

The formulae  $\frac{\partial \rho u_i}{\partial x_j} + \frac{\partial}{\partial x_j}(\rho u_i u_j) - \frac{\partial \tau_{ij}}{\partial x_j} + \frac{\partial}{\partial x_j}(\mu \frac{\partial u_i}{\partial x_j}) + g_i(\rho - \rho_0)$  for building  $\frac{\partial}{\partial x_j}(\rho u_i u_j) - \frac{\partial \tau_{ij}}{\partial x_j} + \frac{\partial}{\partial x_j}(\mu \frac{\partial u_i}{\partial x_j} - \rho u_i u_j) + g_i(\rho - \rho_0)$  state of the art  $\frac{\partial}{\partial x_j}(\rho u_i u_j) - \frac{\partial \tau_{ij}}{\partial x_j} + \frac{\partial}{\partial x_j}(\lambda \frac{\partial T}{\partial x_j} - \rho u_i u_j)$  biomedical research facilities.

## Building Enclosure Commissioning and Testing

Architectural commissioning was introduced in the January 2023 News to Use article “Architectural Commissioning: An Overview,” which is available on the NIH ORF website [News to Use \(nih.gov\)](https://www.orf.od.nih.gov/news-to-use/nih.gov). Many architectural systems may require commissioning in the execution of a project, including finishes, doors, hardware, equipment, and the building enclosure. Commissioning ensures the approved design and specifications have been faithfully executed. Building enclosure commissioning introduces an independent expert to establish acceptance criteria, evaluate and peer-review the construction documents, and complement the contractor’s quality control program for all enclosure components, including but not limited to roofing, wall assemblies, fenestration, and above and below grade waterproofing. This article reviews the testing requirements for the architectural enclosure commissioning process.

### Testing

Testing is an essential aspect of enclosure commissioning because enclosures consist of assemblies and systems constructed on-site, in unique configurations, whose performance cannot otherwise be assured. Testing exposes assemblies to real world conditions under which they will operate to assess their performance. As part of the development of the commissioning plan and commissioning specifications, the commissioning agent (CxA) will develop a list of tests to be conducted on materials, assemblies, and subassemblies to quantify their performance and ensure that they meet the Owner’s Project Requirements. Testing can focus on materials, interfaces, sealants, flashings, fasteners, joints, and other potential points of failure. Of particular concern are thermal performance, air transmission, vapor pressure drive, load capacity (structural, wind, blast), differential movement, durability, and other demands on enclosure components.

ASTM E2813 2018 *Standard Practice for Building Enclosure Commissioning* establishes the standard for developing an Owner’s Project Requirement document and conducting the Building Enclosure Commissioning process.

### Quality Control and Quality Assurance

Quality Control (QC) tests are conducted by the contractor as part of the construction quality control plan. The CxA should observe these tests to ensure compliance with established test protocols and performance requirements. Quality Assurance

(QA) tests are usually conducted as part of the commissioning plan. QA testing may be conducted by the CxA or by an independent testing agency under the oversight of the CxA. Categories of testing include:

- **Laboratory tests**, which are performed on materials and components by an independent testing agency with specialized equipment to determine their physical characteristics and predict their performance in service. Tests may include resistance (i.e., thermal, chemical, corrosion, UV, abrasion), strength, permeability, and adherence. Individual materials or assemblies may be tested.
- **Mock-up tests**, which are performed on full-size assemblies constructed for testing purposes on-site or at a testing facility. Mock-ups should include joints, transitions, corners, penetrations, sealants, and all other conditions and be constructed with the same techniques, materials, and contractors that will be used on a project. Mock-up tests may include structural/blast, air and water infiltration, and acoustical and thermal performance. Mock-ups may also be used to assess aesthetics, constructability, maintainability, compatibility of materials, and other factors. The primary objectives are to determine how components perform as assemblies and establish acceptance criteria for the actual installed conditions.
- **Field tests**, which are performed on actual building assemblies and are typically part of the finished construction. The primary objectives are similar to mock-up tests: to determine how components perform as assemblies and to establish acceptance criteria for similar conditions. Many of the field test procedures are also similar to mock-up testing, but more limited because they are not conducted in a testing facility.

### Conclusion

An enclosure commissioning program, including required testing, ensures that the building enclosure meets the OPR, sets performance standards and minimizes complications and re-work during construction.