent who is responsible to somehow check the work of the design and construction team. I find this outside focus completely untenable and recommend that anyone investigating this particular commissioning system to instead internalize the focus towards the project team.

RediCheck[1] is both a methodology for checking of nearly completed construction documents and a professional service to conduct such checks. The RediCheck system does add rigor to a final independent checking which I highly recommend but I caution that it does not by itself ensure quality. For example, if a design assumption is flawed but otherwise properly documented, RediCheck may not catch the flaw. Use RediCheck or a similar final review by someone not on the project team to check the completeness and coordination of a set of construction documents but do not trust this one step to deliver quality.

## CORPORATE KNOWLEDGE

Every firm of more than a few people begins to develop a corporate knowledge base, the collective knowledge of the individuals that is larger than the knowledge of any individual within the firm. A central tenet of any quality program must be how to retain corporate knowledge and apply it to each project. Office guide details, customized checklists, office master guide specifications, etc. can and should be repositories for corporate data, the bits of information that make up corporate knowledge.

However, don't confuse data with knowledge. Quality management must harness the knowledge of those individuals within the firm who have the most to offer a particular project and feed that knowledge into the project team. An excellent method is to conduct peer reviews at the beginning of project phases that include the project team and peers from outside the team. Look for peers with senior level experience on similar projects but also include some "outsiders" who may bring an innovative approach unconstrained by past solutions.

There are no easy answers to providing quality. It takes a continuous and consistent message from the leadership of the firm that quality is important to them and that they recognize their staff as the only path to quality.

There are no easy answers to providing quality. It takes a continuous and consistent message from the leadership of the firm that quality is important to them and that they recognize their staff as the only path to quality. Investing in the staff will garner their commitment, trust, and hard-work, and will result in high-quality work done in a productive manner by happy people. In the end, can we ask for much more? ■

## NOTES

* ISO 9000, www.iso.org.

** *ASHRAE Guideline 0-2005, The Commissioning Process*, www.ashrae.org. See also, www.wbdg.org/project/buildingcomm.php.

*** RediCheck, 109 Greensway, Suite 100, Peachtree City, GA 30269, www.redicheck-review.com.

## REFERENCE

1 The RediCheck system was developed in 1981 by William T. Nigro, AIA.

*David W. Altenhofen AIA is the Technical Design Principal for RMJM Hillier, a 300 person architecture and design firm in New York, Princeton and Philadelphia with affiliated offices world-wide. He is responsible for managing the Technical Excellence Plan for the firm.*

## RECOMMENDATIONS FOR PREPARING A QUALITY MANAGEMENT PLAN

Every firm must custom design its own quality program around its own expectations, the peculiarities of its own practice, and its own professional goals. Below is a basic outline of preparing a quality management plan:

- Firm leadership should discuss quality frequently to develop common expectations. Appoint a principal to lead quality management but always emphasize that every principal must constantly reinforce quality. Establish a culture of excellence that is reinforced by daily actions.
- Hire good staff, train them well and mentor them continually through their own personal growth and through the development of the project.
- Ensure that firm leadership and project level leaders understand the importance of training and empowerment. They likewise should be trained in the mentoring and training of the staff.
- Analyze the firm's processes and history. Write out the steps you know are essential for quality.
- Manage for success. Start each project with a reasonable work plan that includes more than just a fee burn-rate. Set milestones for key coordination and information transfer points. Check project progress against the plan make small periodic adjustments to keep up with the schedule rather than allowing the team to fall behind and then try to recover in the last weeks of CDs.
- Provide your staff with tools to do excellent work; CADD standards, checklists by phase, guide details, specification guidelines, etc. Good tools provide for productivity which allows time for good work. Start from commercial sources but customize the tools to suit your particular practice. Constantly update these tools with lessons learned from projects.
- Conduct timely reviews during the beginning of each phase to apply the assembled knowledge of senior staff to each individual project. Such peer reviews can be the single most important tool to ensure that designs are solid, that owner's project requirements are met, that the best knowledge of the firm is incorporated into the project and to lay a solid foundation for subsequent work without later backtracking or duplication.
- Require that a written document describing the owner's project requirements and the basis of design answering those requirements be developed for the end of schematic design and updated through the life of the project.
- Require that your consultants perform similar quality assurance measures and ask them to provide documentation that such measures have, in fact, been completed.
- Conduct quality control checks of each deliverable before it leaves the office to ensure that the firm's quality process has been followed and that deliverables meet quality expectations. The reviews should be performed by senior staff independent of the day-to-day project team. Allow sufficient time to make corrections before delivery, one or two days for small packages; up to two weeks for larger packages. Note that if the other aspects of the quality management plans have been followed then this final check should be minimal.
- Require that your consultants perform similar quality assurance measures; ask them to provide documentation that such measures have in fact been completed.
- Implement methods for continuing the quality process into the construction phases by requiring senior review of important submittals, field testing of mock-ups, checklists, etc. and of course the emphasis on the staff doing CA.
- For liability reasons, it is recommended that records of performing the tasks required of a quality management plan be maintained. However, it may not be desirable to keep records of the actual content of meetings and reviews. Discuss record keeping with your counsel.
- Continually monitor the quality management plan and adjust it based on feedback from projects and changing conditions of the practice.

# **Case Study:** Commissioning of the Building Envelope of Children's Corporate Center Milwaukee, Wisconsin

**By Brian Stroik**, The Boldt Company

*ASTM 1186 Smoke Test performed on the actual building enclosure.*

*Children's Corporate Center is an eight-level, 280,000 square foot office building located one block west of Children's Hospital of Wisconsin. The building opened in December, 2005. Photo courtesy of the Children's Hospital and Health System.*

THE CONSTRUCTION MANAGER'S INTERVIEW for Children's Corporate Center at Children's Hospital of Wisconsin in Milwaukee focused on the need to create an energy efficient building that was pleasing to the eye, enjoyable to work in and could operate in Wisconsin's wide ranging climate. The Boldt Company, along with architects Shepley Bulfinch, Richardson & Abbott, Boston, and Zimmerman Architectural Studios, Wauwatosa, WI, took on this challenge.

Boldt's Project Management Team implemented its Enclosure Quality Management (EQM) program. This program is designed to commission any building envelope through the use of Built In Quality (BIQ). The process consists of a plan review, mock up testing, on-site training, third party inspections and random site testing of installed products. The program was designed and implemented prior to the release of NIBS Guideline 3-2006 Exterior Enclosure Technical Requirements for the Commissioning Process, yet incorporates many of the same principles.

The first step of the EQM program occurred prior to the bidding process for the building enclosure components. Boldt reviewed all of the enclosure details and specifications to confirm the proper use of barrier materials and their interfaces with adjacent materials. The review initiated discussions with the designers, Shepley Bulfinch Richardson & Abbott, and where warranted changes were made to the details. The review also aided in creating various lists of concerns and potential issues for the different enclosure disciplines. These lists were used in the interview process, preconstruction meetings and Boldt's Quality Assurance Program.

The construction, full testing, documentation and implementation of lessons learned from an enclosure mock up constituted the next phase of the EQM program. The mock up was built and tested at Architectural Testing Incorporated (ATI), located in York, Pa. The subcontractors for the project were required to send their lead men (who were then required to be a part of the installation team on the project) out to the testing facility to install their materials. The "hands on" experience and knowledge attained by installing the materials prior to it actually being installed on the building proved to be invaluable.

For the mock up's first series of air infiltration, moisture, thermal and structural tests, the contractors, architects, third party consultants and Boldt representatives were on hand to witness the issues that were discovered. The team reviewed each issue and agreed upon a potential solution and path forward. This process continued until the mock up passed all of the required tests. The mock up proved to be an integral part of the construction process and led to a number of manufacturing, schedule sequencing, and installation sequence changes prior to the building's enclosure being constructed on site.

The Boldt Company integrated the information and lessons learned from the mock up and created a training program that every tradesman that worked on the building envelope was required to attend. The training program emphasized the importance of installing the work properly the first time and reviewed the failures from the mock up testing along with discussing other high risk areas that were part of the envelope design. The on site training program instilled a sense of teamwork and stressed the importance of each worker and his diligence to the project details. Most importantly it let the tradesmen know how important communication is and that it was okay to ask questions if something in the field did not appear correct.

As the building enclosure construction began, the EQM program moved into its next phase: Boldt's Quality Assurance Program and third party consultant site visits. Boldt's QA Program emphasizes proactive measures by requiring foremen and/or superintendents to regularly review and document that their material has been installed correctly by their field personnel. The third party consultants included a curtain wall (unitized system) consultant who visited both the site and glazers manufacturing plant, an air and vapor barrier consultant who performed visual inspections, pull tests, and smoke tests (ASTM E 1186-03), and audits by the Air Barrier Association of America. All of the consultants made numerous trips to the job site at various times, thus ensuring contractors did not become complacent in their work.

As the work on the enclosure progressed, Boldt hired ATI to field test the interfaces of various components and individual systems. The first series of these tests were conducted early on so as to eliminate the possibility of a repetitive problem being overlooked and installed throughout the facade. The most common tests performed on site were: ASTM E 1105 (Field Determination of Water Penetration of Installed Exterior Windows, Curtain Walls and Doors by Uniform or Cyclic Static Air Pressure Difference) and AAMA 502-02 (Voluntary Specification for Field Testing of Windows and Sliding Glass Doors, Test Method A).

The Enclosure Quality Management process Boldt utilized to commission the exterior envelope of the Children's Corporate Center proved to be successful as the building functions and performs as it was designed. The EQM process along with the lessons learned from this project are currently being employed on a 12-story, 425,000 square foot hospital addition underway at Children's Hospital. In conclusion, contractors whom facilitate commissioning of the building envelope need to recognize that this is a system which contains numerous processes starting at the design phase and continuing through to the completion of the project. ■

---

*Brian Stroik is the Quality Process Manager for Oscar J. Boldt's Central Operations Group and specializes in field quality assurance process development and building enclosures.*

# Characterizing Air Leakage in Large Buildings: Part II

By **Terry Brennan** and **Michael Clarkin**, Camroden Associates Inc.

*In the Summer 2007 edition of JBED Terry Brennan and Michael Clarkin talked about what a fan pressurization test is, why it's important and how to go about completing one. In Part II of their article, they'll explain what the results of the test actually mean.*

## MEASURING PRESSURE DIFFERENCES

Electronic micromanometers designed for use in pressure testing buildings are available from the blower door manufacturers. A micromanometer has at least two air ports. A pressure sensitive transducer measures the air pressure difference between the two ports. Flexible tubing can be attached to each port so pressure differences between two locations that are distant from each other can be measured. **Figure 1** shows a two channel micromanometer. The green tubing runs to an outdoor measurement location. 2.1 Pascals air pressure difference is measured between the outdoor end of the tube and the open port at the bottom left. The building in this photo has none of the test fans operating—the pressure difference is due to a slight breeze. The blue tube runs to the flow nozzle on a blower door. The display switches between the two channels using the round knob below the display.

Wind and stack effect have important effects on pressure differences. Building air pressure is lower inside than outside on the windward side of the building; higher inside than outside on the leeward side. On sides parallel to wind usually the building is slightly lower air pressure than outside. When outdoor air is colder than indoor air the air pressure at the top of the building is higher than outdoor air and the air pressure at the bottom of the building is lower than outdoor air. The ASTM, ATTMA and CGSB standards provide guidance for dealing with these problems.

The wind and stack problems found while conducting tests on small single zone buildings are compounded in larger, more complex buildings. In addition, uneven depressurization or pressurization between floors or zones during the test can produce errors in larger, multi-zone buildings. For example, in a two story office building with the first and second floor connected mostly by open doors at the top and bottom of a stairwell, and entry doors on the first floor the only place to install blower doors, the pressure difference between the first floor and the outdoors may be significantly greater than the pressure difference between the second floor and outdoors. Sometimes this problem can be mended by placing a fan door in a window opening or a roof hatch. Sometimes exhaust fans or outdoor air fan on the second floor can be used to produce more uniform pressure differences across the enclosure.

In larger buildings there is a great advantage to simultaneously measuring the pressure difference between indoors and outdoors at several locations or between floors and zones. This gives immediate feedback on the effect wind, stack and interzonal airflow resistance is having on the pressure differences across all walls. Recording the data allows later analysis when data points with the smallest differences between orientations can be used. An eight channel micromanometer from the Energy Conservatory is shown in **Figure 2**. For this test four of the channels measure the pressure difference across four wall orientations, one channel measures the pressure difference between first and second floor and


*Figure 1 – A two-channel micromanometer.*

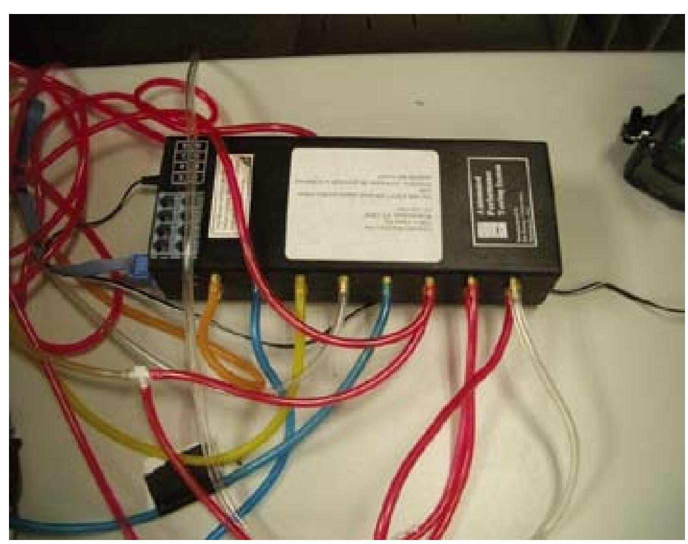


*Figure 2 – An eight channel pressure difference datalogger.*

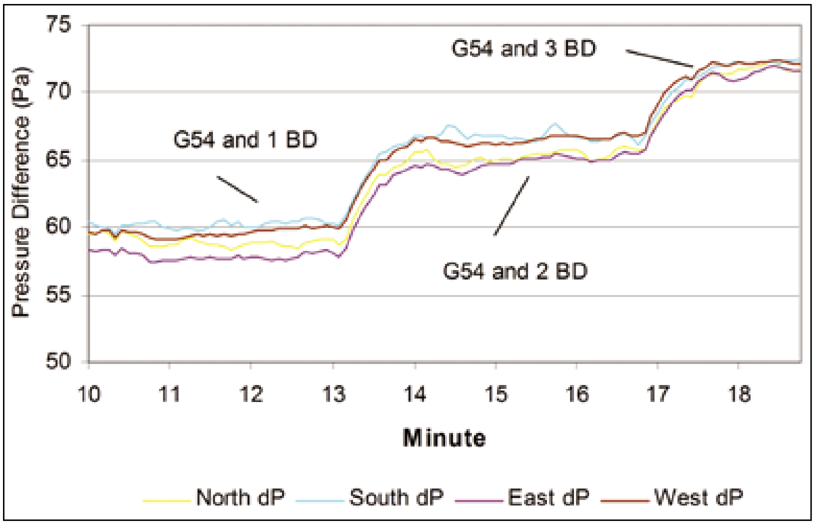



*Figure 3 – Continuous pressure difference data reveals the impact of changing pressurization air flows and the effect wind has on the pressure differences.*

the remaining three channels measure the pressure drop across the flow orifices for three blower doors. NOTE: If using tubing longer than 100 feet, the tiniest airleaks cause erroneous pressure difference measurements. Accuracy must be verified across each wall if tubing longer than 100 feet is used.

**Figure 3** shows a time series of pressure difference data across four walls during a test. At the beginning of the trace the building is being pressurized using a trailer mounted G54 and one blower door—a total of around 66,000 cfm. A second blower door is turned on at 13 minutes adding another 6,000 cfm and increasing the indoor/outdoor pressure difference by 6 to 8 pascals. A third blower door is turned on at around 17 minutes, increasing the indoor outdoor pressure difference again. Notice the time lag between when the additional air was supplied and when the pressure difference stabilizes. This is due to the data collection time interval and the rather large 32,000,000 cubic foot volume of the warehouse being tested.

During the test the wind was from the northeast. The pressure difference across the north and east walls are usually within a pascal of each other. The pressure difference across the south and west walls are usually within a pascal of each but are generally 1 to 2 pascals greater than the north and east wall. This is consistent with the wind direction. With the graph plotting on the computer screen in real time, data at each new flow can be collected long enough to assure small wind effects are noticed, and fan flows can be adjusted to maintain uniform pressure differences for multiple zones.

If you are testing the building at multiple airflow-pressure points, it is a good idea to plot the data and do the regression analysis as the data is collected. Outliers become obvious and can be retested. At the very least, plot the data while the test equipment is still setup. It's an expensive mistake to discover consistent data when everything is taken down and you're back at the office.

## REFERENCES FROM BOTH PART I AND PART II OF THE ARTICLE

ASHRAE 2005, Handbook of Fundamentals, American Society of Heating Refrigeration and Air-conditioning Engineers, 2005.

ATTMA 2006, ATTMA Technical Standard 1. Measuring Air Permeability of Building Envelopes, Air Testing and Measurement Association 2006.

Brennan 2002, Brennan, T., Cummings, J. "The Moisture Impact of Unplanned Airflows in Buildings", ASHRAE Journal November, 2002.

Brennan 1997, Brennan, T., Clarkin, M., Lstiburek, J., Turner, W. "Unintended Consequences of Planned and Unplanned Airflows in Commercial Buildings" ASHRAE Healthy Buildings/IAQ 97, held at NIH, Bethesda, MD, September 1997.

CGSB 1996, CGSB-149.15-96 Determination of the Overall Envelope Airtightness of Buildings by the Fan Pressurization Method Using the Building's Air Handling Systems, Canadian General Standards Board, 1996.

Cummings 1996, Cummings, J.B., C.R. Withers, N. Moyer, P. Fairey, B. McKendry, "Uncontrolled Air Flow in Non-Residential Buildings", Prepared for Florida Energy Office, Department of Community Affairs, FSEC-CR-878-96, March 29, 1996.

Cummings 1996, Cummings, J. B., C.R. Withers, N. Moyer, P. Fairey, and B. McKendry. "Field Measurement of Uncontrolled Air Flow and Depressurization in Restaurants". ASHRAE Transactions, 1996, Vol.102, Part 1, p.859.

Emmerich 2007, Emmerich, S. "Impact of Airtightness on Energy Use". Journal of Building Enclosure Design" Winter 2007.

Emmerich 2005, Emmerich, S., Persily, A., McDowell, T., "Impact of Commercial Building Infiltration on Heating and Cooling Loads in U.S. Office Buildings" Conference proceedings "Ventilation in Relation to the Energy Performance of buildings", AIVC, 2005.

Henderson 2006, Henderson, H. et al "Mitigating the Impacts of Uncontrolled Air Flow on Indoor Environmental Quality and Energy Demands in Non-residential Buildings", New York State Energy Research and Development Association, 2006.

Lee 1998, Lee,B. "Protocol for Field Testing of Tall Buildings to Determine Envelope Leakage Rate", Masters Thesis, Architectural Engineering Department, Pennsylvania State University, 1998.

Lstiburek 2007, Lstiburek, J. "The Hollow Building". ASHRAE Journal June, 2007.

PECI 2005, Portland Energy Conservation Inc., TG12 Envelope Leakage Test, PECI Functional Testing Guidance, 2005.

Persily 1986, Persily, A., "Airtightness of Commercial and Institutional Buildings: Blowing Holes in the Myth of Tight Buildings", Thermal Envelopes VII Conference, 1998 Clearwater, FL.

Persily 1999, Persily, Andrew K. "Myths About Building Envelopes." ASHRAE Journal, March 1999.

Potter 2007, Potter, N. "Air Tightness: The British Experience" Journal of Building Enclosure Design" Winter 2007.

SMACNA 2002, *HVAC Systems Testing, Adjusting and Balancing*, Sheet Metal and Air Conditioning Contractors National Association, Inc., 2002.

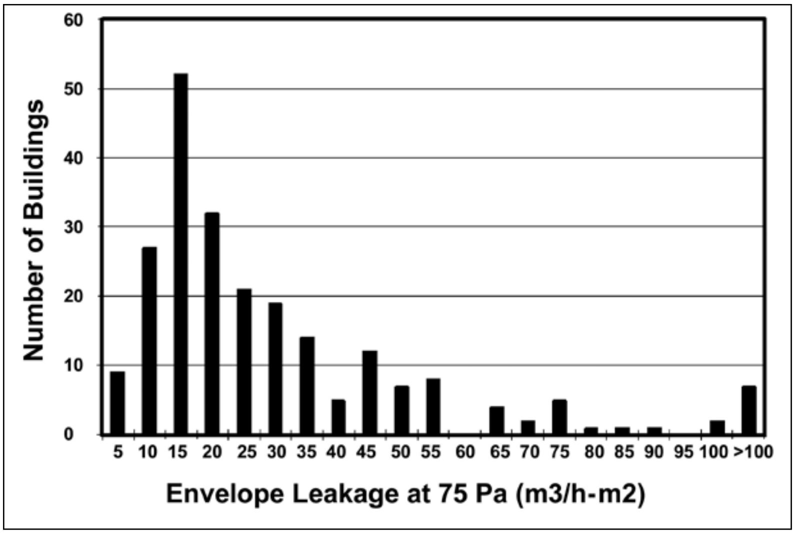



*Figure 4 – Histogram of enclosure tightness measurements for large buildings.*

## WHAT DOES IT MEAN?

Analysis of the data and interpretation depends on the purpose of the test. If the purpose is to compare the enclosure tightness to a target—for example specified as performance criteria by owner, designer or regulation—then the analysis must report the result in the same measurement units as the target specification. The measurements must be made so the uncertainty in the result is small compared to the target tightness level. For example, if the target is the same as the British normal practice of 6 $m^3$/hr@50pascals per $m^2$ of enclosure (where enclosure area includes the top, bottom and exterior sides of the building), then the results must be converted to these units. The British ATTMA standard (multi-point test), ASTM E-779-03 (multi-point test) and ASTM E-1827-96 (single-point and two-point test) each provide criteria for bias and uncertainty, corrections for air density and accounting for environmental conditions.

The tightness of an enclosure can also be compared to similar buildings that have been previously tested. Figure 4 shows a histogram of the measured airtightness of 229 large building enclosures collected by the National Institute of Science and Technology from a number of data sources (Emmerich 2005). The results are reported in $m^3$/hr@75 pascals per $m^2$ surface area (where the surface area includes the roof, bottom floor and exterior walls of the enclosure). Enough data has been collected to see that the distribution is log-normal. To give some perspective on the data:

- British Part L energy requirements require office buildings to be air sealed to an airtightness of 10 $m^3$/hr@50 pascals per $m^2$ surface area; for comparison to the NIST data set this is converted to 13 $m^3$/hr or 3.6 L/s @75 pascals per $m^2$ surface area—assuming n=0.65 (Potter 2007). Just over 28 percent of the buildings in the dataset meet this target.
- British normal practice for office buildings is 5 $m^3$/hr@50 pascals per $m^2$ surface area (6.5 $m^3$/hr or 1.8 L/s @75 pascals per $m^2$ surface area—assuming n=0.65) (ATTMA, BSRIA). Just over 6 percent meet this target.
- British best practice for office buildings is 2 $m^3$/hr@50 pascals per $m^2$ surface area (2.6 $m^3$/hr or 0.72 L/s @75 pascals per $m^2$ surface area—assuming n=0.65) (ATTMA, BSRIA). Two of the buildings in the dataset are within 10 percent of this target, but none definitively meet it.
  - For commercial buildings Henri Fennell suggests a State of the Art target of 2.7 $m^3$/hr@50 pascals per $m^2$ surface area (3.5 $m^3$/hr or 0.97 L/s @75 pascals per $m^2$ surface area—assuming n=0.65) (Fennell 2005). Just over 2 percent of the buildings meet this target.
  - ASHRAE Addendum z to 90.1 2004 allows 2 L/s @ 75 Pa per $m^2$ surface area.
  - US Army Corps of Engineers airtightness requirement is set at 1.25 L/s @ 75 Pa per $m^2$ surface area.

The challenge to those designing high performance buildings is to meet the airtightness target values listed above, placing their buildings in the tightest few per cent of the building stock. To routinely achieve these target levels the construction documents must contain drawings and specifications detailing continuity of an air barrier system in all sections. It must be clear enough that contractors can understand what must be done. Pressure testing is an important tool in helping those who design and build to learn what is needed to air seal to meet airtightness target levels. ■

*Terry Brennan and Michael Clarkin are building scientists who work at Camroden Associates Inc. They have been pressure testing buildings since 1981.*

# BEC Corner

## BOSTON

By Jonathan Baron, AIA, Spagnolo Gisness & Associates, Inc.

The Boston-BEC continues to meet monthly (except for August and December) for one and a half to two hours at the BSA headquarters in Boston's Financial District. Recent presentations have included a review of the jury process for the first BEC-Boston Award for the Most Innovative Building Enclosure, *Cellulose Insulation* by Betsy Petit of Building Science Corporation, *Fall Protection* by Brent LaPorte of Pro-Bel Enterprises, Ltd., and *Sound Transmission through the Building Envelope*, by Jeff Fullerton of Acentech, Inc. We typically have 20 to 30 attendees at our meetings, and there is always spirited discussion with the presenters.

The BEC sponsored a number of events at Build Boston, in November 2007, including a presentation of the first BEC-Boston Award for the Most Innovative Building Enclosure. Members of the jury reviewed the winning project, 60 Oxford Street at Harvard University, and members of the project team described the project and the sensitive treatment of the building enclosure.

Upcoming meetings will focus on the effects of structural movement on building enclosures and the interrelationship of ASHRAE 90.1 and enclosures. More information about our current initiatives as well as future and past meetings can be found at our website www.bec-boston.org.

## MARYLAND

By H. Michael Hill, AIA, Torti Gallas and Partners, Inc; Fiona Aldous, Wiss, Janney, Elstner Associates, Inc.; and Paul E. Totten, PE, Simpson Gumpertz & Heger Inc.

Following successful and well attended programs featuring Understanding Garden Roofs and Selling Them to Clients; Curtain Wall Fabrication and Cladding of 1101 New York Avenue; Wind Information for Ballasted Roofing Systems; What is a Window Wall?; Stone Cladding Design Considerations: An Overview; and Double Skin Facades, the DC-BEC ended the year 2007 with a "town hall meeting" to introduce the new co-chairs and brainstorm the needs and expectations of our local BEC community.

David A. Harris, FAIA, President of NIBS addressed the group with accolades to Tim Taylor and Bob Tarasovich for their devotion to sustaining the council with interesting and relevant monthly programs since our beginning in February 2005. Harris applauded us for continuing the effort of providing a means by which the DC, NoVA and MD building envelope community with interest in the enclosure and related building science can discuss and obtain information. A format of quarterly themes will be explored, with the first series of 2008 addressing "Unnatural Forces" on the building enclosure. Presentations will explore the relationships and issues associated with the building enclosure and fire, sound and blast. Although these events do naturally occur, their existence beyond the natural poses unique challenges to the designer to mitigate and control. The January 2008 topic of fire was presented by Dr. Jonathan Barnett and included discussion on fire and smoke controls for atria, as well as design considerations for phased occupancy.

Meetings for the first quarter will continue to convene at Gensler's office on the first Wednesday of each month at 4pm.

## MINNESOTA

By Judd Peterson, AIA, BEC-Minnesota Co-chair and Jodelle Senger, AIA, LEED AP, BEC-Minnesota Co-chair

The BEC-Minnesota is preparing for the BEST 1 Symposium which will be held in Minneapolis, MI on June 10-12, 2008. Topics and speakers have been selected. We are now in the process of securing sponsorships from national and regional companies that have a strong interest in the building enclosure. We hope that everyone will be able to attend and participate in this historic event. We also hope that the valuable information that is learned from this conference can lead to advancements in both energy efficiency and durability of the building exterior. Please visit the conference website to find out more about this exciting event, www.thebest-conference.org.

Our local BEC continues to grow as we invite interesting experts to speak at our monthly meetings. recent speakers and topics have included John Edgar of Sto Corporation: Recommended Application Systems for EIFS Stucco; Steve Pedracine of Minnesota lath and Plaster: Residential Code Changes for Stucco Installations; and Al Gerhke of American Hydrotech: Design and Installation of a Green Roof. BEC-Minnesota also hosted a seminar at our local AIA Convention in October 2007. Michael Petermann of Wiss, Janney, Elstner Associates, Inc. of New York and Ed Gerns of the WJEA Chicago office presented, "Are our Building Facades Safe?" which addressed building facade inspection ordinances. Since we received such interest in the topic, we continued the discussion at our November 2007 meeting, inviting the leaders of BOMA so we could hear their thoughts on the benefits and challenges of enforcing inspections. BEC-Minnesota has decided to survey key building owners to try to find a way to better protect the public without negatively impacting the building owner. We are looking forward to what 2008 has to offer.

## PORTLAND

By David C. Young, PE, RDH Building Sciences Inc.

After venue hopping each month for the past year, the Portland-BEC Chapter is happy to announce that our monthly meetings are now being held at the new Portland Center for Architecture, office of the AIA. We wish to thank all the companies that provided space for our meetings over the past year and additionally, thank all presenters and attendees for being flexible with the changing venues.

The new AIA Center for Architecture building is a testament to green design. The existing single story building was renovated as an example of carbon neutral construction techniques. The building calculates to be 83 percent below the current

$CO_2$ emissions. The facility will be used as an educational center for both the design community and the community at large for environmentally responsible design. The space suits our needs perfectly and we look forward to the upcoming seminars we have planned this year.

The new year is appropriately starting out with green topics such as passive solar design and day-lighting. Seminar topics later in the year will focus on roofing and seismic considerations for brick veneer cladding. We are also planning a flashing rodeo this summer after witnessing the success of the Charleston, SC event. ■

**DID YOU KNOW?**

The National Institute of Building Sciences (NIBS) was authorized by the U.S. Congress in the Housing and Community Development Act of 1974, Public Law 93-383. In establishing NIBS, Congress recognized the need for an organization that could serve as an interface between government and the private sector. The Institute's public interest mission is to improve the building regulatory environment; facilitate the introduction of new and existing products and technology into the building process; and disseminate nationally recognized technical and regulatory information.

As a non-profit, non-governmental organization, NIBS brings together representatives of government, the professions, industry, labor and consumer interests to focus on the identification and resolution of problems and potential problems that hamper the construction of safe, affordable structures for housing, commerce and industry throughout the United States. NIBS provides an authoritative source of advice for both the private and public sector of the economy with respect to the use of building science and technology. Congress recognized that the lack of such an authoritative voice was a burden on all those who plan, design, procure, construct, use, operate, maintain and retire physical facilities, and that this burden frequently resulted from failure to take full advantage of new useful technology that could improve our living environment.

NIBS' councils and standing committees, which include the Consultative Council, the Seismic Safety Council, the Building Enclosure Technology and Environment Council, the Facility Information Council, the buildingSMART Alliance, the Multihazard Mitigation Council and the Facility Maintenance and Operations Committee, focus on broad-based and specialized building process issues. Each specialty council is governed by a voluntary board of direction comprised of nationally recognized leaders in appropriate disciplines.

NIBS is headquartered in Washington, D.C. and is directed by a 21-member Board of Directors, 15 of whom are elected and six of whom are appointed by the President of the United States, subject to the approval of the U.S. Senate.

**For more information go to www.nibs.org.**

**PLEASE SUPPORT OUR ADVERTISERS.**

# JOIN BETEC

**Building Enclosure Technology and Environment Council**

1090 Vermont Avenue, NW, Suite 700 | Washington, DC 20005-4905
Tel: (202) 289-7800 | Fax: (202) 289-1092 | www.nibs.org/BETEC

To become a member of the Building Enclosure Technology and Environment Council, please complete and return the following application form:

Name: ______________________ Title: ______________________
Company: ______________________ Address: ______________________
City: ______________________ State: __________ ZIP Code: __________
Telephone: ______________________ Fax: ______________________
E-Mail Address: ______________________

MEMBERSHIP CATEGORY:
- ☐ Individual Member - $100
- ☐ Corporate Member - $250 (optional alternate member)

RESEARCH COORDINATING COMMITTEES:
I will participate on the following Research Coordinating Committees (RCC's):
- ☐ Heat Air and Moisture
- ☐ Fenestration
- ☐ Membranes
- ☐ Materials and Resources
- ☐ Existing Building Enclosures
- ☐ Education
- ☐ Window Security Rating and Certification System

**OPERATIONAL COMMITTEES:**
I will participate on the following Operational Committees (OC's):
- ☐ Technology Transfer
- ☐ National Program Plan
- ☐ Network for the Advancement of Building Science

ALTERNATE MEMBER INFORMATION
**(corporate members only):**
Alternate Name: __________
Alternate Title: __________
Alternate's RCC's and OC's: __________
__________

**DUES PAYMENT:**
☐ Check or Money Order enclosed payable to BETEC ☐ Please bill my Credit Card: ☐ AMEX ☐ MC ☐ VISA
Account No. ______________________ Exp. Date __________
Cardholder's Name ______________________ Billing Address ______________________
City ______________________ State __________ ZIP __________
Signature ______________________ Date __________

---

# JOIN NIBS

**National Institute of Building Sciences**

1090 Vermont Avenue, NW, Suite 700 | Washington, DC 20005-4905
Tel: (202) 289-7800 | Fax: (202) 289-1092 | www.nibs.org

**Membership Application**

Membership in the National Institute of Building Sciences is open to all interested parties as provided in the enabling legislation. Individuals are eligible to become either public interest or industry sector members. Organizations that wish to support the Institute in achieving its objectives may become sustaining or contributing organization.

Name ______________________ Title ______________________
Company ______________________ Addres ______________________
City ______________________ State __________ ZIP Code __________
Telephone ______________________ Fax ______________________
Nature of Business/interest areas: ______________________

☐ **INDUSTRY SECTOR MEMBER:** Open to any individual in the following categories: Building construction; labor organizations; home builders; building or construction contractors; producers, distributors or manufacturers of building products; trade and professional associations; organizations engaged in real estate, insurance or finance; research and testing of building products; and code and standard organizations. ANNUAL CONTRIBUTION: $150

☐ **PUBLIC INTEREST SECTOR MEMBER:** Open to any individual in the following categories: Federal, state and local government, consumer organizations, nonprofit research and educational organizations, the media, architects, professional engineers or other design professionals, and retirees. ANNUAL CONTRIBUTION: $75

☐ **SUSTAINING ORGANIZATION:** Open to organizations in the public interest or industry sectors desiring to provide additional support for and participation with the Institute to achieve the goals and objectives. Sustaining organizations may designate up to five individuals from their organization to be Institute Members. ANNUAL CONTRIBUTION: $1000

☐ **CONTRIBUTING ORGANIZATION:** Organizations making contributions to the Institute in an amount substantially exceeding $1000. Contributing organizations are accorded the same rights and privileges as sustaining organizations and such other rights and privileges as authorized by NIBS' Board of Directors. ANNUAL CONTRIBUTION: $__________

**Annual Contribution $** __________ ☐ **Payment Enclosed** ☐ **Bill Me** ☐ **Charge to my MC/VISA/AMEX:**
**Account No.** __________ **Exp. Date**__________ **Name on Card** __________
**Billing Address** __________

The National Institute of Building Sciences is a nonprofit organization with an Internal Revenue Service Classification of 501(c)(3) tax exempt status. Contributions to all 501(c)(3) organizations are tax deductible by corporations and individuals as charitable donations for federal income tax purposes.

**Signature** __________ **Date** __________

**Send information on the following council/committee:** ☐ **BSSC** ☐ **BETEC** ☐ **FIC** ☐ **IAI** ☐ **FMOC** ☐ **MMC**


## It's time to do the math on IAQ.

Indoor air quality (IAQ) is one of the most important health issues facing schools today; the U.S. Environmental Protection Agency ranks poor IAQ as a top-five environmental health threat, and estimates that half of U.S. schools have IAQ problems.

One way to clear the air on IAQ concerns is to specify low-emitting building products like Knauf Insulation. Knauf's 1000° ASJ/SSL Pipe Insulation, Friendly-Feel Duct Wrap* and thermal/acoustical batts all meet the toughest industry IAQ standards—certification from the GREENGUARD Environmental Institute, including the GREENGUARD for Children and Schools designation, and California's strict Section 01350 limiting chemical emissions like formaldehyde. Knauf is also the only insulation manufacturer that is a member of the Collaborative for High Performance Schools.

That means Knauf has the insulation formula for healthy, energy-efficient schools—so you can pass your IAQ test with flying colors.

*All products except vinyl faced.


For more information call (800) 825-4434 ext. 8283
or visit us online at www.KnaufInsulation.com

KNAUF INSULATION