Feature

Commissioning Airtight Building Enclosures:

The Importance of the Pre-Construction Phase Commissioning Process

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TODAY'S DESIGN AND CONSTRUCTION of commercial buildings is placing new challenges and demands on one of the oldest industries known to man. As the world population increases, we are forced to live in areas which were previously unoccupied—areas which often possess extreme climates. As such, the requirements for environmental separation between exterior environment and interior occupied space have increased. Additionally, energy use has become a global concern and buildings represent one of the most significant users of non-renewable energy resources and contributors to greenhouse gas emissions.

To this end, the building designer is not only the artist that will create the aesthetics of the building, but he now has the responsibility of selecting materials and designing systems that are both energy efficient and durable. In some cases, the expected service life of the building may be, in relative terms, short (25 years or less). In other instances, the building is considered a "monument", with an expected service life in excess of one hundred years. As a result, the onus falls upon the designer to understand the concepts of occupied space use, aesthetics, budget and the science of environmental separation.

Prior to 1950, most building enclosures were comprised of simple building materials and constructed by master tradesmen and qualified, experienced installers. Today, building enclosures include many different materials installed by multiple trades, and as a result, it becomes difficult for each trade to know how to coordinate his work with the overall installation of the other building enclosure components. Compounding the problem is the potential for chemical and physical incompatibilities between these materials and adjoining systems. The general contractor must schedule construction so that all of the materials can be installed into an assembly, and the different assemblies joined for a complete functional building enclosure. With the need to build throughout the whole year, numerous environmental conditions are faced—rain, snow, humidity, and $\triangle$T of 140F (60C)—and yet materials must be installed within recommended installation tolerances. Given all of these challenges, the potential for failure of one or more building enclosure components increases dramatically. These conditions require advanced planning to ensure that the construction satisfies the design intent and ever-changing energy code requirements, and provides a robust and durable building enclosure that will function over the full life cycle of the building.

Some contractors have developed their own quality control (QC) programs, but rarely do these programs address the building enclosure in a complete and holistic manner. For this reason, there is a recognized need for a specialized discipline to commission the building enclosure to address environmental separation and provide for an effective building enclosure, the requirements of which include: a thermal barrier to provide insulating properties; a vapor retarder to reduce the diffusion of moisture through the building enclosure; drainage planes to effectively manage water infiltration; and an air barrier to control the movement of air through the building enclosure. To address these issues, the National Institute of Building

Sciences (NIBS) has developed a guideline for the commissioning of building envelopes: *NIBS Guideline 3-2006 Exterior Enclosure Technical Requirements for the Commissioning Process*. Specifications are also now readily available for building enclosure separation project management, coordination and commissioning.

When one thinks of building enclosure commissioning, or in fact, any procedures to ensure a functional building enclosure, the focus usually falls upon the work-in-progress phase of construction. Specifically, what inspection and testing procedures will be conducted during construction (or even post-construction) to ensure an effective building enclosure? But, in actuality, many issues that may arise during the construction process, such as inconstructable details and other design issues, material incompatibilities, scheduling or sequencing conflicts with detailing assumptions, confusion or disagreements over testing procedures, and a myriad of others, can be eliminated through proper commissioning procedures conducted during the *pre-construction* phase of the project. The remainder of this article will focus on some of the procedures conducted prior to the start of construction that can greatly reduce the number of issues encountered during the work-in-progress phase of the project.

PRE-CONSTRUCTION PROCEDURES

With so many different design options and with the variety of different climates under which we build, the matrix of different system-climate combinations is so large that it becomes impossible to effectively "standardize" a testing protocol applicable to any building (for example, employing off-site testing for performance of materials and/or predetermined assemblies as the sole means of quality assurance). Buildings need to be viewed as individual projects with requirements peculiar to each project. Once an understanding of the aesthetics, performance requirements, climatic conditions and expected design life of the building has been gained, the selection of materials and their placement within the building enclosure can be made.

The building enclosure commissioning process begins early in the design phase of the project with the aforementioned functions diligently examined for their performance requirements, both individually and together as one functioning system. Reviews of the drawings and specifications are made, generally at 50 per cent, 90 per cent and 100 per cent completion, that consider constructability, the correct building science, material selection, and continuity between assemblies and systems (as the functions of different systems must not be compromised at junctions). While the final details will often change to suit the selected components and assemblies used in the successful tender (bid), these details are also reviewed prior to being constructed. Concurrent to the design review, testing and inspection protocols to be used throughout the project are developed, including designating specific test standards and procedures, review of contractor quality control programs and third-party quality assurance (QA) programs.

Prior to awarding the contract, a review of the tender submittals should be made to confirm compliance with tender documents. After the award of the contract, meetings are conducted to ensure all parties involved in the construction of the building enclosure understand their responsibilities. These meetings usually require the participation of the owner, designer, building envelope commissioning agent, general contractor, appropriate subcontractors, and third-party inspection/testing agencies or consultants. The general contractor will submit the construction schedule, and at this time, the sequence of installation of an assembly can be examined to ensure all components can be installed as designed. Often, details have to be revised to accommodate a different scheduling sequence than originally envisioned. QC and QA programs are reviewed so all parties understand who is responsible for what activities. Any environmental protection issues should be addressed by the general contractor to protect both work-in-progress and finished work.

The next phase involves construction of a mockup or mockups of typical wall sections to prove the functionality of the assembly, to identify any design or construction concerns, and to set a benchmark level of acceptance for the project. Four different types of mockups can be considered:

- An off-site laboratory setting is not uncommon for large or high-performance projects, and usually involves testing for air, thermal, and water penetration, and ability to withstand structural stress loads.
- On-site "stand-alone" mockups allow for the opportunity to work out any problems before the construction process begins. As the mockup is constructed and tested on-site, testing is usually more limited than what can be conducted in a laboratory setting. The benefit to on-site testing is that the mockup is exposed to conditions for which the remainder of the construction can be reasonably expected to be exposed.
- Designating a portion of the final construction of the mockup is fairly common, and like stand-alone mockups, is more limited in what can be tested. Unlike stand-alone mockups however, if problems are encountered, projects may be delayed due to the time needed to correct issues found during testing.
- Small mockups are often constructed for review of details that could not be included in the larger, start-up mockup. Ultimately, the type and number of mockups required will depend upon the size, complexity and performance requirements of each individual project.

Test results for the mockup must satisfy the performance requirements of the project, but be careful with the test results! Consider a mockup of the air barrier system, where the sample area consists of more than one component. Testing may reveal air leakage within the system, although the amount of leakage detected may be within the allowable leakage as specified in the tender documents. However, if the leaks are concentrated in one area, the amount of leakage might not be within the allowable amount if it were not "diluted" over a large test area. In other words, there may be a point failure within the tested area (or a failure of an individual component), but the result is diluted over the total test area giving a misleading "pass" result. For this reason, it is imperative that the tester have a comprehensive understanding of the test method, and ample experience conducting the test in question. It is one thing to be able to run a test and publish a result—it is quite another to be able to go beyond the numbers to provide an accurate analysis of what the numbers represent.

Once the mock-up is approved we move on to the construction phase of the project where the testing and inspection programs designed during the pre-construction phase can now be implemented. Although this article has stressed the importance of the pre-construction phase commissioning, by no means should this undermine the importance of commissioning during the work-in-progress phase. Think of it as if it were a building, where the pre-construction phase commissioning is seen as laying the foundation for a successful project. Once the foundation is laid, work-in-progress inspection and testing can be used as a tool to help ensure that construction continues on the right path to providing a functional building enclosure. ■

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If you would like a copy of the Building Envelope Environmental Separation Project Management, Coordination and Commissioning Specification, please contact Retro-Specs Consultants Ltd. at (800)-837-3207 or at retrspec@mts.net.