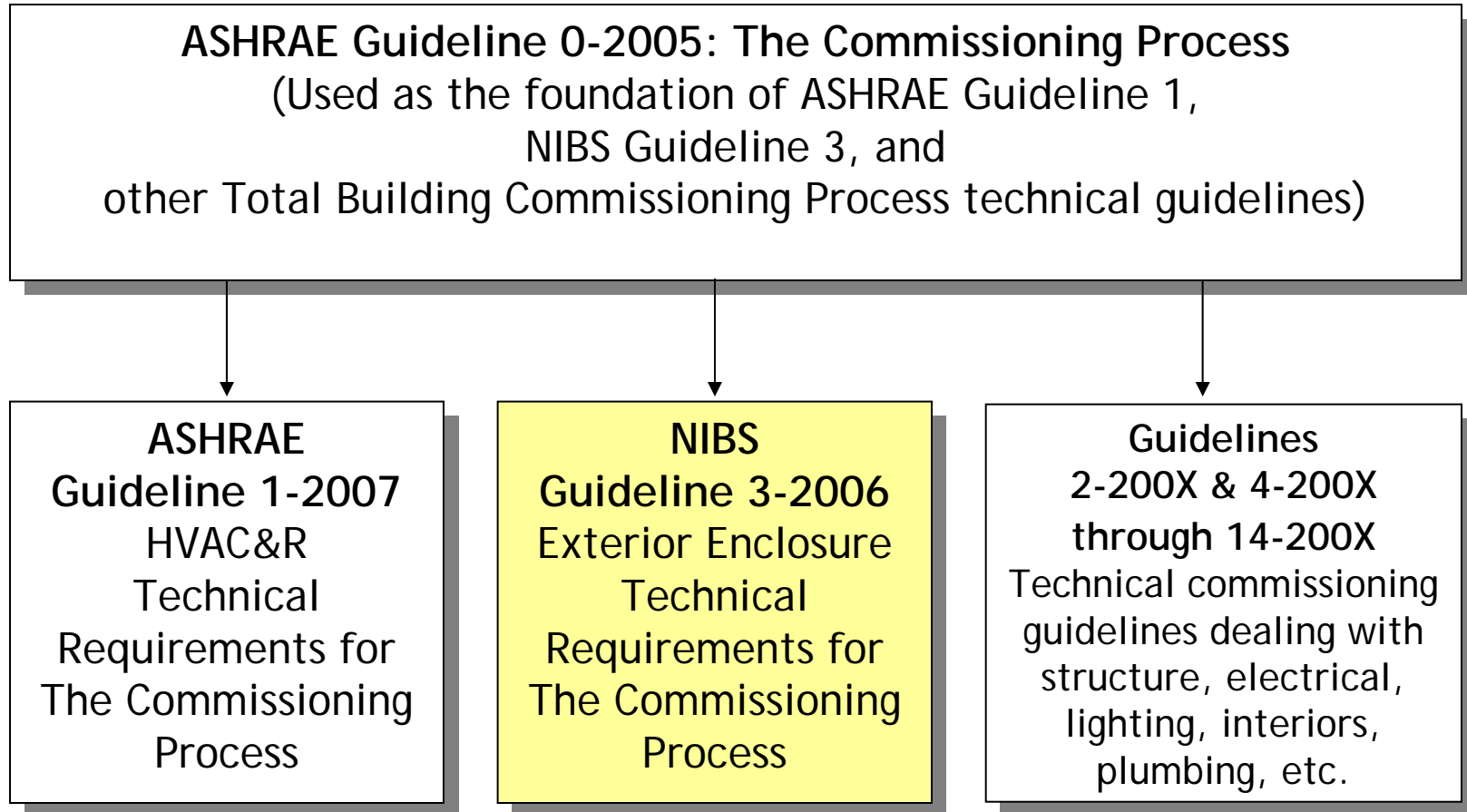


NIBS Guideline 3-2006

Exterior Enclosure Technical Requirements For the Commissioning Process

by Joseph J. Deringer AIA LEED AP
The Deringer Group Inc Berkeley CA
White Box Technologies Berkeley, Boulder, Butte, & Galveston

TOTAL BUILDING COMMISSIONING PROCESS



AUTHORS of this paper

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*

PROJECT COMMITTEE for NIBS GL 3-2006

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Don Acker

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Andrew Persily

Nik Vigener

Paul Totten

Paul Tseng

Thomas Smith

Richard Walker

Mohammed Ettouney *Liaison, ASCE*

Charles E. Dorgan *Liaison, NIBS/
ASHRAE GL0, GL1*

Dagmar Epstein/Larry Ross
Liaison, BCA

STATUS

- Public Review and Approved in 2006

STRUCTURE

- Table of Contents
 - Foreword
 - 1. Purpose
 - 2. Scope
 - 3. Utilization
 - 4. Definitions
 - 5. Pre-Design Phase
 - 6. Design Phase
 - 7. Construction Phase
 - 8. Occupancy and Operations Phase
 - Annexes



ANNEXES: *Focus on Exterior Enclosure*

- B - Commissioning Process Flowchart
- C - Costs and Benefits
- D - Documentation and Responsibilities
- F - Roles and Responsibilities - Cx Team Members
- J - Owner's Project Requirements
- K - Basis of Design
- L - Specifications
- M - Construction Checklists
- O - Systems Manual
- R - Integration Requirements
- S - Interference and Coordination with other Systems
- U - Exterior Enclosure Testing Procedures
- Z - List of Example Calculation Procedures and Tools

Annexes A, E, G, H, I, N, P, T, V, W, X, Y are not used, see GL0

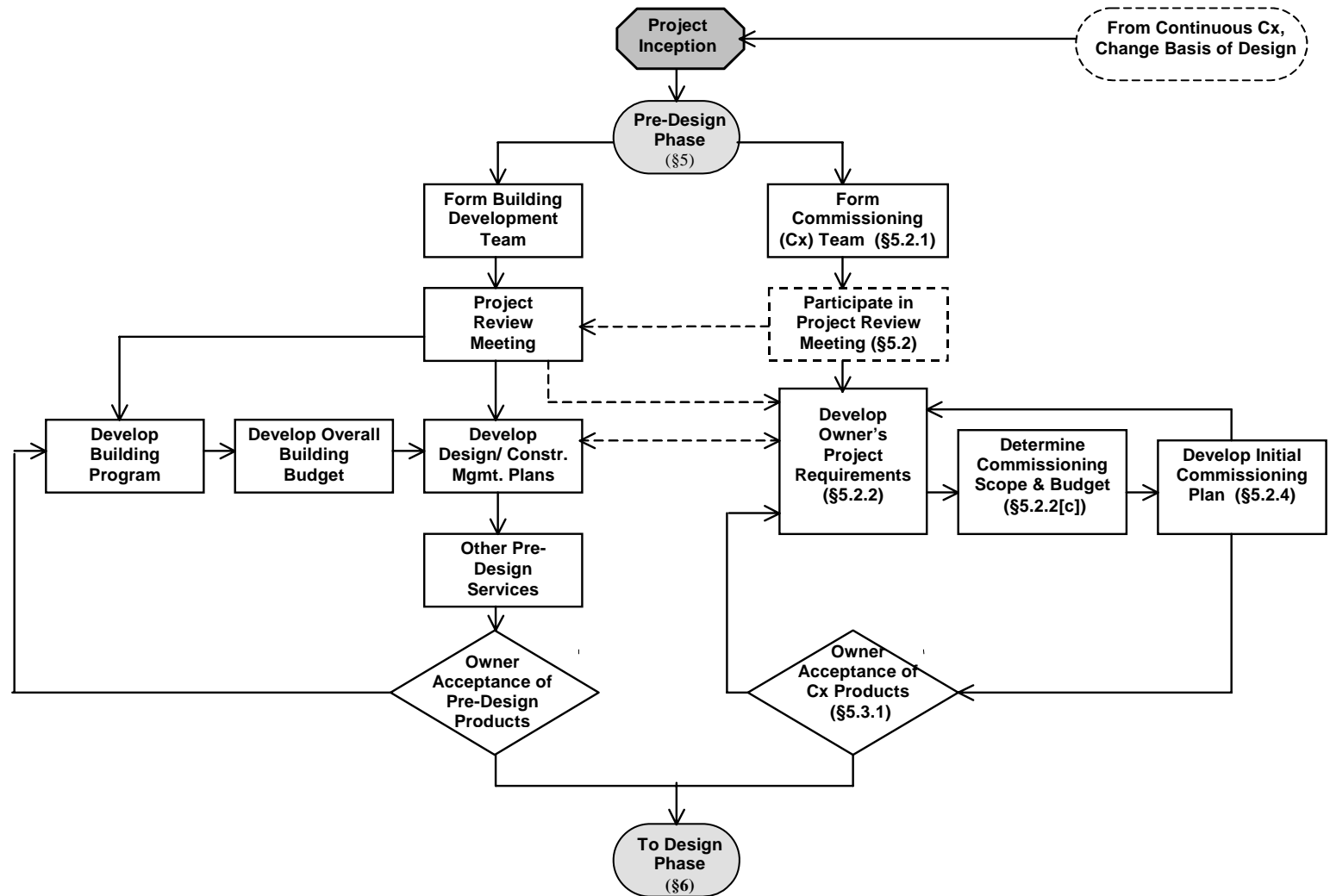
ANNEX B - REFINEMENT TO GL-0 APPROACH

- Expands on GL0 flow diagram
 - Building Development Process on Left
 - Commissioning (Cx) process on right
 - Each element of Cx process tagged to a section in text of GL3-2006.
-
- Examples follow

ANNEX B - PREDESIGN *(1 of 5 pages)*

Building Development Process

Commissioning Process



ANNEX C – COSTS (for Cx EE)

- General Estimate of Cx Costs for Exterior Enclosures
 - Estimates provided are being checked now
- Recommended Structure for estimating Cx EE Costs
 - OPR
 - BOD
 - Design Review
 - Construction Checklist Creation
 - Site Visits
 - Testing
 - Documentation
 - Total
- Objective - develop general cost estimates by building siz

ANNEX F -ROLES & RESPONSIBILITIES

Phase &
GL-3
Section
number Document

Phase & GL-3 Section number	Document	Owner	CxA	Design Team						ExEncl	Contractors				Specialists					Bldg Ops		Notes					
		Owner, or Owner's Representative	Commissioning Authority	Architect	Structural Engineer	Mechanical Engineer	Electrical Design Engineer	Lighting Design professional	Interior Systems Design Prof.	Exterior Enclosure Consultant	Ext. Enclosure Manufacturers	Construction Manager	General contractor	Exterior Enclosure Contractors	Testing contractor	Electrical Contractor	Indoor Air Quality Specialist	Acoustic specialist	Vibration specialist	Moisture/mildew specialist	Measurement/verification specialist		Information technology specialist	Physical security specialist	Blast (and Chem-bio) Security	Facilities management	Facilities engineer (O&M)
Pre-Design																											
5.2.2	Owner's Project Requirements	A	R	I	I	I	I	I	I	I	P													I	I	I	Design Team not hired yet?
5.2.3	Allocation	P/A	U	U	U	U	U	U	U		P													I	I		Design Team not hired yet?
5.2.4	Commissioning Plan	A	P	I	I	I	I	I																I	I	I	Design Team not hired yet?
5.2.4.4	Issues Log & Report	R	P	U	U	U	U	U		I	U	U	U	U										I	I		Design Team not hired yet?
5.3.1	Acceptance & Commissioning Process Report	R	P	U	U	U	U	U		U	U	U	U	U										U	U		Close of Phase report
Design																											
6.1.1	Owner's Project Requirements (OPR) Update	A	P	I	I	I	I	I		I	I					I								I	I	I	
6.1.1.1	OPR - Schematic Design Phase	A	P	I	I	I	I	I		I	I					I	I	I	I	I	I	I	I	I	I	I	
6.1.1.2	OPR - Design Development Phase	A	P	I	I	I	I	I		I	I					I								I	I	I	
6.1.1.3	Phase	A	P	I	I	I	I	I		I	I					I								I	I	I	
6.2.2	Basis of Design	A	R	P	I	I	I	I		I						I								I	I	I	
6.2.2.1	BOD - Schematic Design Phase	A	R	P	I	I	I	I		I						I	I	I	I	I	I	I	I	I	I	I	
6.2.2.2	BOD - Design Development Phase	A	R	P	I	I	I	I		I						I								I	I	I	
6.2.2.3	BOD - Construction Document	A	R	P	I	I	I	I		I						I								I	I	I	
6.2.3	Commissioning Plan - Update	R	P	U						U	U	U												I	I		
6.2.4	Construction Specifications for Commissioning	R	P	U						I	I	R												I	I		May also be provided by Owner's Rep
6.2.4	Construction Checklists	R	A	R						R	I	R												I	I		Contractor may not be hired yet
6.2.5	Systems Manual Outline -	A	P	I	I	I	I	I		I		R												U	U		Contractor may not be hired yet
6.2.6	Specifications	A	R							I		R				I								I	I		
6.2.7	Commissioning -Focused Design Reviews	A	P	U	U	U	U	U		I		U				I								I	I	I	
	Issues Log & Report	A	P	U	U	U	U	U		I		U				I								I	I		
6.3, 6.4	Acceptance & Commissioning Process Report	A	P	U	U	U	U	U		I		I				I								I	I	I	Close of Phase report

Key	
P	Provided by
A	Approved by
R	Reviewed by
R/A	Reviewed/Approved by
I	Input from
U	Used by

ANNEX J - OWNER'S PROJECT REQUIREMENTS (OPR)

- Commentary
- Example Checklist for an OPR (*example below*)
- Example OPR from a project

ANNEX GL3 - J: Exterior Enclosure Checklist for Owner's Project Requirements (OPR)

1. Building Objectives	List the objectives that are unique to exterior enclosure and that expand upon the objectives and goals described in the Whole Building Commissioning.
2. Site Description and Requirements	List criteria that have a major influence on the Architectural development of the building design. Coordinate with Site/Civil.
2.1. Neighborhood / Context	Describe the influence of the project site, neighborhood and context on the building design.
2.2. Existing Buildings	Describe existing buildings and their influence on the design.
2.3. Master Plan	Describe existing or in progress master planning issues which affect the design
2.4. Circulation / Access	Describe the opportunities and constraints imposed by circulation issues and required access. Major Building Access: Secondary Building Access:

ANNEX K – BASIS OF DESIGN

- Commentary
- Example Checklist for BOD (*example below*)
- Example BOD from a project

1. Exterior Envelope Thermal Performance

Describe compliance with criteria for the thermal performance of the exterior envelope.

1.1.1

Describe the method of analysis used.

1.1.2

Coordinate this section carefully with the Mechanical Engineers and with other paragraphs below describing the exterior systems.

1.1. *Alternate Compliance*

Describe alternate analysis methodology if used, to verify compliance.

1.1.1. Envelope Method

1.1.2. Total Building Method

ANNEX L - SPECIFICATIONS

- Likely Specification Sections with Cx EE specs
- Cx EE MasterSpec Section
- Several examples from projects

ANNEX M – CONSTRUCTION CHECKLISTS

- 12 example checklists

A.M. Blank Family Offices Page 1
 SEC&H - 20139 Building Envelop – Prefunctional Checklist

Prefunctional Checklist
BUILDING ENVELOP SYSTEM

Components included: ___ unit masonry, ___ limestone veneer, ___ cast stone, ___ sheet metal flashing & trim, ___ roof, ___ joint sealants, ___ wood windows/doors

1. Submittal / Approvals

Submittal: The above components and systems integral to them are complete and ready for functional testing. The checklist items are complete and have been checked off only by parties having direct knowledge of the event, as marked below, respective to each responsible contractor. This prefunctional checklist is submitted for approval, subject to an attached list of outstanding items yet to be completed. A Statement of Correction will be submitted upon completion of any outstanding areas. None of the outstanding items preclude safe and reliable functional tests being performed. ___ List attached.


Sealant Contractor	Date	Glazing Contractor	Date
Ext. Limestone Veneer Contractor	Date	Sheet Metal Contractor	Date
Masonry/Cast Stone Contractor	Date	Steel Fabricator	Date
General Contractor	Date	Roof Contractor	Date

Prefunctional checklist items are to be completed as part of installation & initial checkout, preparatory to functional testing.

- This checklist does not take the place of the manufacturer's recommended checkout and installation procedures or reporting requirements.
- Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).
- Contractors' assigned responsibility for sections of the checklist shall be responsible to see that checklist items by their subcontractors are completed and checked off.
- "Contr." column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item. A/E = architect/engineer, All = all contractors, CA = commissioning agent, GC = general contractor, LVC = limestone veneer/sheet metal contractor, SC = sealant contractor, GLC = glazing contractor, UMC = masonry/cast stone/sheet metal contractor, RC = roof contractor, SMC = sheet metal contractor

Approvals: This filled-out checklist has been reviewed. Its completion is approved with the exceptions noted below.

Commissioning Agent	Date	Owner's Representative	Date
---------------------	------	------------------------	------

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ANNEX O - SYSTEMS MANUAL

- Outline of Structure of an Example Systems Manual
- Example Sections

ANNEX R – INTEGRATION REQUIREMENTS

2nd – Between EE and Other Building Systems

		Issues & Opportunities											
Material/System Type or Criteria D = Direct Interrelationship P = Possible Interrelationship		Exterior Enclosure	Daylighting Integration Across Systems	Interiors	Ventilation	Value	Control System/ Building Automation	Fire Protection	Structural	Acoustical	HVAC	Electrical	Energy Savings
		II Air flow Control											
II.a	Air Barrier	EX-5		I.3	V2				S6,7		H.3		
II.c	Natural Ventilation	EX-7		I.5	V4		C2,4		S.8			EI.13	En.4
II.b	Biological/Chemical Isolation	EX-6		I.4	V3				S.2		H.4		
III Water Vapor Flow Control													
III.a	Vapor Retarder	EX-8,9		I.3					S7,9		H.5		
III.b	Self-Drying Assemblies	EX-10							S10		H.5		
IV Rain Penetration/Water Control													
IV.a	Drainable/Rain Screen Systems	Ex.11-13							S11		H.6		
IV.b	Thin Barrier Systems	Ex.13-14		I.6					S12				
IV.c	Massive Barrier Systems	Ex.15,16	D.3						S.10,13		H1,7	E.2	En.5,6
IV.d	Double Facades	Ex.17	D.5		V5		C.3		S.14		H1,2,6,8		En.7
IV.e	High Below-grade Watertable	Ex.18,18a		I.7					S15,16		H.9	EI.3, EI.4	
I Heat Flow Control													
I.a	Increased enclosure insulation	EX-1	D.2								H1-2	EI.1	En.1,5
I.b	Thermal Mass	EX-4	D.1	I.1	V1				S3,4		H1,2	EI.1	En.1
I.c	Structure Outside of Thermal	EX-3		I.2				F.1	S1, 5, 23				En.2
I.d	Reflective Solar Barrier	EX-2									H1,2	EI.1	En.3
V Light, Solar and other Radiation													
V.a	Daylighting	Ex19,20	D.1	I.8,9,10			C.1		S17,18		H.5,10,11	EI.5	En.8
V.b	Shading	Ex.21		I.11			C.4		S.18		H.12	EI.5,13	
V.c	Glare Control	Ex.22											
V.d	Photovoltaic Generation	Ex.23										EI.6, EI.7	
V.e	Radio Frequency/Electromag-netic	Ex24,25									H13,14		
V.f	Green Roof	Ex26,27							S.19		H1,2	EI.1	
VI Noise and Vibration Control													
VI.a	Acoustic Isolation	Ex28-30							S.3		H15,16	EI.8	
VI.b	Vibration Control	Ex28-29							S20,21		H15,16	EI.8	
VII Fire Control													
VII.a	Passive Fire Protection	Ex31-32							S.22		H.19		
VII.b	Active Fire Protection			I.12				F.2			H.19	EI.9	
VII.d	Catastrophic Fire Protection	Ex31-33						F.3	S.24		H.18,19	EI.10	
IX Structural Performance													
IX.a	Seismic Resistance	Ex.34							S.30				
IX.a	Seismic Resistance	Ex.34							S.30				
IX.b	Blast Resistance	Ex 35-37							S25-27		H20,21	EI10,11	
IX.c	Forced Entry Resistance	Ex39-41							S.3,27		H20,22	EI.10,11.	
IX.d	Hurricane/High Wind Loads	Ex42-44							S.28		H.23..	EI.10,12.	
IX.e	Stiffness of Structure												
IX.f	High-Rise Buildings												
IX.g	Geotechnical Bearing Capacity												
X Durability													
X.a	Extended Life Span	Ex.45							S.29				
X.b	High Reliability										H.10,18		
X.c	Microbial Growth Resistance												

ANNEX R – INTEGRATION REQUIREMENTS

3rd – Lists of Issues and Actions

R.1 Air Flow Control

R.1.1 Air Barriers

AB.1 Air Barrier: Air barriers are an extremely important component in the control of the separation of the internal and external air masses, with resulting impacts on durability, indoor air quality, and energy consumption. Air barrier detailing must be complete around the full perimeter of exterior enclosure and across all systems.

The Commissioning Authority should verify the following:

- o Design Phase: Design Phase: The Design Team has selected systems with appropriate air barriers and permeance for each component of the enclosure, and has detailed continuity of air barrier across joints between the air barriers.
- o Construction Phase: Test air leakage through exterior systems.

AB.2] Air Barrier Penetrations: Numerous penetrations are likely through the air barrier, including MEP systems, anchorage devices for cladding, or electrical outlets and other penetrations of interior faces of exterior walls.

The Commissioning Authority should verify the following:

- o Design Phase: That the Design Team has reviewed the extent of penetrations and provided detailing, including:
 - Sleeves with integral flanges at mechanical penetrations,
 - Means of sealing at electrical conduit and plumbing piping penetrations.

In addition, That the Design Team has evaluated the type of anchorage and substrate to which the anchors are being installed to or through to determine likelihood for future voids to be created in the air barrier due to future actions of the wall, such as movement due to thermal cycling.

- o Construction Phase: Verify that sealing of penetrations are properly installed. Periodically inspect penetrations for proper sealing and integration with the air barrier.

ANNEX U – TESTING PROCEDURES

U1: Laboratory Testing

- U.1a: Example Laboratory Testing of Assemblies and Mock-ups Case Study

U2: Field Testing

- U.2a: Example Field Testing Case Study
- U.2b: Recommended Practice for Incremental Inspection and Field Air and Water Testing
- U.2c: Example Doors & Windows Functional Test for a recent project
- U.2d: Example Mock up Window Functional Test for a recent project
- U.2e: Example Windows & Grills Test Procedure for a recent project

U.3: Resources for Testing

- U.3a: Reference Standards for Field Testing
- U.3b: Technical information Resources
- U.3c: Testing Resources by Wall Assembly

ANNEX U - LAB TESTING CASE STUDY



Figure 1. Lab mockup during ASTM E283 air infiltration test

ANNEX U - LAB TESTING CASE STUDY



Figure 2 Dynamic Water test

ANNEX U - LAB TESTING CASE STUDY



Figure 3. Strain gauges for measuring inter-story drift

ANNEX U - FIELD TESTING CASE STUDY



A chamber is created using polyethylene and a simple wood frame (Figure 2), a smoke device is released, or generated using theatrical foggers, while air from a fan depressurizes or pressurizes depending on the configuration.

ANNEX U - TESTING PROCEDURES

Sub-Annex Ub2: Recommended Practice for Incremental Field Air and Water Testing

Ub2-1 Recommended Practice for the Incremental Inspection and Field Air and Water Testing of Exterior Enclosure Elements

Ub2-1.1 **Incremental field air and water inspection and testing of subassemblies.** The incremental field air and water testing of subassemblies of all building exterior enclosure elements should be a standardized practice on projects of all sizes. The "Incremental" concept signifies testing of critical air and water management enclosure components, such as air barriers, window and door air and water seals, flashings, etc. while those components are still visible and before those components are buried or covered up by other construction in a completed assembly, so that repairs can be done effectively and inexpensively.

Ub2-1.1.1 During team selection, a criterion in the owner's selection of the architect should include the architect's track record in specifying the incremental and final field water testing of the full range of exterior enclosure elements. Likewise, a criterion in the owner's selection of the General Contractor or Construction Manager should include their track record in designing and successfully carrying out incremental field water testing of all building exterior enclosure elements.

Ub2-1.1.2 During design, Owners should be informed that water leakage can be a source of significant problems downstream, and that incremental field water testing is a practical, low-tech, and low cost means of identifying and avoiding such leaks. Owners should be made aware that eliminating such testing as a result of value engineering or other cost cutting measures during construction could result in significant costs and potential health hazards later during building operations. Air leakage can result in condensation, mold, rust, decay, indoor air quality problems, premature failure of enclosure assemblies, and is a major source of energy loss.

Ub2-1.1.3 Construction documents for the building exterior enclosure should include specific provisions for planning and accomplishing the incremental field water testing being recommended in Section U.2.1 of this Annex.

Ub2-1.1.4 The scope of air barrier and building assembly testing for air leakage and air barrier continuity should be discussed with the Owner, and included in the specifications. A list of such inspections and testing is included herein.

Coordination is required between subcontractors to provide continuity of an air barrier system and achieve an airtight building enclosure; the interconnections between materials and assemblies of materials and the penetrations should be a focus. Determining who is responsible for the interface joint between the different air barrier system assemblies, where one trade stops and the other starts, and the trade responsible for the joint between the two is vital. Determining who is responsible for sealing penetrations should be established. Sequencing construction operations so that the joints are accessible and constructible is an important milestone discussion in a commissioning process.

Ub2-1.1.5 Each manufacturer should provide specific instructions for the incremental field water testing of subassemblies within the installation instructions for its exterior enclosure products.

ANNEX U - FIELD TESTING CASE STUDY



Chamber depressurization using detection liquids utilizes a device nicknamed the “bubble gun” (Figure 3). A bubble solution is spread on the suspected penetration or joint, such as a brick tie fastened to a wall. The plastic dome of the device is placed over the area and depressurized to 500 Pa (2.0” w.g.). Bubbles form if there is an air leak.

ANNEX Z - Tools and Resources

- Lists of resources and tools available for Cx EE



NEXT STEPS for Cx EE

- Continued work of Cx EE Project Committee
- Supplement on Daylighting
- Supplement on Cx EE for Small Buildings
- Expand all Annexes
- Refine process for Design-Build situations
- Add Annex on Training for Cx EE
- Better integration with GL-0 (online?)

THANK YOU!

ANY QUESTIONS?

Prepared by: Joseph Deringer, AIA, LEED AP
jjd@deringergroup.com
jderinger@whiteboxtechnologies.com