

Guideline 3-2006 Exterior Enclosure Technical Requirements for The Commissioning Process

Joseph Deringer
The Deringer Group Inc

David Altenhofen
Hiller Architecture

Wagdy Anis
Shepley Bulfinch Richardson and Abbott

Tim Corbett
Social Security Administration

William Nash
McCarthy Building Companies, Inc.

Earle Kennett
National Institute of Building Sciences

Synopsis

Guidelines 0, 1 and 3 are integral parts of the National Institute of Building Sciences (NIBS) Whole Building Commissioning Guideline series. ASHRAE/NIBS Guideline 0-2005 (GL-0) describes the general commissioning process. Guideline 1 describes the technical requirements for commissioning HVC&R systems. Guideline 3, the subject of this paper, is the newest guideline of the series, and describes the technical requirements for commissioning the building exterior enclosure.

GL 0-2005 is the 3rd generation of this ASHRAE guideline; the 1st version was published in 1989, and the 2nd version was published in 1996. GL 1-2007 will be the 2nd generation of this ASHRAE guideline; the 1st version was published in 1996. GL 3-2006 is the 1st version of this NIBS guideline to be published.

Commissioning process (Guideline 0-2005): The commissioning process for delivering quality new construction projects has been formulated in ASHRAE Guideline 0-2005 (GL-0) for all building systems and assemblies. Guideline 0-2005 has been developed in the context of a joint program between ASHRAE and NIBS. GL-0 allows owners to set key project requirements that can be used to continuously verify the project is meeting the project requirements. These are defined as Owner's Project Requirements (OPR). GL-0 provides owners and commissioning authorities the guidance to integrate the commissioning process into their projects from pre-design through occupancy. This is achieved by integrating the quality principles of the commissioning

process into the owner's current process to achieve an improved process that will enhance all future projects.

Technical Requirements for the Exterior Enclosure (Guideline 3-2006): Exterior enclosure systems, assemblies and materials are important in all buildings. For ventilation and thermal comfort, the exterior enclosure may be considered part of the HVAC system. For visual comfort the exterior enclosure is an integral part of daylighting and lighting systems and can strongly influence the visual quality of spaces. The procedures, methods, and documentation requirements in Guideline 3-2006 (GL-3) describe the application of the Commissioning Process to building exterior enclosure systems for each project delivery phase from pre-design through owner occupancy and operation. GL-3 supports the Commissioning Process activities described in ASHRAE GL-0, The Commissioning Process. GL-3 has been developed as part of a joint program between ASHRAE and NIBS.

GL-3 includes requirements for:

- (a) Exterior enclosure systems to fully support the Commissioning Process activities,
- (b) Identification and review of the Owners Project Requirements at the beginning of each phase of the commissioning process,
- (c) Verification during each phase,
- (d) Acceptance during each phase,
- (e) Documentation during each phase,
- (f) A Systems Manual, and training for operations and maintenance personnel and occupants.

Technical Requirements for HVAC&R (Guideline 1-2007): Guideline 1-2007 (GL-1, is expected to be published in late 2007) has similar objectives to GL-3 and provides information on HVAC&R needs and tasks for specific requirements to be addressed during each phase of the project. GL-1, like GL-3, also provides substantial guidance through a set of illustrative annexes. The annexes to both GL-1 and GL-3 cover topics from sample verification checklist in all phases, sample construction document specifications, systems manual and other pertinent topics.

About the Authors

Joseph Deringer, AIA, LEED AP, President of The Deringer Group, has over 25 years experience in the analysis and design of energy-efficient sustainable buildings worldwide. He worked on building performance standards in the US, has assisted 9 countries to develop first-generation energy efficiency building codes, and has developed interactive computer-based education tools. He chaired the envelope subcommittee of the ASHRAE Standard 90.1 committee for 10 years, has served on the ASHRAE Standard 55 committee, and has served as senior advisor to the AIA Committee on the Environment. He chaired the NIBS project committee that produced NIBS Guideline 3-2006.

David Altenhofen, AIA, is Technical Director of the Philadelphia office of Hiller Architecture. He serves on the NIBS Building Enclosure Technology and Environment Council (BETEC) and chaired the Design Subcommittee of the NIBS Guideline 3-2006 project committee.

Wagdy Anis, FAIA, LEED AP, is Principal and Building Enclosure Expert with Shepley Bulfinch Richardson and Abbott. He serves on the envelope subcommittee of ASHRAE 90.1 and he is Chairman of the NIBS Building Enclosure Technology and Environment Council (BETEC). He chaired the Pre-Design Subcommittee of the NIBS Guideline 3-2006 project committee.

Tim Corbett is a Project manager for the Federal Government, Social Service Administration. He is a member of the ASHRAE Guideline 0 & 1-2007 project committee. He chaired the Occupancy/Operations Subcommittee for the NIBS Guideline 3-2006 project committee and for Guideline 0 & 1. He is a member of CSI and holds a CDT designation.

William Nash, P.E., is Quality Assurance Director for McCarthy Building Companies, Inc. He has served on numerous construction industry committees for ASCE, ASTM, plus the NIBS Building Enclosure Technology and Environment Council (BETEC). He chaired the Construction Subcommittee of the NIBS Guideline 3-2006 project committee.

Earle Kennett is Vice President of the National Institute of Building Sciences. He has managed and directed hundreds of projects in architecture and engineering as Vice President at the National Institute of Building Sciences (NIBS) and past Administrator for Research for the American Institute of Architects (AIA). As Vice President at NIBS, he manages a range of programs including the Whole Building Design Guide (WBDG), the Construction Criteria Base (CCB), The NIBS Consultative Council, the International Alliance for Interoperability (IAI), the Buildings and Mold Alliance (BMA), the Facility Information Council (FIC), the National CAD Standard, the National BIM Standard, the Building Enclosure Technology and Environmental Council (BETEC) and Facility Maintenance and Operations Committee (FMOC)

Introduction

Overview: Guidelines 0, 1 and 3 are integral parts of the National Institute of Building Sciences (NIBS) Whole Building Commissioning Guideline series. ASHRAE/NIBS Guideline 0-2005 (GL-0) describes the general commissioning process. Annex A of GL-0 was developed to provide guidance and templates for technical guidelines to support specific topics such as HVAC (GL-1), the building exterior enclosure (GL-3), and others.

To develop Guideline 3-2006 (GL-3) a NIBS project committee of over 25 people used Annex A from GL-0 as a template and resource. Like GL-0, GL-3 is process-oriented. However, GL-3 goes beyond process and also addresses a broad range of technical performance objectives for the exterior enclosure that might be required by a building owner including the control of:

- Heat flow
- Air flow,
- Noise,
- Fire,
- Light,
- Infrared,
- Ultraviolet,

- Rain penetration,
- Moisture,
- Structural performance,
- Durability,
- Security,
- Reliability,
- Aesthetics,
- Value,
- Constructability,
- Maintainability, and
- Sustainability.

The commissioning objectives for a building's exterior enclosure can vary tremendously by type of owner, type and size of building, and the owner's project objectives across the large list of objectives just mentioned, plus others. Thus GL-3 is not a one-size-fits-all "how to" document on avoiding leaky envelopes. However, it does provide a broad range of commissioning guidance and examples.

Use of GL-3: The NIBS GL-3 project committee urges building owners to:

- Use GL-3, and related GL-0 and GL-1, from the outset of a project's life cycle.
- Use these guidelines to help determine a balance among the functional, quality, risk and cost objectives for the building project
- Indicate in the owner's Requests for Proposals to the design team, the construction manager, and the commissioning authority for the project that GL-0, GL-1 and GL-3 and their annexes be used as guidance in accomplishing the work for the project.

GL-3 supplements the Commissioning Process detailed in ASHRAE Guideline 0-2005. NIBS GL-3 must be used in conjunction with ASHRAE GL-0. GL-3 is not intended for use as a standalone document.

GL-3 Body

The body of GL-3 is short – only 33 pages including the foreword. On the other hand, the annexes to GL-3 include some 300 pages and provide numerous examples of approaches and solutions to a range of specific technical circumstances and issues during pre-design, design, construction, testing, and O&M. The GL-3 *"annexes are included to assist in further understanding the implementation of the Commissioning Process to building exterior enclosure systems. The Annexes are based upon specific project experience, with details based upon current best practice. The Annexes illustrate application of the Commissioning Process to a variety of Building Exterior Enclosure systems and equipment. The Annexes should be viewed as examples of how to develop and define ongoing communications, Owner's Project Requirements, Basis of Design, and Commissioning Plan documents, verification, testing requirements, and training."*

This paper provides an overview to assist owners and commissioning teams to effectively use GL-3. For the body of GL-3 this paper focuses on the key elements in the Pre-Design Phase, with an emphasis on the Owner's Project Requirements and the Scope and Budget for the commissioning process. Since the Sections in NIBS GL-3 follow the same numbering format as GL-

0 and GL-1, this paper will not address them in detail. One exception is that in GL-3 the Design Phase is broken into 3 sub-phases - Schematic Design, Design Development and Construction Documentation - to better address exterior enclosure design sequences and issues.

Owner's Project Requirements (OPR): The *Owner's Project Requirements (OPR)* is a key commissioning document throughout a building delivery project starting from the inception of a project. An important activity throughout the life of a project is the proper transfer of the OPR information from one party to the next. Ideally the OPR should be developed at the outset of the building delivery process since this document provides the basic requirements from which all design, construction, acceptance, and operation decisions are made. Objectives and functional requirements of building exterior enclosure systems to be considered include the following 20 items that are listed and described in GL-3 Section 5.2.2:

- (a) Owner's Vision
- (b) Project budget and schedule
- (c) Owner directives
- (d) Occupant requirements
- (e) System Performance requirements
- (f) Systems integration requirements
- (g) Site information
- (h) Restrictions and limitations
- (i) Training requirements
- (j) Warranty requirements
- (k) Quality requirements of systems, materials and construction
- (l) Statistical and quality tools
- (m) Benchmarking requirements
- (n) Operation and maintenance
- (o) Allowable range of operation
- (p) Applicable codes and standards
- (q) Insurance requirements
- (r) Owner safety requirements
- (s) Constructability
- (t) Project documentation requirements

These items are discussed in more detail in the body of GL-3 as well as in the annexes.

Identify the Scope and Budget of Cx Process (GL-3, Section 5.2.3): Developing preliminary estimates of Cx scope and budget early on during the Pre-Design Phase provide important tools that permit the Owner to balance quality objectives for the building against with costs of achieving those desired levels of quality. Identifying this balance between desired quality and cost to achieve at this early point in the process provides a solid basis for subsequent decision making by the entire building delivery team. Also, the tradeoffs between quality and cost will likely be revisited and refined numerous times during subsequent phase of building delivery, using this early set of estimates as a starting point.

The remainder of the Pre-Design Section discusses other activities and steps to be taken early on in the process, including such items as preparing the Commissioning Plan (Section 5.2.4), estab-

lish Issues Log Procedures (Section 5.2.5), and Preparing an Issues Report (Section 5.2.6). All of these activities in the Pre-Design Phases are then reviewed and refined in subsequent phases of the building delivery process.

GL-3 Annexes

The annexes are a very important part of GL-3. These annexes contain formats and examples developed by the NIBS GL-3 project committee. These examples often contain substantial detail and their adaptation and use long with similar materials from GL-0 and GL-1 should improve both the project delivery process and the integration of the commissioning process. They should be modified for each new project to meet the specific needs owner project requirements and building delivery process.

The guideline provides substantially more detailed example documents than previous commissioning process guidelines that follow the commissioning process.

The following is a list of annexes and approximate length:

Annex B	Cx Process Flowcharts (6 pgs.)
Annex C	Costs and Benefits (2 pgs.)
Annex D	Documentation and Responsibilities (7 pgs.)
Annex F	Roles and Responsibilities - Commissioning Team Members
Annex J	Owner's Project Requirements (26 pgs.)
Annex K	Basis of Design (16 pgs.)
Annex L-	Specifications (68 pgs.)
Annex M	Construction Checklists (42 pgs.)
Annex O	Systems Manual (?? pgs.)
Annex R	Integration Requirements (?? pgs.)
Annex U	Exterior Enclosure Testing Procedures (?? pgs.)
<i>Annex Y</i>	<i>Constant Commissioning of the Building's Exterior Enclosure (?? pgs.)</i>
<i>Annex Z</i>	<i>Example Calculation Procedures and Tools (?? pgs.)</i>

Annex B: Flow Diagram of Building Development and Commissioning Processes

The following is an excerpt from the introduction to the Annex.

“This annex is intended to provide a detailed description of the commissioning (Cx) process and how it relates to the overall building development process. While the intent has been to describe the commissioning process for the building exterior enclosure, the flow diagrams contained on the following pages are probably sufficiently general to be used to describe commissioning and building development processes for all major building systems.”

“This annex is a major expansion of a less detailed flow diagram that is listed in Appendix B of ASHRAE Guideline 0-2005. Several key additions have been made in this newer Annex B to NIBS Guideline 3-2006:”

- *“First, this annex shows two parallel related flow diagrams, with major activities of the building development process on the left and key commissioning activities on the right,”*
- *“Second, the building design phases have been disaggregated into 3 sub phases – Schematic Design, Design Development, and Construction Documents.”*
- *“Third, most boxes within the right-hand Cx flow diagram have section numbers that link them to specific sections within the body of Guideline 3, in an effort to provide consistency between the text of the guideline and the sequences shown in the flow diagrams shown within this annex.”*

“The reader is cautioned not to conclude from this annex that all boxes identified in as Cx activities are unique to the Cx process. Indeed, some of these activities have been included in traditional quality control procedures for some time. Unfortunately, most buildings have benefited from little or no quality control activity. Some buildings have been blessed with more extensive quality control activities.”

An example from one of the 5 pages of flow diagrams covering the building delivery process is shown on the next page.

Annex C: Costs and Benefits

This annex is intended to provide available information and examples about the costs and benefits of commissioning activities explicitly for the exterior enclosure. This annex is a first effort and contains only a modest amount of cost information. Future versions are expected to present more detailed cost information.

Annex D: Commissioning Process Documentation Matrix

Annex D consists of examples of matrices that tabulate the documentation that can occur during the commissioning (Cx) process for the building exterior enclosure. Two example documentation matrices are included at this time: Annex D.1 contains a matrix for an office building with a developer-owner; and Annex D.2 contains a matrix for a small office building using a design-build process. Additional example matrices for other building development cases for government and private sector buildings are planned for future versions of this annex.

Annex F: Roles and Responsibilities Matrix

Annex F provides an overview perspective of the typical roles and responsibilities of all building development team members in the commissioning (Cx) process relative to the building exterior enclosure. The information in Annex F is strongly related to the information in Annex D.

Annex J: Owner's Project Requirements for the Exterior Enclosure

Annex J provides an example checklist of contents of the OPR for the building exterior enclosure. This example is the type of product used in practice by firms that place high priority on commissioning activities for the exterior enclosure.

Annex K: Basis of Design (BOD) for the Exterior Enclosure

Annex K parallels Annex J in providing an example checklist of contents of the BOD for the building exterior enclosure that represents the type of checklist used in practice by firms that place high priority on commissioning activities for the exterior enclosure.

Annex L: Specifications

Annex L contains 5 sub-annexes that together provide several perspectives and examples of relevant specifications for the exterior enclosure. The 5 sub-annexes are:

- (1) Preliminary Table of Contents of Masterspec Sections that may Include Facility Exterior Enclosure Commissioning Requirements
- (2) Masterspec Facility Exterior Enclosure Commissioning 019115
- (3) Example Draft Specification, Section 01811 - Building Exterior Enclosure Commissioning
- (4) Example Specification 01810 of General Requirements for a Recent Project
- (5) Example Specification 01811 of Fenestration System Testing Requirements for a Recent Project.

Annex M: Construction Checklists

Annex M provides 12 example checklists compiled from the experience of several members of the project committee. Ten examples are construction and industry checklists:

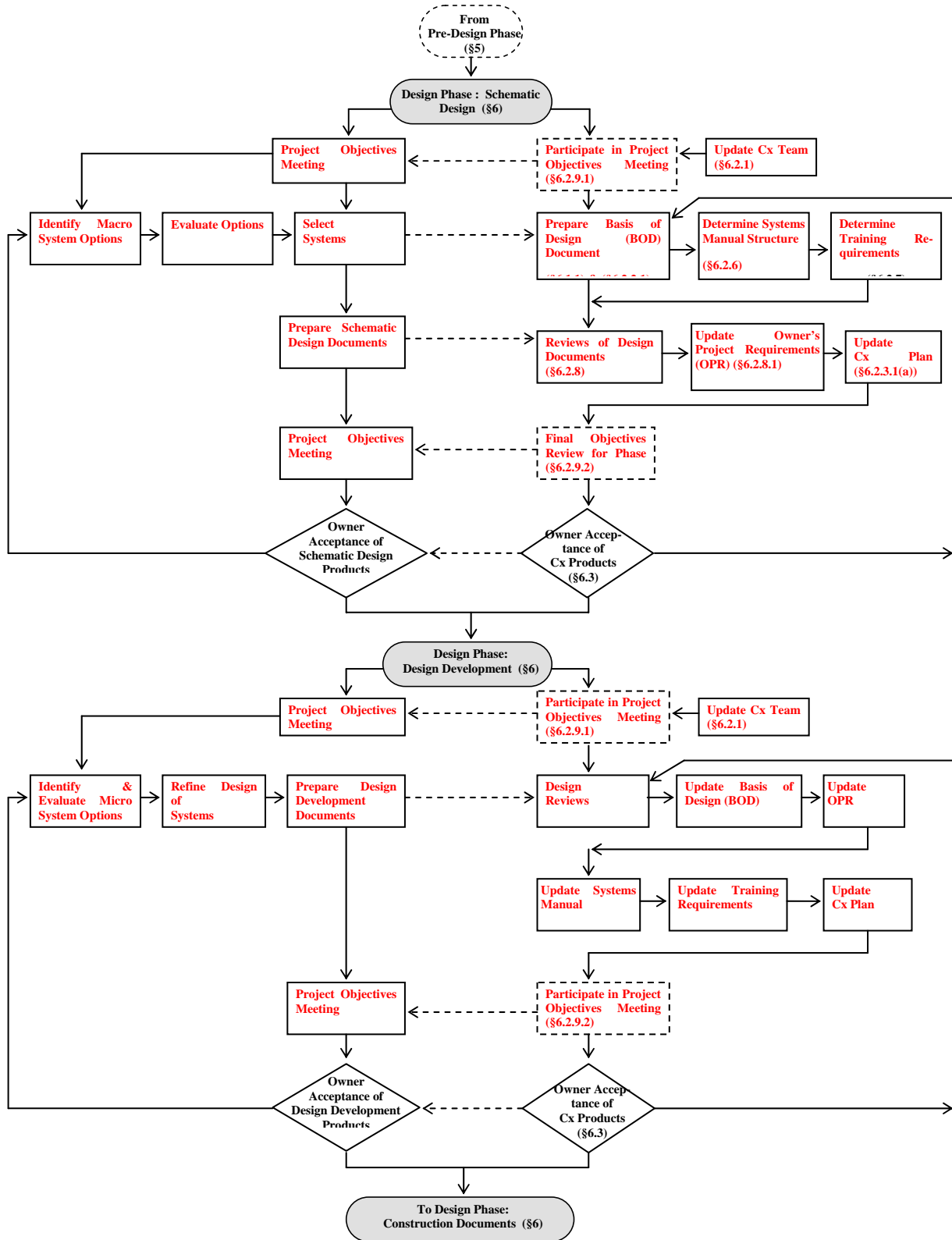
1. Checklist for Waterproofing, 07100, Division 7, Thermal and Moisture Protection
2. Checklist for EIFS, 07240, Division 7, Thermal and Moisture Protection
3. Checklist for Commercial Low Slope Roofing Systems, 07500, Division 7, Thermal and Moisture Protection
4. Checklist for Flashing and Sheet Metal, 07600, Division 7, Thermal and Moisture Protection
5. Checklist for Joint Sealers, 07900, Division 7, Thermal and Moisture Protection
6. Checklist for Entrances and Storefronts, 08400, Division 8, Doors and Windows
7. Checklist for Windows, 08500, Division 8, Doors and Windows
8. Checklist for Skylights, 08600, Division 8, Doors and Windows
9. Checklist for Glazing, 08800, Division 8, Doors and Windows
10. Checklist for Glazed Curtain Walls, 08900, Division 8, Doors and Windows

The other two examples are pre-functional checklists:

1. Checklist for Building Envelope (Exterior Enclosure) System
2. Checklist for Windows and Doors.

Building Development Process

Commissioning Process



Annex O: Systems Manual

Annex O provides an example of a portion of a Systems Manual extracted from a project by a GL-3 project committee member. The extract contains a list of the players involved and an outline of the Systems Manual.

Annex R: Integration Requirements

Annex R provides an overview of issues involved in the integrated design of exterior enclosure systems, and also the issues involved in the interaction of such exterior enclosure systems with other building systems. Two matrices provide a summary of the many interactions involved and show how all of the issues relate to each other. One table shows the many issues and interactions to be integrated just within the exterior enclosure. The second table shows the issues and interactions to be integrated between the exterior enclosure and the other building systems. The bulk of the annex contains a listing of the identified integration issues.

This annex is by no means complete. The project committee considers this current version as just a first draft to be expanded and refined over time. Also, while this material is being presented here in hard copy format, the project committee thinks that the best form of presentation of this material will be within interactive, object-oriented software that will allow all linkages among the issues to be more easily accessed than is possible in the current hard copy version.

Annex U: Testing Procedures

Annex U provides information about three types of testing of building exterior enclosures, with a sub-annex for each type of testing: (1) Laboratory testing and mock-ups; (2) Field testing and mock-ups, and (3) Testing and Evaluation Using Design Information. This annex focuses on field-testing because such field-testing is an important but seriously under-used tool for producing higher quality building exterior envelopes.

Laboratory Testing: The sub-annex for laboratory testing and mock-ups contains a case study test from a project of a project committee member. A photograph from one of the tests is shown below.

Field Testing and Mock-ups: This sub-annex contains 5 parts including

- (a). Example Field Testing Case Study.
- (b). Recommended Practice for Incremental Inspection and Field Air and Water Testing
- (c). Example Doors & Windows Functional Test for a recent project
- (d). Example Mock up Window Functional Test for a recent project
- (e). Example Windows & Grills Test Procedure for a recent project

All of these examples are derived from recent project experience and expertise of members of the project committee. The two figures on the following page are examples from the Field Testing Case Study.



Figure U-1. Lab mockup during ASTM E283 air infiltration test

Resources for Testing: This sub-annex contains 3 parts including

- (a). Reference Standards for Field Testing
- (b). Technical information Resources
- (c). Testing Resources by Wall Assembly



Figure 10 ASTM D 4541 adhesion pull testing



Figure 11 ASTM E 783 test with exterior chamber, testing a window and its perimeter window-to-wall joint

Annex Y: Constant Commissioning

Annex Y provides an overview discussion of issues and approaches to establishing and conducting a constant commissioning program for a building or set of buildings.

Annex Z: Example Calculation Procedures and Tools

Annex Z provides a 4-page list of available information and examples of calculation procedures and tools to assist the exterior enclosure commissioning process. Many of the citations include links of online access to the tools and information.

Summary

As part of NIBS overall Total Building Commissioning program, GL-3 now joins GL-0 and GL-1 in providing a consistent approach to the overall commissioning process plus technical requirements for two key building systems.

Building owners and organizations should use these commissioning guidelines (0, 1, 3, and others to follow) for their general guidance about both process and technical issues, for the use of

these guidelines should improve building quality and performance and improve the cost-effectiveness of delivering and operating buildings.

GL-3 is a 1st-generation document. The project committee that developed the document invites you feedback and input as you review and use the document. Hopefully, the next generation of this document will refine and improve on the current guidance offered and will also expand upon the technical examples and case studies provided in the annexes.

Meanwhile, the GL-3 project committee is planning to develop additional annex materials and supplements to the current document. Current plans include development of:

- An annex on training related to commissioning of the exterior enclosure
- A supplement on commissioning of daylighting systems, which require a high degree of system integration and cross-discipline communication.
- A supplement on commissioning the exterior enclosures of smaller buildings.

Your input, feedback, support, examples and case studies are most welcome toward accomplishing these and related activities.