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AIR BARRIER EDUCATION TRACKS FOR THE CONSTRUCTION INDUSTRY

# **Commissioning the Air Barrier**

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Gale Associates, Inc.



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# What is Building Enclosure Commissioning?



"The process by which the design and constructed performance of building enclosure materials, components assemblies and systems are validated to meet defined objectives and requirements of the project, as established by the Owner."

### **NIBS Guideline 3-2012**









- Owner's Project Requirements
- Basis of Design





- Control heat, air and vapor flow
- Control water penetration
- Control light and solar radiation





#### • Monitor and Inspect Construction





#### • Test and Verify Installed Assemblies



# **Timeline of Recent Standards Development**











# **Proposed ASTM E2813**

Identifies mandatory tests for commissioning projects

Identifies mandatory tests for commissioning projects

- Fundamental
- Enhanced

air barrier **abaa** association of Note that lab testing is not required but may be beneficial based upon project and wall component types

### **Proposed ASTM E2813**

Property	Standard Designation	Title	Lab System Testing <sup>62</sup>	Fundamental		Enhanced	
				Field Mockup Testing <sup>4</sup>	In-Situ Field Testing	Field Mockup Testing <sup>4</sup>	In-Situ Field Testing
Air Infiltration				10 11	*	1×	30.
Air leakage	ASTM E283	Test Method for Determining the Rate of Air Leak- age Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen	ML		о 2010	57623	IN
	ASTM <mark>E77</mark> 9	Test Method for Determining Air Leakage Rate by Fan Pressurization		000	OF	37823	MF (1X) <sup>63</sup>
	ASTM E1827	Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door	2227	222	OF	6115	MF (1X) <sup>63</sup>
	ASTM E783° Opaque Walls	Test Method for Field Measurement of Air Leak- age Through Installed Exterior Windows and Doors		MF (1X)	MF (1X)	MF (1X)	MF (1X)
	ASTM E1186	Standard Practices for Air Leakage Site Detection DMT3 [DA4] in Building Envelopes and Air Barrier Systems.			I	<u>MF</u> (1X)	<u>ME</u> (1X)
	ASTM E783 <sup>8</sup> Windows	Test Method for Field Measurement of Air Leak- age Through Installed Exterior Windows and Doors		MF (1X)	MF (1X)	MF (1X)	MF (2X)
Thermal Derform	ance and Conde	neation Resistance	15	ļ		货	*
Condensation resistance	AAMA 1503	Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors, and Glazed Wall Sections	OLC	OF	OF	OF	OF
Insulation	ASTM C1153	Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging			MF (1X) <sup>E</sup>	(2000)	MF (1X) <sup>E</sup>
Temperature index calculation/test	AAMA 501.5	Test Method for Thermal Cycling of Exterior Walls	OL			27822	87775

Water Penetration

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# **Proposed ASTM E2813**

Water penetra- tion	ASTM E331	Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference	ML				
	ASTM D5957 <sup>₽</sup>	Guide for Flood Testing Horizontal Waterproofing Installations		OF	MF (All horizontal surfaces)	OF	MF (All horizontal surfaces)
Static water penetration	ASTM E1105	Test Method for Field Determination of Water Pen- etration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference		MF (1X)	MF (1X)	MF (1X)	MF (2X)
Dynamic water penetration	AAMA 501.1	Standard Test Method for Water Penetration of Windows, Curtain Walls, and Doors Using Dy- namic Pressure	OL	OF	OF	OF	MF (1X)
Nozzle Testing	AAMA 501.2	Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems	101	MF (3X)	MF (3X)	MF (5X)	MF (5X)
Durability							
Sealant durability <sup>3</sup>	ASTM C1193, Appendix X1-Method A	Guide for Use of Joint Sealants: Field-Applied Sealant Joint Hand Pull Tab		MF (1X)	MF (1X)	MF (1X)	MF (3X)
Structural Perform	nance		10 1021. 10				
Envelope de- flection due to wind loading	ASTM E330	Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference	ML		-26 22-		
Inter-story drift	AAMA501.4	Recommended Static Test Method for Evaluating	OL				

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### **Mandatory BECx Tests**

Air and Water Infiltration Testing of Opaque Walls

#### **Infrared Roof Scan**

Air and Water Infiltration Testing of Windows (Chamber)

Flood Testing of Horizontal Waterproofing

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Sealant Inspection Testing

### **Mandatory Enhanced BECx Tests**

Whole Building Air Test

**Dynamic Fan Testing** 

air barrier **abaa** association of america Air Barrier Leak Testing

# Why Building Enclosure Commissioning?



# Air Leakage Accounts For:

- 40% of a building's energy consumption (DOE)
- 43% of heat loss (NIST)
- 26% of cooling loss (NIST)





# **LEED Version 4:**

- BECx 2 points
- References ASHRAE Guidelines 0, 1.1 and NIBS Guideline 3
- Tasks: all fundamental tasks, plus (partial list):
  - Review contractor submittals
  - Review building operations 10 months after substantial completions
  - Develop an ongoing



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# **State and Municipal Requirements**



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# Building Enclosure Commissioning Helps to Avoid Common Problems in Building Construction

Water intrusion	Air infiltration (energy loss and occupant discomfort)
Indoor air quality issues	Improves balancing of HVAC equipment
Mold growth	

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# **Key Causes of Enclosure Failure**





20<sup>th</sup> Century Building Enclosures:

- Simple building materials
- Limited layers
- Trained workforce





- Complex, new building materials
- Multiple layers/configurations
- Limited designer/contractor experience



# Reliance on a single water barrier (i.e. sealants)



### New untested building materials



# **Complex geometries**



## **Repetitiveness of problem details**



## **Repetitiveness of problem details**



# Lack of technical understanding of moisture intrusion mechanisms





#### eQUEST 3.64.7130

Monthly Evergy Consumption by Enduse

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# Lack of modeling / review / testing / startup

Close



# Lack of coordinated details between construction trades



# Workmanship
### The Building Enclosure Commissioning Process



### **Pre-Design Phase Services**

Assist in creation of Owner's Basis of Design

Review prime architect's early schematic designs

Identify options for enclosure systems

The Jackson Laboratory for Genomic Medicine Basis of Design Document -- Schematic Design Phase

May 4, 2012

Option 3: Same as Option 2, use 2" insulated composite horizontal backup panels in lieu of cavity wall insulation, sheet or fluid-applied sinvaportmoisture barrier, and exterior sheathing. Provide fastaners, anchors, clips as required.

Other components include: cavity drainage inserts, wenp vents, stativiess steel drip edge tashing, misoelianeous steel framing to secure stone to building structure; pre-pelinated copper window return trim at punch openings and ribbon windows.

At some grade locations veneer assembly will have 6° concrete masonry unit back-up or reinforced concrete depending upon the structural requirements. Provide dovetail anchors at reinforced concrete. Dampproofing required at all stone below grade.

Stone Products:

NEED

2"

INSUL.

W/NOT

PRIVIDE

1=0.069

(R15.625)

Adatr Limestone, Artiscraft International (Besis of Design) Split faced veined Sepie color striated pattern Blue-Gray color striated pattern Other products to be reviewed

Wall Assembly Type 2 - Metal Wall Panels Thermal resistance: maximum U Factor =0.084 (R = 15-625)

Flat lock seam metal wall panels, 16 oz. pro-petinated Nontic Graen Iving finish. (ASTM B 882) copper sheet. 20 oz. clips and cleats, slip sheet, sheet or fuidapplied atriveportmoisture barrier, 5/8° exterior grade plywood sheathing. 2° Goody wall installion; all secured to stud system Steel studs, structural gauge as

Optional Wall assembly allemative. Provide 1" pavity wall institution and Spray Polyeurathane Foam insulatori within stud cavity.

Other components include: Self-tapping screws, bots, nuts, self-tocking rivets and bots, and-welded studs, and other suitable fasteners designed to withstand design loads; sheet metal flashing; bituminous costing Provide 8' high granito base at grade where metal panels are used.

Panel Product options: Canadian Brass and Copper Company - Aurubis Architectural – Nordic Green Pre-patinsted copper (Nordic Green Iiving 1 and 2)

PSJackson\_Label/2007-0091\_Design#101\_ProjScop#fam9basis of Design/2012 0504 JAX 8001 - Schematic Design/doc 5/7 The Jackson Laboratory for Genomic Medicine Basis of Design Document - Schematic Design Phase

Dolyvethane

May 4, 2012

Spray Polyethylene Foam: closed cell colyethylene foam insulation, minimum density of 1.5 tb/cu. Ft., thermal resistivity of 6.2 dag F x h x sq. fVBTU x in. Provide ignition and thermal barriers to satisfy building code requirements.

Insulation Product: Web The, BASF Corporation Instruct DC-SB DOES NOT MOET Other approved equal DATA SUPPLIED ABOVE

Sprayed-Feam Insulation at Gaps; water-cure closed cell polyurethene containing no urea-formaldehyde and no CPCS.

Insulation Product: Pur Fil 1G, Todol Products Other approved equal

Curtain wall insulation and perimeter fire containment: Provide spandrel panel perimeter angles, stiffener tess, mineral wool batts insulation, and safing system, and till material to comply will UL Design number CW-D-2042

### Exterior Walls

Exterior wall assembly types are to be as described in the paragraphs below. For estimating purposes, percent of total well area has been indicated in the descriptiona below. Wall assemblies to include all necessary wall opening supplementary components including: lintels, joint sealants, feathing, and sits.

Wall Assembly Type 1 - Stone Veneer Wall Assembly Thermal resistance: maximum U Factor =0.064 R = 15.625

Option 1: Dimension stone panels set with individual anchors (vertical or horizontal orientation): 2'-3' stone panels and trim, 1' air space, cavity wall insulation, sheet or fluid, applied air/vaporhnoisture barrier, 5/8' sectors sheathing, and cold-formed metal study with 5/8' gypourn interior face. Stud back up and anchors to be engineered and coordinated with stone veneer.

Option 2: Anchored stone masonry to cold-formed metal framing and sheathing: 4" stone manorry, 2" air space, cavity wait insulation, sheat or fluid-applied air/vapor/moisture barrier, 58" exterior sheathing, and cold-formed metal stude with 58" gyssum intarior face.

Prüschen judni 2006-0014, Designi VOT, ProjEcopellant Basis of Casign 2012 0004 AX SOD - Schemalis Design Acc 56

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### Wall System Peer Review (BOD)

W.U.F.1

Chick

required

determine

interior

2 + 1 c.1

maximum

insulation

nickness





### Wall System Peer Review (BOD)

### **Design Phase Services**

Develop Commissioning Specifications

Peer Review DDs and CDS

Testing Matrix and Commissioning Plan

Standardize approach to design development

## **Design Requirements**

Combinations of building enclosure components are numerous Design specifications must be clear and coordinated with drawings

Building enclosures must perform as a system with all joints, junctures, and penetrations detailed

All components must work in conjunction with adjoining assemblies

### **Importance of Design Phase Review**





	ENG	NEERING	REVIEW COMMENTS		1 DA Ap	ril 24, 2005
2. X DESIGI		CRITERIA WSMC	☐ JSC ☐ % REVIEW		MSFC SGS-DE	(vmbol)
3. PROJECT: #814 The New Institute of 100 Northern Ave.,	500 f Contemporary Art Boston, MA 02210		4. SECTION ARCHITECTURAL- BUILDING ENVELOPE	5. ENGINEER JPB, EJS	(onice o	ymour
<sup>5.</sup> ITEM <sup>7.</sup> NUMBER	DRAWING OR PARAGRAPH NUMBER	8.	COMMENTS		9.	ACTION BY REVIEW CONFERENCE
			DRAWINGS			
	General	mechanic roof syst installatio for install Please n Contracto directly to of the Mechanic DensDec recomme construct the syste Gale note required I roof syste FM-150 a the use o	cally attached insulation has been speci tem. While coverboard has been speci lation between the membrane and the ote that neither Gale nor NRCA (Nation ors Association) recommends adhe o polyisocyanurate insulation due to co insulation and subsequent loss of cal attachment of the coverboard (su k specified) on top of the insulation inded for protection of the insulation, for proper performance over the se m, and for higher wind uplift resistance. The this coastal location will be require approved system. The manufacturer ma of a coverboard to meet this wind uplift resistance.	fied for the becified for d or shown insulation. hal Roofing ering PVC compression adhesion. ich as the sulation is ion during rivice life of re "As s that the d to be an y require esistance.		

### **Typical Review Table**



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### **Design Considerations**



### **Design Considerations**



### **Constructability Concerns**



### **Level of Detail**



**Level of Detail** 

# **Procurement Phase Services**

Attend a Pre-Bid Conference to review the BECx specification with prospective bidders

Assist with the development of addenda

Review and assist with the evaluation of enclosure related bidder RFIs Review and assist with the evaluation of enclosure related subcontractor bids

# **BE Sub-Bid Evaluations**

Scheduling, Phasing, and Coordination of Trades Quality Assurance (QA) and Quality Control (QC) Programs

Qualifications and Exclusions

Substitutions and "Value Engineering" Options

# **Pre-Construction Phase Services**

**Review Shop Drawings** and Submittals Mock-Up Review and Testing

Conduct Enclosure coordination meetings Update Testing Matrix and Commissioning Plan

Implementation of the BECx Plan

Review Construction Sequencing and Scheduling

# **BE Component Coordination Meeting**

Members include architect, owner, BECxA, CM/GC, and sub trades

### **Review "by others"**

Review and coordinate shop drawing details at which various enclosure components interface

Review construction sequencing and scheduling







# **Shop Drawing Review**



Bridgewater State College	Curtainwall	Curtainwall Shop Drawings BHN/JPB		
Aarshall Conant Science Buildin	See Below		l	
Detail 11 Sheet 7	Provide detail of flashing at the guardrail post penetration.			Not Addressed
	Indicate protection layer l	Addressed		
Detail 10	Throughwall flashing			
Sheet 7	ent clips fastened at from the weather.			
Detail 13 Sheet 8	Seal all penetration weather tight or is s wall is not weather metal coping to prote	s at curb. IS the v ome water infiltrati tight then conside ect the roofing syste	wall above the curb ion expected? IF the er continuous sheet m.	
Detail 14 Sheet 8	Concealed fasteners exposed then requir moisture infiltration	are recommende e a gasketed fasten	d, if fasteners are er to reduce air and	
Detail 13, 14, 15 Sheet 8	Indicate roof vapor retard barrier. Foam insulate top of para	ter extent and coordina	te overlap with wall A/V ayer continuous.	Addressed
Detail 13 Sheet 8	Strip in sheet metal counter flashing.			
Detail 16,17,18 Sheet 9	Indicate roof vapor retarder extent and coordinate overlap with wall A/V barrier.			Addressed
Detail 16	Consider adding counterf	ashing with securement	clins at the termination	

# **Curtain Wall Shop Drawing Review**



## **Curtain Wall Shop Drawing Review**

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## **Curtain Wall Shop Drawing Review**

	ENGINEERING REVIEW COMMENTS DATE					
		⊡ CRITERIA √ REVIEW	□ мsc			
PROJECT Bridgewater State College Marshall Conant Science Building		Roofing Shop Draw g See Below	ings 02	BHN/EJS		
ITEM NUMBER	DRAWING OR PARAGRAPH NUMBER		ACTION BY REVIEW CONFERENCE			
comments an Roofing Sho	re shown in bold fa	ice type. Refer to redlined drawin	gs for additional comm	ients.		
	Sheet 1	Locate walk way pads identified				
	Sheet 1	Coordinate solar hot water colle	ia			
	Sheet 1	Locate and detail scuppers at roo				
	Sheet 1	Coordinate mechanical l indicates type 4 while prev	g			
	Elevation A Sheet 2	Confirm extent of flashin window location or is this	at			
	Elevations Typical	Provide end dams at exten	t of all flashing loc	ations.		
	Elevations Typical	Not all flashing locations shop drawings. Review fla	appear to be indi shing locations and	cated on thes lownership.	se	
	Dianation C	Deview entent of fleshing	a alanat atala and			

# **Curtain Wall Shop Drawing Review**











# Mock-Up

To be built by onsite trades Access for modifications to address potential problems

Full-scale laboratory testing

Troubleshoot potential problems

To include as many typical details as possible

Establishes standard of care for trades

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To be tested for compliance with established standards

### **On-Site Mock-Up**







# **Construction Phase Services**

Finalize commissioning plan based on results of mock-up testing Integration of RFIs and change orders to the Commissioning Plan

Verify and document field QA/QC programs Provision and followup of ongoing deficiency lists

# **Construction Administration**

Attend periodic progress meetings to discuss enclosure construction issues

Address detail modifications due to construction changes

**Document applicable** comments/discussions Review and verify ongoing compilations of as-built drawings and conditions to be used for future updates and corrections

# **Construction Monitoring**

Perform periodic onsite observations of contractor's work Witness and verify field tests and field data reports

Attend job-site meetings while critical enclosure components are being installed

Review unique interface conditions to verify that they meet the design intent

air barrier **abaa** association of america Summarize observations, concerns, and recommendations in a written report

Confirm that defective conditions are rectified Dimeo Construction Company's (Dimeo) attention prior to installation of the air and vapor barrier and acceptance by the Town of Newton. Attached you will find a reduced wall elevation to assist with the approximate locations of the preliminary punch list items. The numbers described below represent the outstanding items found throughout the elevation.

### Item - General

**Date Completed** 

- 1. Prime and install air barrier transition membrane between the gypsum sheathing and the concrete foundation.
- 2. Install backer rod and sealant, prime and install transition membrane from the top and bottom sides of steel relieving angles to the gypsum sheathing.
- 3. Prime and install transition membrane over exposed structural steel at floor slabs.
- 4. Prime and install transition membrane and/or sealant over the deflection joint at column locations per the detail provided by Dimeo.
- 5. Prime and install transition membrane at outside corners.
- 6. Prime and install air barrier transition membrane between the gypsum sheathing and the concrete masonry unit walls at the window openings along the fourth floor.

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## **System Punch List Inspections**


#### **System Punch List Plan**



**System Punch List Elevation** 

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	Gale Associa	Chapman sign off	Bm/WBI sign off	Gale sign off		
	Photo Index					
Prepared I	For: Boston Universiity		1-2-14 A			
Job Name	Boston University Arena and Recreational Ce	enter	Date : June 25, 2004			
Job Numb	er: 811630 File Name: i:\811630\punchlist\p	ounchlist062504.xls	Page: 1 of 1			
Photo No.	Description	Repair Recomme	ndation / Comments			
1, 2	Leading edge of below-grade waterproofing has be covered with overburden at the Arena's northeast corner.	Excavate to expose minimum), clean wate substrate and extend w wall to achieve a corr sy				
3	Exposed waterproofing has signs of UV deterioration along the Arena's north wall.	Remove damaged w waterproofing and				
4, 5, 6	Exposed gypsum substrate was damaged at various locations along the Arena's north wall	Repair subs	rate as needed.			
7	Damage below-grade waterproofing along Arena's north wall. Concrete was observed to be between drainage layer and membrane	Excavate to expose the limits of the damage waterproofing, remove the damaged waterproofing, clean adjacent waterproofing membrane and substrate and extend waterproofing system up the wall to achieve a correct tie-in to wall air/vapor system.				
8, 9	Exposed waterproofing has signs of UV deterioration along the Arena's north wall.	Remove damaged w waterproofing and	aterproofing, install new temporary protection			
	Exposed waterproofing membrane was damage at the Arena's northwest corner	Excavate to expose waterproofing, re	the limits of the damage emove the damaged			

# **Deficiency Photo Log**

	Gale JN 975200 Gateway Community College Gale Associates, Inc. / Dimeo Construction Co.								
Date Updat	ale Updated 8-Jan-11								
nspection Date	Primary Product	Location	Deficiency	Repair Recommendation	Responsible Party	Date of Repair	Date of Overburder	Comments	Open / Closed
5/11/10	CCW860	Along CL 18 between CL A and C	Inadequate primer, membrane wrinkles, inadequate sealant cant at change in plane (both horizontal and vertical). Inside and outside comers not properly installed per manufacturer standard details	Cants and inside/outside corners per 860-1, 860-58. Sili, roll and patch fish-mouths. Sill membrane, install sealant cants (velical and horizontal), strip in with 12" wide membrane strips. Add additional layer of membrane at outside corners.	Division 3	5/17/2010	5/27/2010	Incomplete repairs. Final repairs completed on 05/20/10 Drainage composite and backfill to be installed immediately.	). Closed
5/11/10	Mira PLY	At CL GC from CL G3.5 to G5	Fish-mouths, dry laps, incomplete removal of release paper, inadequate term bar fasteners, missing membrane anchors	Install per approved shop drawings and manufacturer standard details	Division 3	5/17/2010	N/A -see 06/03/10 below	Removed release sheet. Installation approved by Cartisle.	Closed
5/11/10	Barricoat R	At CL 18 near CL J existing garage wall	Slumping, improper surface prep, pinholes, tears, bissiers. Used product not yet approved.	Strip and replace all improperty applied membrane waterproofing	Division 3	5/18/2010	K.	Carlisle reports that existing membrane system is compatible with Barricoat - no repairs to membrane have been conducted. Membrane warranted by Carlisle.	Open
5/11/10	Water-stop	At CL GC from CL G3.5 to G5	Water-stop partially hydrated and not in substantial contact with concrete surface	Remove and replace per manufacturer requirements	S&F	6/15/2010	6/17/2010	Damaged waterstop has been removed, Waterstop replaced	Closed
5/17/10	CCW 860	Along CL 18 between CL A and C	An unapproved membrane material was used to patch Carlisle sheet membrane	Remove and replace with approved membrane product	Division 3	5/20/2010	5/27/2010	Drainage composite and backfill to be installed immediately.	Closed
5/27/10	Mira DRAIN	Along CL 18 between CL A and C	Filter fabric not adhered property to drain composite substrate	Adhere overtap to prevent migration of fine into drain composite	Division 3	5/27/2010	5/27/2010	Repair completed	Closer
6/2/10	CCW 860	Along CL 18 between CL A and C	Vertical termination and transition to existing concrete work is not per manufacturer specs. Surface prep at existing concrete has not been performed.	Prepare existing surfaces for application of waterproofing membrane. Install dual membrane and sealant cants at inside/outside corners per manufacturer's specs.	Dimeo / Division 3	6/3/2010	6/4/2010	Repair completed	Closed
-6/3/10	MiraPLY	At CL GC from CL G3.5 to G5	Remove Architect rejected material	Replace with approved membrane (Grace PrePrufe)	Division 3	6/7/2010	6/8/2010	Removed Mira Ply and replace w/ Grace PrePrule	Closed
6/10/10	PrePrute	CL GC from CL G5.5 - 6	Membrane laps and termination sealant at base	Dry substrate and install seam tape/repair misaligned seams	Division 3	6/11/2010	6/15/2010	Repaired deficiencies	Closed
6/10/10	CCW 860	CL 31 from CL E - J	Fill material between protection board and membrane	Remove debris from between protection board and membrane	Division 3	6/29/2010	6/30/2010	Removed dirt, debris and repaired	Closed
6/10/10	Concrete Substrate	CL BB from CL G5 - G6	Chipped and out of plane concrete at expansion joint waterproofing location	Patch concrete at location of expansion foam joint sealant	Dimeo / Division 3	6/11/2010	6/15/2010	Repaired from CL G5 - 5.8	Closed
6/16/10	Emseal Joint	CL 88 from CL G1-G6	Lower expansion joint not fully engaged with Bed of epoxy	Get Architect approval to leave as-is. Top with expansion fearm and secondary joint. Plan for injection waterstop repairs at this locationOR - Remove and replace per specifications	Dimeo / Division 3	6/21/2010	6/22/2010	Lower joint only partially adhered to concrete substrates. Installed expanding foam and top joint per spec	Closed
6/17/10	Emseal Joint	CL BB near CL G5	Missing silbone sealant at edges and butt joints	Install per specifications	Division 3	6/18/2010	6/22/2010	Silicone installed at butt joints	Closed
6/17/10	Water-stop	CL GC at CL G4 - G4.9	Unapproved material installed	Remove and replace per specifications	S&F		6/23/2010	Concrete poured - Architect approved wirstp	Closed
6/18/10	Substrate	CL G6 near CL GB	Poor substrate condition	Prepare substrate	S&F	6/18/2010	6/18/2010	Substrate repaired and membrane installed	Closed
6/18/10	Substrate	CL 18 at CL C - D	Poor substrate condition	Prepare substrate	S&F	6/18/2010	6/18/2010	Concrete poured	Closed
6/22/10	Water-stop	CL GC at CL G5	Improper overlap and unapproved material	Remove and replace per specifications	S&F			Concrete poured - item not repaired	Open
6/25/10	Emseal Joint	CL BB at CL G2 – G5.5	Missing silicone sealant at edges and butt joints	Install per specifications	Division 3	6/28/2010		installed sealant	Closed

# **Deficiency Tracking Log**



#### BUILDING ENCLOSURE DEFICIENCY TRACKING LOG

No.	Field Report (FR) No./Ref.	Location	Deficiency	Responsible Party	Date of Repair/ Resolution	Action Column / By Whom	Open/ Closed
12.	Field Report #10 Item 10.2 C	Foundation Wall Areaway - North elevation, North Bar	Delaminated waterproofing membrane from concrete header	Waterproofing Installer		<ul> <li>Repair delaminated waterproofing membrane per manufacturer's requirements. Columbia was informed of issue.</li> </ul>	Open
13.	Field Report #10 Item 10.3	Foundation Wall – south elevations, North and South Bar	<ul> <li>Damaged rigid insulation and drainage mat</li> </ul>	Columbia		<ul> <li>Replace damaged insulation and drainage mat. Columbia was informed of issue.</li> </ul>	Open
14.	Field Report #11 Item 11.1	Mockup	<ul> <li>Unsealed limits in VPAB membrane installation.</li> </ul>	Air Barrier Installer	Covered by fiber reinforced concrete panels (FRCP) prior to Gale's Field Visit No. 19.	<ul> <li>Seal installation limits to provide continuous drainage plane in field of wall and at windows. Columbia was informed of issue. Repairs to be confirmed by Columbia.</li> </ul>	Open
15.	Field Report #11 Itern #11.4	Exterior Walls – North and East Elevations	<ul> <li>Damaged SIP edges, exterior and interior side of walls.</li> </ul>	SIP Installer	SIPs covered by exterior wall components prior to Gale's Field Visit No. 28.	<ul> <li>Repair damaged SIPS per the project requirements to provide a continuous substrate surface. Columbia was informed of issue. Repairs to be confirmed by Columbia.</li> </ul>	Open
16.	Field Report #11 item #11.5	Exterior Walls – Various Locations	<ul> <li>Delaminated SIP joint stripping on interior side of walls</li> </ul>	Air Barrier Installer	Joint stripping covered by exterior wall components prior to Gale's Field Visit No. 28.	Repair delaminated joint stripping per manufacturer's requirements. Columbia was informed of issue. Repairs to be confirmed by Columbia.	Open
17.	Field Report #11 Item 11.6 A	Exterior Walls - South Elevation, North Bar (above roofline)	Damaged window flashing membrane	Air Barrier Installer	Windows are covered by temporary enclosures.	<ul> <li>Repair damaged window flashing membrane per manufacturer's requirements. Columbia was informed of issue.</li> </ul>	Open

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# **Deficiency Tracking Log**

# **Acceptance Phase**





# Testing

Smoke tests, tracer gas (qualitative)

Spray nozzle, spray rack leak tests

Chamber tests (quantitative)

Infra-red (after enclosure complete or with temp. heat)





## ASTM E 1186, Standard Practice for Air Leakage Detection in Building Enclosures and Air Barrier Systems



ASTM E 1186-03, Standard Practices for Air Leakage Site Detection in Building Enclosures and Air Barrier Systems



ASTM E 1186, Standard Practice for Air Leakage Detection in Building Enclosures and Air Barrier Systems



### ASTM D 4541 Standard Test Method for Pull-Off Strength of Coatings – Portable Adhesion Testing



## ASTM C 1193, Standard Guide for Use of Joint Sealants, Method A, Field Applied Sealant Joint Hand Pull Tab



### ASTM C 1153, Standard Practice for Location of Wet Insulation in Roofing Using Infrared Imaging



#### ASTM E 779, Standard Test Method for Determining Air Leakage Rate by Fan Pressurization



ASTM C 1060, Standard Practice for Thermographic Inspection of Insulation Installations in enclosure Cavities of Frame Buildings





ASTM C 1060, Standard Practice for Thermographic Inspection of Insulation Installations in enclosure Cavities of Frame Buildings

# **Post Commissioning**

Maintenance Staff Training Review performance with owner / user

**Lessons Learned** 

10 month walk-through Warranty / seasonal evaluation

Post-Occupancy Commissioning

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# Typical Design/ Construction Issues







# **Thermal Bridging Issues**



# **Avoid This – Flashing Conflict**



# Avoid This – Most Common Issue (Leakage/Business Interruption)



### **Three-Dimensional Sketch**

# **Specifications vs. Drawings**





## **Avoid This – Poor Workmanship**

- 4. Finish: 70 percent polyvinylidene flouride
- 5. Color: To be selected by Architect from manufacturer's custom range

#### 2.04 ACCESSORIES

- A. Fastevers: Stainless steel.
- Metal Accessories: Provide cleats, straps, hangars, anchoring devices, and similar accessory units as required for installation of work, noncorrosive, size and gage required for performance.
- C. Underfayment Barrier: Provide one of the following:
  - 1. ASTM 0226, organic roofing felt, Type I ("No. 15").
  - Self adhering vapor retarder / air barrier; same material as selected for membrane roofing system. Formulation for high temperature resistance.
- D. Primer: Zinc chromate type.
- E. Sealant: Type B1 specified in Section 07 90 05.
- 2.05 SNAP IN FLASHING
  - A Springlock Reglet and Flashing: Where indicated on drawings, provide surface-mounted reglet or set into masonry joints depending on project conditions. Both types shall be for use in masonry. Reglet and flashing shall be made of Type 304 stairless steel (.020°). Reglet shall have a 1° factory tonted and lap; flashing shall have a 3° end lap.
  - B. Reglet and flashing system shall be certified by the manufacturer to resist 110 MPH wind loads for a minimum of two continuous hours as verified by independent test results.
  - C. Reglet to be installed level with the top of the reglet at least 7 inches above the high point of cant strip
  - D. Surface recurited Nashing shall be supplied with special washers (7/8\* diameter stainless steel with neoprene facing) to seal stainless steel drive pin penetrations

#### 2.06 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Fabricate cleate of same material as sheet, minimum 2 inches wide, interlooking with sheet.
- C. Form pieces in longest possible lengths.
- D. Hem exposed edges on underside 1/2 inch; miter and seam corners.

E. Form material with tap and backer plate seams per drawings, except where otherwise indicated. At moving joints, use sealed lapped, bayonat-type or interlocking hocked seams.

- Expansion Provisions: Where tapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25mm) deep, filled with elastomeric or butyl sealant concealed within joints.
- F. Fabricate corners from one piece with minimum 18 inch long legs; seam for rigidity, seal with sealant.
- G. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.

#### 2.07 GUTTER AND DOWNSPOUT FABRICATION

- A. Gutters: SMACNA Architectural Sheet Metal Manual, Rectangular profile.
- 8. Downspouts: Reclangular profile.
- C. Gutters and Downspouts: Sizes indicated.
- D. Accessories: Profiled to suit gutters and downspouts.
  - Anchorage Devices: In accordance with SMACNA requirements. Fasteners shall be stainless stael for fastening into pressure treated lumber.
  - 2. Gutter Supports: Brackats
    - a. Brackets shall be fabricated of 1/8 inch thick Galvalume steel finished to match gutter, and include matching concealed straps across top of gutter.
- 3. Downspoul Supports: Brackets.
- E. Downspout Boots: Steel, made of same material as metal fascia, formed to make transition from rectangular gutter to round drainage pipe at grade as indicated in drawings.

- F. Seal metal joints.
- G. Gutter guards: Expanded or perforsted metal mesh of same type as gutter, designed to permit entry of water into gutter while preventing accumulation of leaf and other debris in gutter. Guard shall feature not less than 50% tree area at top surface of gutter, and shall be snap-in type or secured to gutter.

#### PART 3 EXECUTION

- 3.01 EXAMINATION
  - A. Examination and Acceptance of Conditions per Section 01 40 00 Quality Requirements, and as follows:
    - Carefully examine installation areas with Fabricator and Installer present, for compliance with requirements affecting Work performance.
      - a. Verify that field measurements, surfaces, substrates, structural support, utility penetrations, tolerances, slope, cleanliness and other conditions are satisfactory and ready to receive Work.
      - b. Verify that substrate system is even, smooth, sound, clean, dry, and from thefects.
      - c. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nating strips located.
      - d. Verify roofing termination and membrane base flashings are in place, sealed, and secure.
      - e. Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.02 INSTALLATION
  - A. General: Install Sheet Metal Flashing and Trim according to the Drawings, submittals, manufacturer's instructions, SMACNA (ASMM), and as follows:
    - 1. Counter Flashings: SMACNA Architectural Sheet Metal Manual, Detail 4-4C.
    - 2. Roof Penetration Flashing: SMACNA Architectural Shoet Metal Manual, Detail 4-14B.
  - Install units glumb, level, square, and free from warp or twist while maintaining dimensional tolerances and alignment with surrounding construction.
  - C. Provide a underlayment barrier between metal surfaces of units in contact with distimilar metals, and between metal and pressure treated wood.
  - D. Secure flashings in place using concested fasteners. Use exposed fasteners only where permitted.
  - E. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.
  - F. Seal metal joints waterlight.
  - G. Install expansion joints at frequency recommended by SMACNA (ASMM). Do not faster moving seams such that movement is restricted.
  - H. Coordinate with installation of rooling system and roof accessories.
  - 1. Secure gutters and downspouts in place using concealed fasteners.
  - J. Install continuous gutter guards at all gutters.
  - K. Cannect downspouts to downspout boots. Grout connection watertight.
  - E Fabricate, support and anchor flashing work to withstand thermal expansion stresses and full loading by water or ice, without damage, deterioration or leakage
  - M. Counterflash mechanical and electrical items projecting through roofing, unless otherwise shown
  - No exposed face penetrations or perforation shall be made in metal panels by fasteners without Architect's specific approval
- 3.03 CLEANING
  - A. Comply with requirements of Section 01 74 19 Construction Waste Management and Disposal
  - Remove protective film (if any) from exposed surfaces of sheat metal promptly upon installation. Strip with care to avoid damage to finishes.
  - C. Clean exposed sheet metal surfaces, removing substances that might cause abnormal discoloration of metal.

#### **Avoid This – Poor Specification**

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# **Atypical Details**





### **Construction Photo**



### **Design Detail**



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## **As-Built Detail**



#### **Final Installation Photo**

#### **Building Enclosure Consulting Services**



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#### **Building Enclosure Commissioning Services**



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**Boston University** 

### **Building Enclosure Commissioning Services**



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#### **Multiple Projects**




## Multiple Building Enclosure Commissioning Projects

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## ThankYou!



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