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# About Us

- Established in 1991
- Multi-Disciplinary
- Small Disadvantaged Business; 8(m) Woman Owned Small Business (WOSB)

GSA Contract Holder
Contract GS-21F-0133Y

**Epsten Group Services:**

- LEED Consulting
- Energy Modeling
- Commissioning
- Retro-Commissioning
- Building Envelope Services
- Roofing & Waterproofing Consulting
- Architecture & Interior Design

# Envelope Commissioning for High Performance Buildings

**SERBCA Annual Meeting– Covington, KY**

**December 6, 2013**

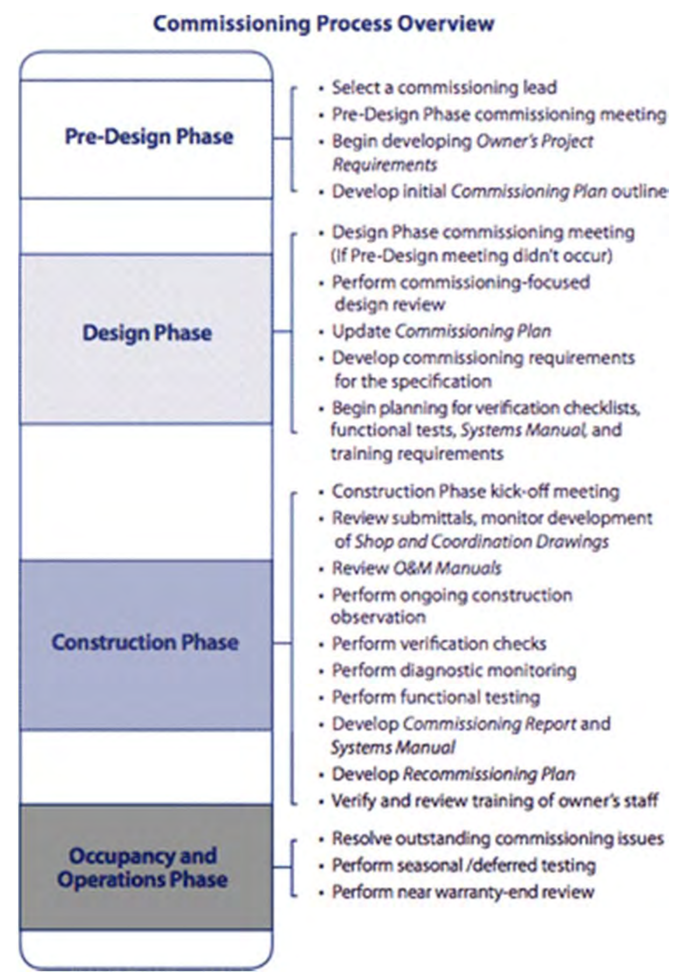
# Learning Objectives

**At the end of this course, participants will be able to:**

1. Recognize the steps in the Envelope Commissioning process.
2. Recognize some of the testing techniques used in the Envelope Commissioning process.
3. Recognize the value of the Envelope Commissioning process to the various stakeholders of the project team.
4. Recognize Envelope Commissioning's value to high performance, sustainable buildings.

# 0.0 Introduction

- Most project teams are familiar with the concepts of Systems Commissioning, especially as required for LEED certification. Envelope Commissioning is slowly becoming more prominent because it adds significant value to the Design, Construction, and Post-Construction phases of a project.
- In addition, Envelope Commissioning is becoming recognized in green building rating systems such as LEED for Healthcare and the impending LEED v4.0 Rating System.

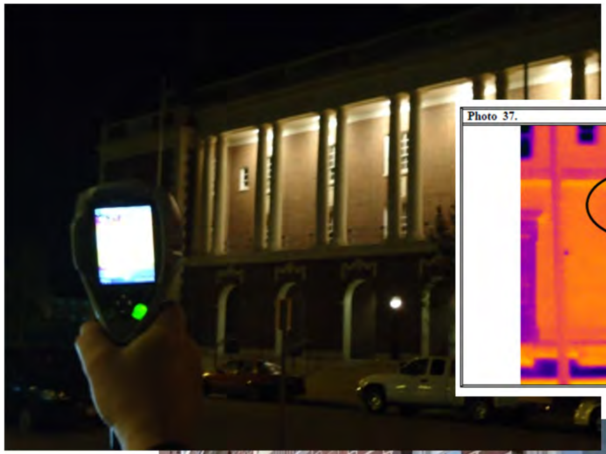


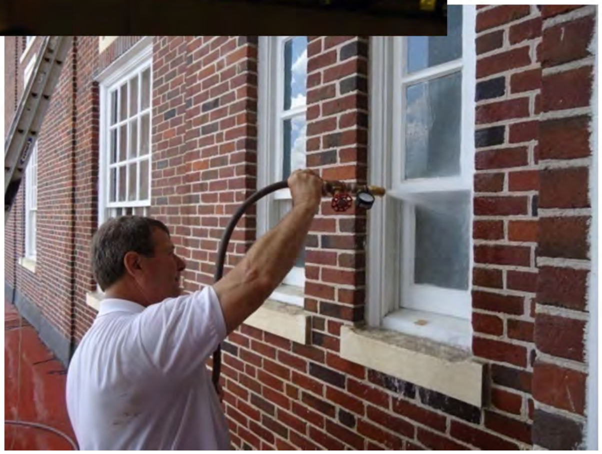
# 1.0 Envelope Commissioning

- Similar to Systems Commissioning, Envelope Commissioning (Cx) is the third-party process of reviewing the design and construction of envelope. The Design Phase of the process consists of the following steps:
  1. Creation/Review of Owner's Project Requirements (OPR) and designer's Basis of Design (BOD)
  2. Commissioning Kick-Off Meeting
  3. Commissioning Plan
  4. Design Document Reviews
  5. Commissioning Specifications including Envelope/Mock-Up Testing Specifications
  6. Development of Installation Checklists

# 1.1.0 Envelope Commissioning

- The Construction Phase of the Envelope Commissioning process includes:
  1. Submittal and Shop Drawing Reviews
  2. Commissioning Meetings
  3. Pre-Installation Meetings with the various envelope subcontracting trades to set clear expectations and responsibilities.
  4. Site Observations
  5. Mock-Up Construction/Testing
  6. Envelope Testing
     - Water Nozzle Testing (AAMA 501.2)
     - Combined Air/Water Testing (AAMA 503.3)
     - Infrared Thermography (ASTM C1060)
     - Combined IR and Blower Door Testing (ASTM E1186)



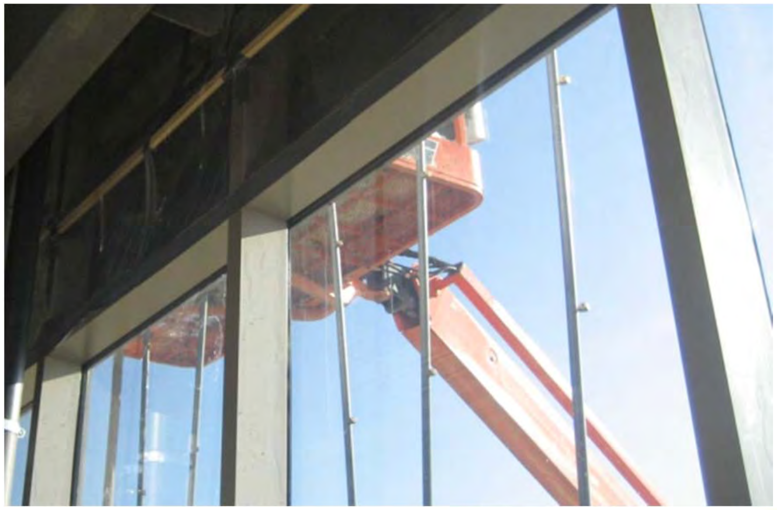



# 1.1.1 Water Leakage Testing

- AAMA 501 – Dynamic water resistance, water nozzle testing
  - Spray at 12” from most exterior window surface.
  - Testing for five minutes per section, prescribed pattern.
- Case Study – Moultrie Technical College
  - Allied Health Building, Moultrie, Georgia
  - 46,000 square feet
  - GSFIC Required Third-Party AAMA 501 testing of a sampling of window and curtain wall systems on the project.
  - Initial field testing was delayed because the GC had not properly prepared windows for testing.
  - Subsequent testing revealed minor leakage at a balcony curtain wall jamb and major leakage through an adjacent balcony knee wall.

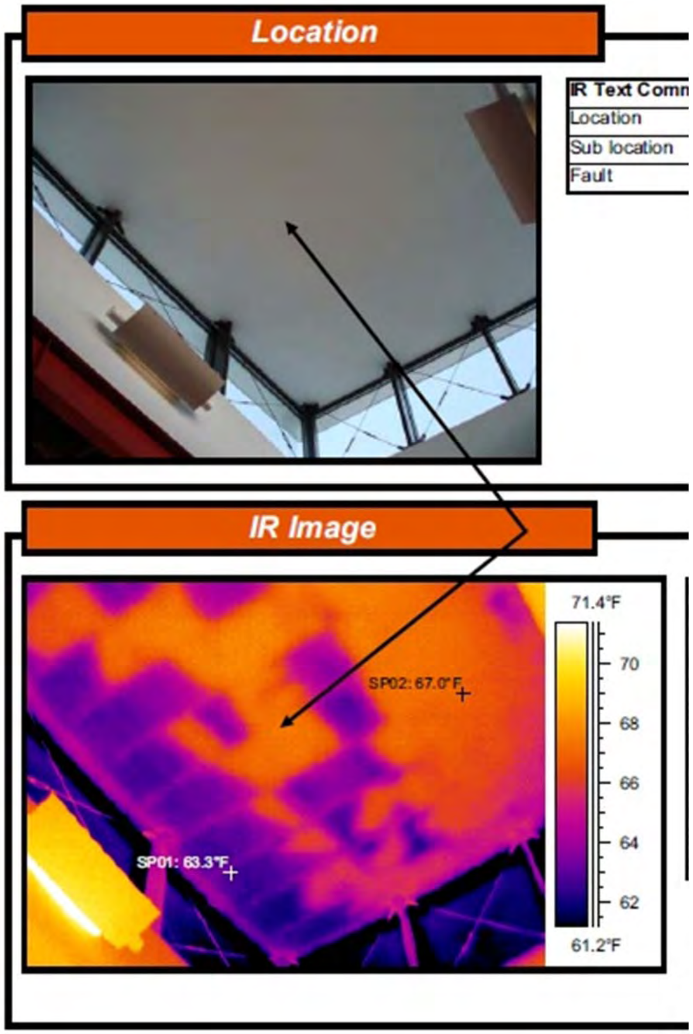
# 1.1.2 Water Leakage Testing

- AAMA 503.03 – Combined Water Penetration and Air Infiltration Test
  - ASTM E783 and ASTM E1105
  - Water nozzle testing – exterior
  - Negative pressure air chamber on window assembly – interior
  - Combined test is equivalent of 1 inch of heavy rain in 1 hour
- Case Study – AGF Evansville
  - New headquarters and expansion
  - 150,000 SF, achieved LEED Gold
  - 2 of 15 walls failed due to improper sealant application, would not have been identified without testing



# 1.1.3 IR Testing

- ASTM C1060 – Infrared Thermographic Testing
  - Reveals locations where insulation is missing, air barrier leakage, moisture intrusion, missing sealant and thermal bridging.
- Case Study – 399 Edgewood
  - Air tight, well-insulated building (closed-cell spray foam insulation).
  - Construction overseen by EGI Envelope Commissioning expert.
  - One location in roof monitor with improperly installed insulation.



# 1.1.4 Blower Door Testing

- ASTM C779 – Standard Test Method for Determining Air Leakage Rate By Fan Pressurization
- ASTM E1827 – Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
- ASTM E1186 – Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
  - Temperature delta of 12-18 degrees.
  - Building pressurization of 25-75 Pa.
  - When observed from the exterior with an IR camera, areas of air leakage can be identified for correction.

# 1.2 Envelope Commissioning

- The Post-Construction Phase of the Envelope Commissioning process includes:
  1. O+M Staff Training
  2. Systems Manuals/Recommissioning Procedures
  3. Final Commissioning Report
  4. Upload LEED Documentation, if applicable

# 2.0 Benefits of Envelope Cx

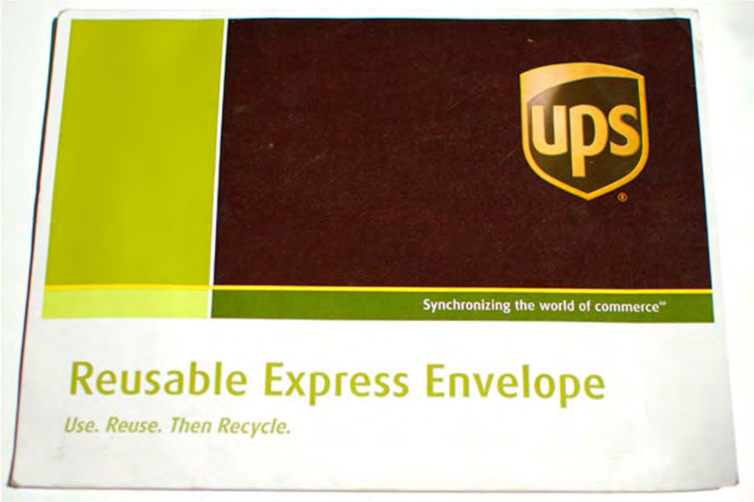
- The benefits of Envelope Commissioning can extend to the Design Team, Contractor, and Owner.
  - Design Team:
    - Added quality control in waterproofing details
    - Added layer of Construction Administration quality control
  - Contractor:
    - Fewer callbacks after project completion
  - Owner:
    - Verification of air tightness and insulation continuity helps decrease energy costs
    - Increased building durability and lower maintenance costs

# 2.1 Cost of Envelope Cx

- The cost of Envelope Commissioning will vary based on the size, complexity, location, testing methods, and CA process for a project.
  - $0.25 - $0.75 per square foot is a good range to consider
  - Compare to $0.40 - $1.00 per square foot for Systems Commissioning
- Compare these costs to the cost of disrupted operations caused by water infiltration and remediation efforts.
  - Unlike HVAC systems, which can often be repaired with minimal disruption to operations, faulty wall and window systems often lead to shutting down sections of a facility while repair operations take place.

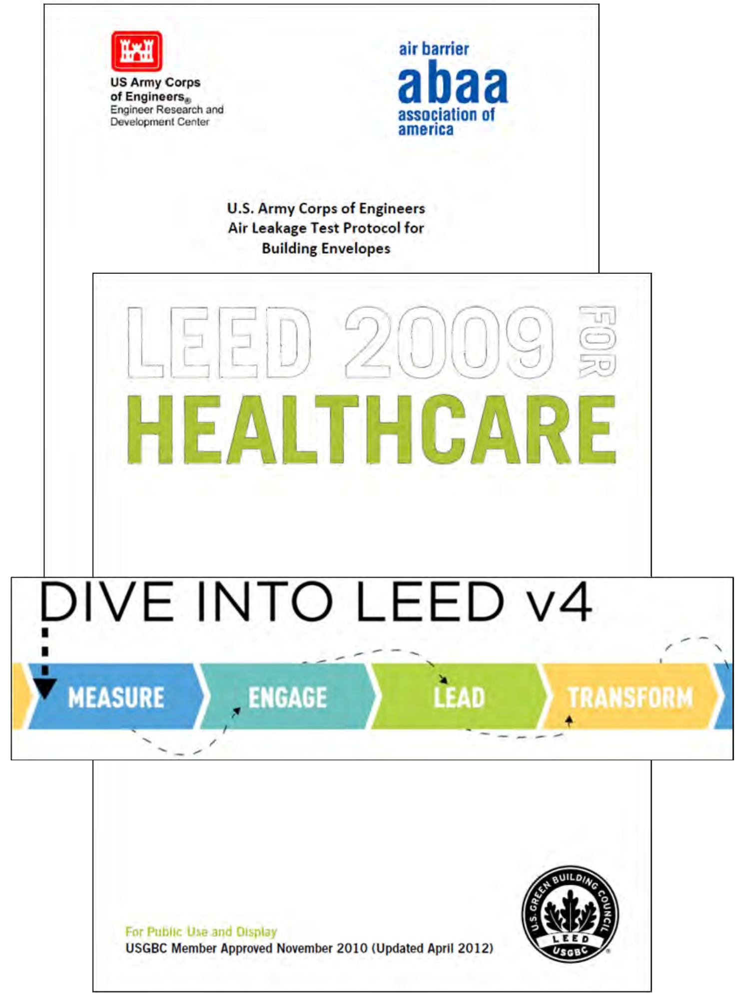
# 3.0 Envelope Cx and Sustainability

- Envelope Cx helps project teams provide more sustainable buildings and promotes better building performance in the following ways:
  - Energy Performance: By emphasizing continuity of thermal insulation and air barriers and validating through site observation and testing, the envelope performs as intended from an energy standpoint.
  - Durability and Maintenance: Envelope Cx helps promote the longevity of building envelopes by emphasizing smart detailing and identifying and correcting durability problems during design and construction.
  - Indoor Environmental Quality: By promoting water and vapor tightness, Envelope Cx helps prevent mold and other IAQ problems.



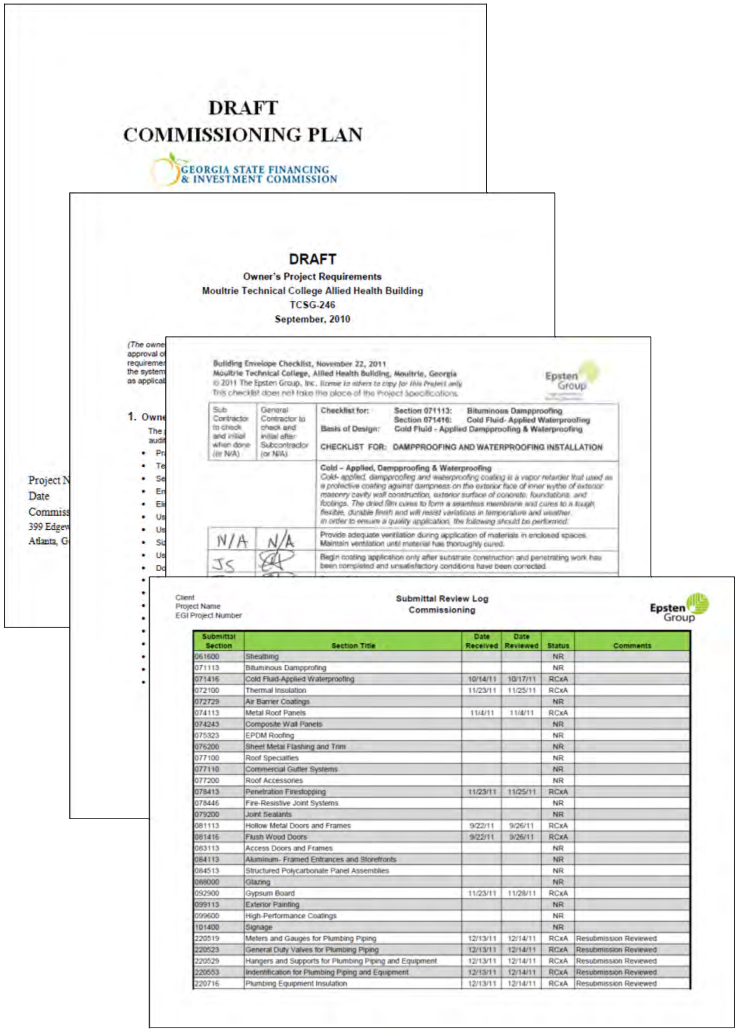

# 3.1 Envelope Cx and LEED

- Envelope Cx is becoming more commonplace in the building industry (U.S. military projects), and is now becoming a more commonplace consideration in the LEED Rating System.
  - Envelope Cx can earn an Exemplary Performance ID credit for EAc3, Enhanced Commissioning in the LEED-BD+C v2009 Rating Systems.
  - Envelope Cx is already included Envelope Cx as an optional point in the LEED for Healthcare v2009 Rating System within EAc3, Enhanced Commissioning.
  - LEED-BD+C v4.0 also includes Envelope Cx as 2 points under EAc3, Enhanced Commissioning.



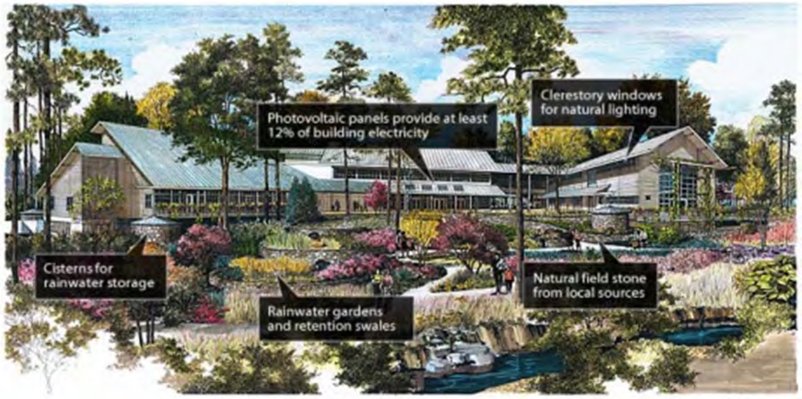
# 3.2 Envelope Cx LEED Submittals

- Although there are no prescribed submittals for the achievement of an Exemplary Performance ID credit, the submittals for Cx for the base prerequisite and credit should be seen as a good rule of thumb:
  1. Owner's Project Requirements (OPR) and designer's Basis of Design (BOD)
  2. Design Review documentation
  3. Commissioning Plan/Report
  4. Envelope Components List listing which components have been Commissioned
  5. Documentation of the Cx Agent's experience
  6. Envelope Systems Manual
  7. Schedule of O+M staff trainings



# Case Study: NC Botanical Garden

- Envelope Cx was conducted on the North Carolina Botanical Garden Education Center in Chapel Hill, North Carolina.
  - The project was designed by architect Frank Harmon, FAIA, and achieved LEED Platinum certification.
  - The project includes a geothermal heat pump system, photovoltaics, and rainwater harvesting cisterns that supply water for irrigation.
  - Epsten Group provided Envelope Cx services for the project.




# Case Study: NC Botanical Garden

- Design Phase Cx activities included:
  1. Review of Owner's Project Requirements (OPR) and designer's Basis of Design (BOD)
  2. Commissioning Kick-Off Meeting
  3. Commissioning Plan
  4. Design Document Reviews (30 potential issues identified):
     - Air and vapor barrier continuity
     - Waterproofing continuity
     - Thermal bridging issues at guardrails, studs, beams, and slab edges
     - Window flashing detailing
  5. Commissioning Specifications including Envelope/Mock-Up Testing Specifications
  6. Development of Installation Checklists

# Case Study: NC Botanical Garden

- Construction Phase Cx activities included:
  1. Submittal and Shop Drawing Reviews
  2. Commissioning Meeting
  3. Pre-Installation Meetings with the various envelope subcontracting trades to set clear expectations and responsibilities
  4. Site Observations
  5. Mock-Up Testing
  6. Envelope Testing
     - Leakage at curtain wall mullions due to incorrect assembly directions from manufacturer
     - Leakage at building corners due to incomplete waterproofing installation

# Case Study: NC Botanical Garden

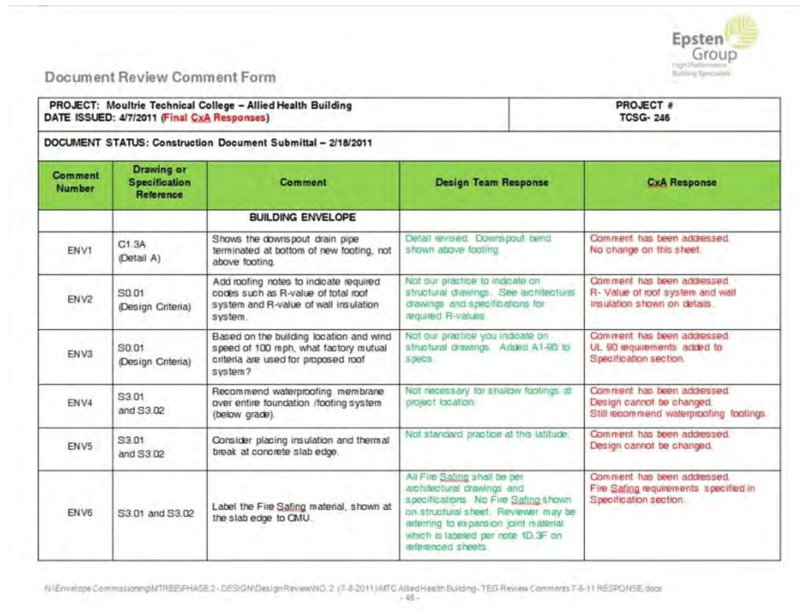
- Post-Construction Phase Cx Activities:
  1. O+M Staff Training
  2. Systems Manuals/Recommissioning Procedures
  3. Final Commissioning Report

# Case Study: Moultrie Tech

- Envelope Cx was conducted on the Moultrie Technical College Allied Health Building in Moultrie, Georgia.
  - All projects financed by the Georgia State Financing and Investment Commission (GSFIC), which finances higher education building projects, require some Envelope Cx in the project scope.
  - The Allied Health Building was originally slated to pursue LEED certification, but LEED was dropped after an Executive Order by the Georgia governor discouraging LEED projects. If LEED had been pursued, Envelope Cx could have earned an ID credit for Exemplary Performance of EAc3, Enhanced Commissioning.

# Case Study: Moultrie Tech

- Design Phase Cx activities included:
    1. Review of Owner's Project Requirements (OPR) and designer's Basis of Design (BOD)
    2. Commissioning Kick-Off Meeting
    3. Commissioning Plan
    4. Design Document Reviews (139 potential issues identified):
        - Downspout and gutter detailing
        - Wall flashing and weeps at brick arches and ACM panels
        - Insulation continuity at $2^{nd}$ floor slab
        - Roof to wall flashing details
        - Adequate warranty specifications
    5. Commissioning Specifications including Envelope Testing Specifications
    6. Development of Installation Checklists



Epsten Group

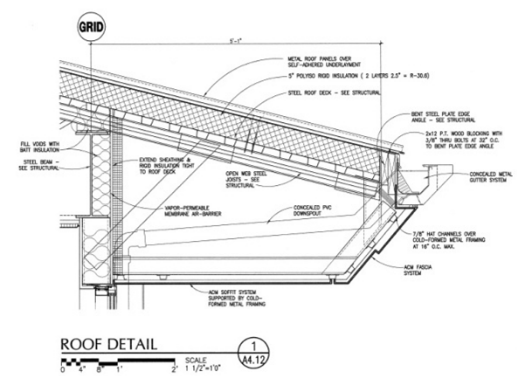
Document Review Comment Form

| PROJECT: Moultrie Technical College – Allied Health Building<br>DATE ISSUED: 4/7/2011 (Final CxA Responses) | PROJECT #<br>TCSG- 246 |
|---|---|
| DOCUMENT STATUS: Construction Document Submittal – 2/18/2011 | |

| Comment Number | Drawing or Specification Reference | Comment | Design Team Response | CxA Response |
|---|---|---|---|---|
| | | BUILDING ENVELOPE | | |
| ENV1 | C1.3A (Detail A) | Shows the downspout drain pipe terminated at bottom of new footing, not above footing. | Detail revised. Downspout bend shown above footing. | Comment has been addressed. No change on this sheet. |
| ENV2 | S0.01 (Design Criteria) | Add roofing notes to indicate required codes such as R-value of total roof system and R-value of wall insulation system. | Not our practice to indicate on structural drawings. See architectural drawings and specifications for required R-values. | Comment has been addressed. R- Value of roof system and wall insulation shown on details. |
| ENV3 | S0.01 (Design Criteria) | Based on the building location and wind speed of 100 mph, what factory mutual criteria are used for proposed roof system? | Not our practice you indicate on structural drawings. Added A1-90 to specs. | Comment has been addressed. UL 90 requirements added to Specification section. |
| ENV4 | S3.01 and S3.02 | Recommend waterproofing membrane over entire foundation /footing system (below grade). | Not necessary for shallow footings at project location. | Comment has been addressed. Design cannot be changed. Still recommend waterproofing footings. |
| ENV5 | S3.01 and S3.02 | Consider placing insulation and thermal break at concrete slab edge. | Not standard practice at this latitude. | Comment has been addressed. Design cannot be changed. |
| ENV6 | S3.01 and S3.02 | Label the Fire Safing material, shown at the slab edge to CMU. | All Fire Safing shall be per architectural drawings and specifications. No Fire Safing shown on structural sheet. Reviewer may be referring to expansion joint material which is labeled per note 1D.3F on referenced sheets. | Comment has been addressed. Fire Safing requirements specified in Specification section. |

N:\Envelope Commissioning\MTREE\PHASE 2 - DESIGN\Design Review\NO. 2 (7-8-2011)\MTC Allied Health Building - TEG Review Comments 7-8-11 RESPONSE.docx

- 46 -



# Case Study: Moultrie Tech

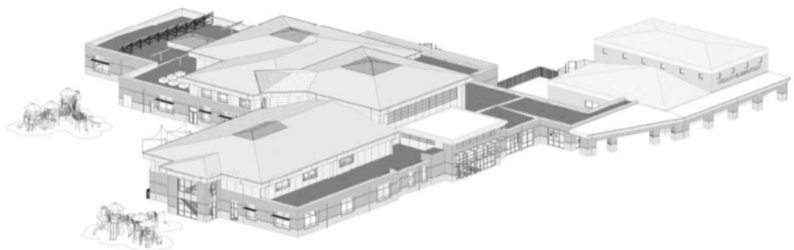
- Construction Phase Cx activities included:
  1. Submittal and Shop Drawing Reviews
  2. Commissioning Meeting
  3. Pre-Installation Meetings with the various envelope subcontracting trades to set clear expectations and responsibilities.
  4. Site Observations
     - Damage to ice and water shield at roof ridge during construction had to be repaired
  5. Envelope Testing
     - Insufficient sealing of 1st floor windows and failed sealant adhesion tests
     - Water testing showed leakage under the wall and at the storefront system sill at the 2nd floor balcony

# Case Study: Moultrie Tech

- Post-Construction Phase Cx Activities:
  1. O+M Staff Training
  2. Systems Manuals/Recommissioning Procedures
  3. Final Commissioning Report

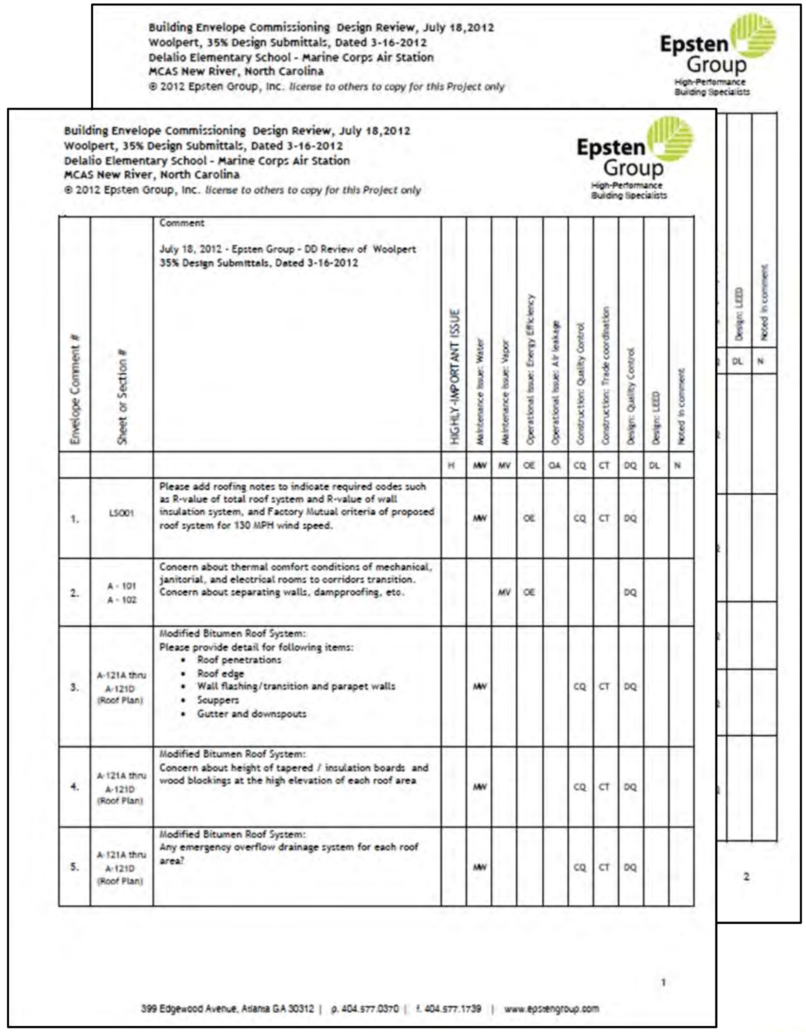
# Case Study: Delalio Elementary

- Envelope Cx is currently underway for Delalio Elementary School at New River Marine Corps Station near Jacksonville, North Carolina.
  - Replacement elementary school for NAVFAC called for Envelope Commissioning in its scope of services.
  - Project has completed the Design Phase and is into the Construction Phase.



# Case Study: Delalio Elementary

- Design Phase Cx activities included:
  1. Review of Owner's Project Requirements (OPR) and designer's Basis of Design (BOD)
  2. Commissioning Kick-Off Meeting
  3. Commissioning Plan
  4. Design Document Reviews (31 potential issues identified):
     - Incomplete detailing
     - Modified bitumen roofing detail for adhering to the roof deck
     - Curtain wall assembly flashing
  5. Commissioning Specifications including Envelope Testing Specifications
  6. Development of Installation Checklists



Building Envelope Commissioning Design Review, July 18,2012
Woolpert, 35% Design Submittals, Dated 3-16-2012
Delalio Elementary School - Marine Corps Air Station
MCAS New River, North Carolina
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| Envelope Comment # | Sheet or Section # | Comment<br>July 18, 2012 - Epsten Group - DD Review of Woolpert 35% Design Submittals, Dated 3-16-2012 | HIGHLY-IMPORTANT ISSUE | Maintenance Issue: Water | Maintenance Issue: Vapor | Operational Issue: Energy Efficiency | Operational Issue: Air leakage | Construction: Quality Control | Construction: Trade coordination | Design: Quality Control | Design: LEED | Noted in comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | H | MW | MV | OE | OA | CQ | CT | DQ | DL | N |
| 1. | LS001 | Please add roofing notes to indicate required codes such as R-value of total roof system and R-value of wall insulation system, and Factory Mutual criteria of proposed roof system for 130 MPH wind speed. | | MW | | OE | | CQ | CT | DQ | | |
| 2. | A - 101<br>A - 102 | Concern about thermal comfort conditions of mechanical, janitorial, and electrical rooms to corridors transition. Concern about separating walls, dampproofing, etc. | | | MV | OE | | | | DQ | | |
| 3. | A-121A thru A-121D (Roof Plan) | Modified Bitumen Roof System:<br>Please provide detail for following items:<br>• Roof penetrations<br>• Roof edge<br>• Wall flashing/transition and parapet walls<br>• Scuppers<br>• Gutter and downspouts | | MW | | | | CQ | CT | DQ | | |
| 4. | A-121A thru A-121D (Roof Plan) | Modified Bitumen Roof System:<br>Concern about height of tapered / insulation boards and wood blockings at the high elevation of each roof area | | MW | | | | CQ | CT | DQ | | |
| 5. | A-121A thru A-121D (Roof Plan) | Modified Bitumen Roof System:<br>Any emergency overflow drainage system for each roof area? | | MW | | | | CQ | CT | DQ | | |

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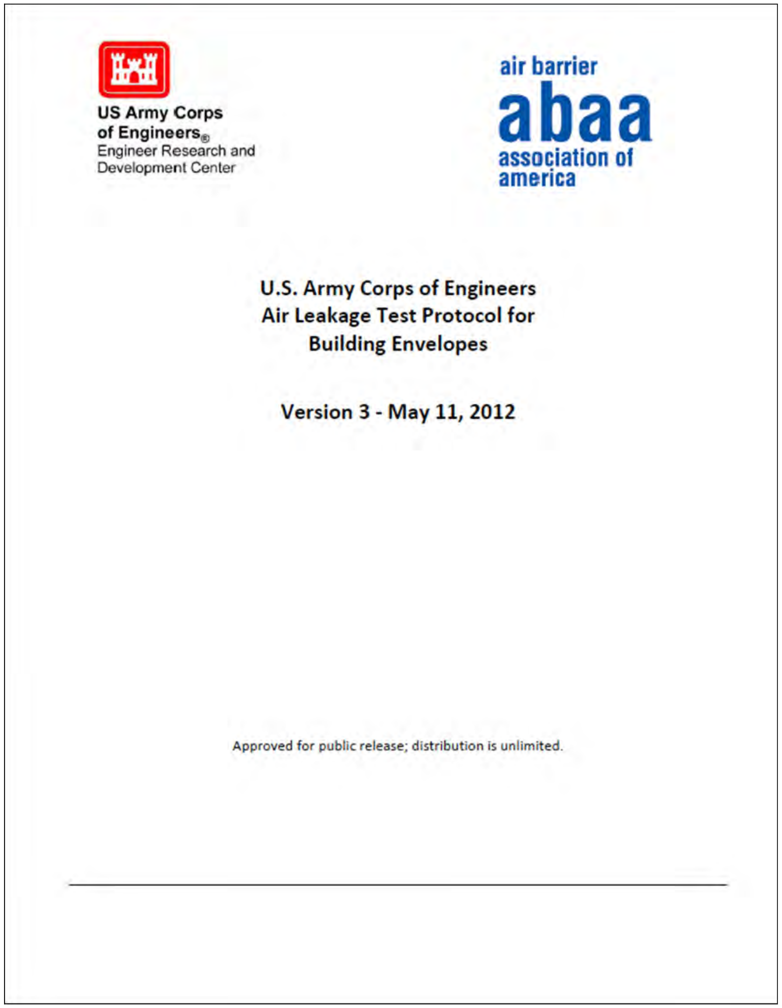
# Case Study: Delalio Elementary

- Construction Phase Cx activities included:
  1. Submittal and Shop Drawing Reviews
  2. Commissioning Meeting
  3. Pre-Installation Meetings with the various envelope subcontracting trades to set clear expectations and responsibilities.
  4. Site Observations
  5. Envelope Testing
     - Blower Door Testing
     - AAMA 501 Water Leakage Testing


US Army Corps of Engineers®
Engineer Research and Development Center

air barrier
abaa
association of america

U.S. Army Corps of Engineers
Air Leakage Test Protocol for
Building Envelopes

Version 3 - May 11, 2012

Approved for public release; distribution is unlimited.

# Case Study: Delalio Elementary

- Post-Construction Phase Cx Activities:
  1. O+M Staff Training
  2. Systems Manuals/Recommissioning Procedures
  3. Final Commissioning Report

# Case Study: New Bern Courthouse

- Following an Envelope Retro-Commissioning process, Epsten Group was hired by the GSA to evaluate the existing conditions of the windows at the New Bern Federal Courthouse and study upgrade options for energy efficiency.
- The project is a historic building constructed in 1935 with most of the original windows meaning:
  - Great care had to be taken to use non-destructive testing on the windows
  - Proposed solutions for upgrades had to meet historic preservation guidelines

# Case Study: New Bern Courthouse

- Epsten Group was contracted to begin the two part study, which was completed over a 91 day performance period in 2011.
  - Part One: Evaluate the condition of the existing windows through non-destructive testing techniques and recommend potential window repair/upgrade/replacement scenarios.
  - Part Two: Evaluate the first cost and estimated annual energy savings of the repair/upgrade/replacement scenarios and make a final recommendation based on criteria including first cost, payback, and historic preservation considerations.

# Case Study: New Bern Courthouse

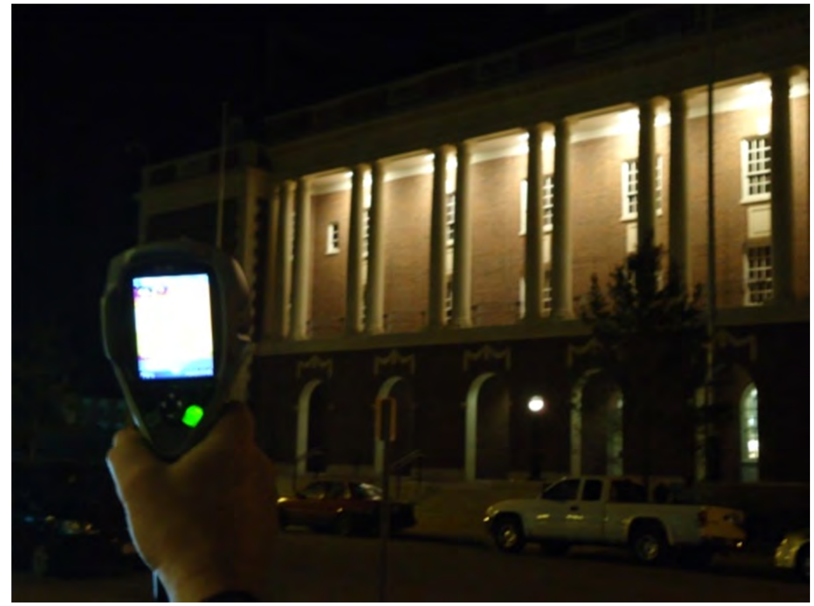
- Epsten Group conducted an evaluation of the approximately 100 windows on the facility. The following techniques were used:
  1. Review of original drawings
  2. Interviews with the courthouse architect
  3. Visual observation: All windows
  4. Hazardous materials sampling and testing: Sample of 21 windows
  5. Water infiltration testing: Sample of 19 windows
  6. Infrared air leakage testing: Sample of 21 windows

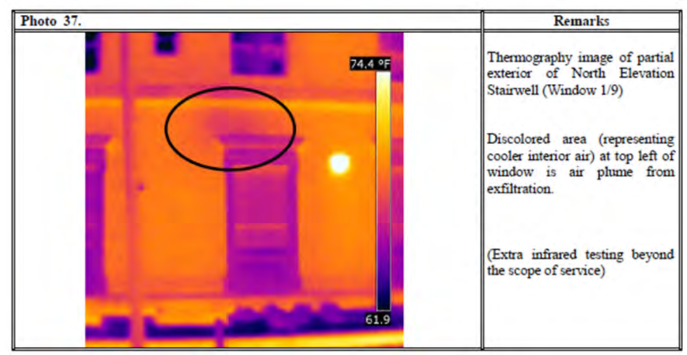
# Case Study: New Bern Courthouse

- A representative sample of 19 windows underwent water leakage following the AAMA 501.2-3 testing protocol.

# Case Study: New Bern Courthouse

- A representative sample of 21 windows then underwent air leakage testing using Infrared thermography, in accordance with the ASTM E779 protocol.





| Photo 37. | Remarks |
|---|---|
| 74.4 °F / 61.9 | Thermography image of partial exterior of North Elevation Stairwell (Window 1/9)<br><br>Discolored area (representing cooler interior air) at top left of window is air plume from exfiltration.<br><br>(Extra infrared testing beyond the scope of service) |

# Case Study: New Bern Courthouse

- The evaluation findings were as follows:
  - The windows were in tremendous condition for their age and window hardware was mostly complete and in tact.
  - Lead paint was present but no asbestos was found in the glazing compound.
  - 16 of 19 window assemblies leaked, but only at the stiles/mullions where glazing compound had worn down. No leakage occurred at the frames despite the lack of flashing.
  - The windows performed surprisingly well in terms of air leakage despite their age.

# Case Study: New Bern Courthouse

- Six repair/upgrade/replacement scenarios were initially recommended:
  1. Minor repairs and resealing of windows.
  2. Refurbish existing sashes and apply solar film.
  3. Minor repairs and resealing of windows  and install energy panels on interior side of windows.
  4. Refurbish existing sashes and install energy panels on interior side of windows.
  5. Replace existing window  sashes.
  6. Replace whole window assembly, including frame.

# Case Study: New Bern Courthouse

- Options 5 and 6 were immediately dismissed because they do not comply with the Secretary of the Interior's Standards for Rehabilitation.
  - *"Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence."*
  - However, Epsten Group still tested these options in Part Two of the project for informational purposes.

# Case Study: New Bern Courthouse

- In Part Two of the project, Epsten Group evaluated the repair/upgrade/replacement scenarios as follows:
  1. Energy cost savings of the scenarios were established by completing an energy model with baseline results calibrated to actual utility data from the courthouse.
  2. First costs were estimated by obtaining pricing from Marvin Windows.
  3. Payback periods and savings-to-investment ratios were then calculated for each recommended scenario.

# Case Study: New Bern Courthouse

- Results were then evaluated using an evaluation matrix based on 9 criteria.
  - Based on our 75% Report findings, GSA requested a calculation for the installation of energy panels alone.
  - The preferred solution for the project will be to refurbish the existing sashes to improve water tightness and install energy panels behind to improve energy performance.
    - Savings were estimated at 6.2% annually, or $3,850 per year
    - Payback periods were high (32 years) because the energy panels all would be custom for the existing window openings

| Option | Remedies Infiltration | Improves Energy Performance ($/yr) | Improves Energy Performance (MBtu/yr) | Complies With Historic Preservation Guidelines | First Cost | Payback Period (Simple) | Payback Period (10-yr Savings to Investment Ratio) | Payback Period (30-yr Savings to Investment Ratio) | Anticipated Life-Cycle Costs |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Good | $0/yr (0.0%/yr) | 0 MBtu/yr | Good | $96,800 | Never | 0.000 | 0.000 | No Change |
| 2 | Better | $674/yr (1.1%/yr) | -9 MBtu/yr | Best | $168,013 | 249 yrs | 0.040 | 0.120 | Better (Long Term) |
| 3 | Good | $3,850/yr (6.18%/yr) | 159.8 MBtu/yr | Good | $221,750 | 58 yrs | 0.174 | 0.521 | No Change |
| 3A | N/A | $3,850/yr (6.18%/yr) | 159.8 MBtu/yr | N/A | $124,950 | 32 yrs | 0.308 | 0.924 | No Change |
| 4 | Better | $3,850/yr (6.18%/yr) | 159.8 MBtu/yr | Better | $263,300 | 68 yrs | 0.146 | 0.439 | Better (Long Term) |
| 5 | Best | $3,745/yr (6.01%/yr) | 158.9 MBtu/yr | Non-compliant | $267,690 | 72 yrs | 0.140 | 0.420 | Better (Short Term) |
| 6 | Best | $3,856/yr (6.19%/yr) | 165.2 MBtu/yr | Non-compliant | $480,165 | 125 yrs | 0.080 | 0.241 | Better (Short Term) |

Table 8.1 - Evaluation Matrix for the New Bern Courthouse Window Study

# 3.0 Summary

- Building Envelope Commissioning Process
  - Design Phase:
    - OPR and BOD Review
    - Cx Kick-Off Meeting
    - Design Document Reviews
    - Cx Specifications
    - Installation Checklist Development
  - Construction Phase
    - Submittal/Shop Drawing Review
    - Cx Meeting
    - Site Observations
    - Mock-Up Testing
    - Envelope Testing

# 3.1 Summary

- Building Envelope Commissioning Process (Continued)
  - Post-Construction Phase
    - O+M Staff Training
    - Systems Manual/Re-Cx Procedures
    - Final Cx Report
    - Upload LEED Documentation (When Applicable)
- Envelope Testing Techniques
  - Water Nozzle Testing
  - Combined Air and Water Testing
  - Infrared Thermography
  - Blower Door Testing

# 3.2 Summary

- Benefits of Building Commissioning
  - For Design Professionals:
    - Improved Quality Control in detailing
    - Improved Quality Control in Construction Administration
  - For Contractors:
    - Fewer callbacks after completion
  - For Owners/Facility Managers:
    - Improved energy performance/cost
    - Improved durability and lower maintenance costs

# 3.3 Summary

- How Envelope Commissioning contributes to sustainable building:
  - Improved energy performance
  - Improved durability and longevity of building envelope materials
  - Helps maintain indoor air quality (IAQ) by preventing potential problems such as mold
- As a consequence, Envelope Commissioning has been added to the LEED for Healthcare Rating System and has been included in the LEED v4.0 Rating System as an optional credit.

# Conclusion

**Knowledge acquired:**

1. Participants can recognize the steps in the Envelope Commissioning process.
2. Participants can recognize some of the testing techniques used in the Envelope Commissioning process.
3. Participants can recognize the value of the Envelope Commissioning process to the various stakeholders of the project team.
4. Participants can recognize Envelope Commissioning's value to high performance, sustainable buildings.

**This concludes The American Institute of Architects Continuing Education Systems Program.**

# Course Evaluation

**Please fill out our course evaluation and let us know what additional improvements can be made to make this course better**

# Questions

**Please feel free to ask any questions you may have for today's course presenters**

# Thank You For Your Time

# About Us

- Established in 1991
- Multi-Disciplinary
- Small Disadvantaged Business; 8(m)
  Woman Owned Small Business (WOSB)

GSA Contract Holder
Contract GS-21F-0133Y

**Epsten Group Services:**

- LEED Consulting
- Energy Modeling
- Commissioning
- Retro-Commissioning
- Building Envelope Services
- Roofing & Waterproofing Consulting
- Architecture & Interior Design