Guidelines for the Practice of Building Enclosure Engineering

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ABSTRACT

The City of Vancouver introduced a requirement in Part 5 of the 1999 Vancouver Building Bylaw (VBBL) that a Building Envelope Professional undertake design review, "enhanced field review" and provide letters of assurance that the components and assemblies of the project substantially comply with the requirements of Part 5 of the VBBL and with the plans and specifications accepted by the City on application for building permit. This requirement applied to all multi-residential buildings and buildings of framed construction.

This action made the practice of building enclosure engineering (or building envelope engineering, or applied building science) a mandatory requirement in a major jurisdiction. This started a process of defining and formalizing the practice of building enclosure engineering in British Columbia. In 1999, the Council of the Association of Professional Engineers and Geoscientists of the Province of British Columbia (APEGBC) adopted the first version of "Guidelines for Professional Practice Building Envelope Professional Engineer".

More recently, members of the Building Envelope Committee of APEGBC reviewed the 1999 document and other relevant documents, such as AIBC's Bulletin 34, endorsed by APEGBC, and produced a document entitled ***Guidelines for Building Enclosure Engineering Services for Part 3 Building Project****. APEGBC's Council is expected to formally adopt these guidelines in the near future. These guidelines set out the standards of practice that a Building Enclosure Engineer should follow and meet when providing building enclosure engineering services for building projects.*

The guidelines reflect the current state of practice in jurisdictions where application of independent building science expertise is both mandatory and mature. The logic and contents of the guideline should be of interest to practitioners and building code authorities.

HISTORICAL PERSPECTIVE

In the mid 1990s it became clear to practitioners and regulators of the construction industry in the Lower Mainland of British Columbia that many recently constructed buildings were suffering severe deterioration due to water intrusion into the walls. The problems were particularly prevalent in the three and four storey wood-framed, multi-residential buildings that had become a major component of the condominium housing stock built during the 1980s and 1990s. Investigations of the nature, extent and cause of the failures (CMHC 1996) highlighted that a dominant causal factor was water ingress

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at penetrations through wall assemblies (including windows, doors, balcony structure and ducts) and at interfaces between enclosure assemblies (including parapets and other roof/wall interfaces, inside and outside corners, and balcony/wall interfaces). Design features such as overhang protection, rainscreen wall assemblies, well designed flashing and sub-sill flashing under windows were observed to minimize the extent and frequency of problems. Other design features such as face-sealed or absorptive cladding systems (such as stucco) and metal framed windows that relied on sealant to make frame joints watertight were observed to increase the extent and frequency of problems.

Homeowners became very vocal in their frustration when burdened with huge repair bills and media attention was galvanized by dramatic photographs of severely deteriorated buildings. In April of 1998, the provincial government established a Commission of Inquiry into the quality of condominium construction in British Columbia. The Barrett Commission was tasked with determining the causes of the Leaky Condo Crisis and "…the adequacy of protection for, and accountability to, consumers for faulty condominium construction." (Barrett 1998). Extensive public hearings and submissions to the commission were consolidated into a report published in June of 1998 with additional reports focusing on some of the key issues published in January and March of 2000.

The Commission accepted that exterior water, i.e., rain, was the main moisture source for the problems and that interface details which allowed this water to get to moisture sensitive materials were the predominant culprits. Poor as-built details were most often caused by inadequate attention to details during design as well as poor construction practices. The Commission also accepted that the building enclosure was a specialized component of the building design and required specialized knowledge for proper design and construction to meet the requirements of the local climate. One of the key recommendations of the commission was:

Any architect or engineer involved in Letters of Assurance and the field review process must have the qualifications, or sub-contract the building envelope design and review to a qualified Building Envelope Specialist…

British Columbia, like other Canadian provinces, has a provincial building code (BCBC) based on the Model National Building Code of Canada (NBC) with a few amendments to reflect specific requirements of the province. The responsibility for interpretation and enforcement is typically borne by each Municipality. However, The City of Vancouver has its own Charter and its own building code, called the Vancouver Building By-law (VBBL) which varies more significantly from the NBC than the provincial code.

The City of Vancouver introduced a requirement in Part 5 of the 1999 Vancouver Building Bylaw (VBBL) that a *Building Envelope Professional* undertake design review, "enhanced field review" and provide letters of assurance that the components and assemblies of the *project* substantially comply with the requirements of Part 5 of the VBBL and with the plans and specifications *accepted* by the City on application for

building permit. The City also established a list of "Building Envelope Specialists" (BES), composed of firms which the City deemed qualified to provide independent inspection and review of building envelope components. The list was based upon the City's perception of the firm's qualifications and past experience in the Lower Mainland. To our knowledge this was the first legislated requirement for the application of building envelope or building enclosure expertise in North America.

There was no similar requirement written into the BCBC but many of the other municipalities in the coastal regions required that qualified specialists be used for building enclosure construction and rehabilitation and informally adopted the City of Vancouver's BES list.

A list of specialists created and managed by a municipality raised concerns, three of which included:

- The City undertook a significant liability by dictating who was and was not qualified to provide these services.

- By accepting engineering firms and professional engineers as specialists in the design of the building enclosure and as prime consultants on rehabilitation projects, the City was allowing engineering firms to provide services which were traditionally and legally within an architect's scope. This recognized that the development of the building science and specifically the understanding of building enclosure moisture performance issues had been primarily by engineering and technical organizations and that was where the expertise resided.

- By dictating qualifications, the City was encroaching on the mandate of the professional governing bodies which were created to oversee the respective professions.

The Architectural Institute of British Columbia (AIBC) and the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC) created a Joint Building Envelope Qualifications Committee and in 1999 they published:

- A Memorandum of Agreement (MOA) which outlined the acceptable boundaries for engineering involvement in this traditionally architectural sphere,

- A procedures manual, recognizing a formal designation, called the Building Envelope Professional (BEP) and outlining the role and scope of services to be provided by the BEP,

- A jointly administered process for accreditation. This included an assessment of the past experience of the applicant, which required a minimum of five years as a registered professional (with liability coverage), at least one of which must be in the province of British Columbia. The applicant had to have completed Building Envelope Education Program developed for and offered by the AIBC under the

continuing education program and include segments on building science principles, design of details, construction practices, field review and legal issues.

As the BEP designation became recognized, municipalities transferred recognition to the BEP list which grew to about 50 qualified professional, approximately two-thirds of whom were engineers.

Just when things looked to be proceeding smoothly, the process was challenged in court by a member of the engineering association who had been denied accreditation by the Qualifications Committee. The 2000 challenge was based upon a technicality in the Engineers and Geoscientists Act, which does not allow for the regulation of the practice of members. Justice Melnick of the Supreme Court of British Columbia ruled:

- …that the Association and the Institute lacked the jurisdiction to establish, by resolution, the [Joint Building Envelope Qualifications] Committee.

- that the APEGBC statute did not make provision for establishing and regulating a specialty designation.

The judge did note in his judgment that the accreditation of individuals for building enclosure construction was an excellent concept and was*"…undoubtedly in the public interest*."

Since that judgment, the process of accrediting Building Enclosure Specialists may have been in limbo but building enclosure consulting has become an integral part of the building industry in British Columbia. Most new, rehabilitation or renovation projects include a building enclosure design professional (architect or engineer). As a result, both the AIBC and APEGBC have "Building Envelope Committees" that address issues that arise with respect to the provision of building enclosure services.

The APEGBC Building Envelope Committee has focused on initiatives to help ensure quality and a consistent standard of practice amongst members in this field. This has included professional development initiatives, practice guidelines for members, and generally providing a point of contact and interface between industry and engineers in the building enclosure engineering field.

Very few North American university engineering programs offer a comprehensive program in building science or building enclosure engineering. As a result, many of the members in this practice area have their more formal training in related fields such as civil/structural, mechanical or materials engineering. It is generally acknowledged that this practice area is a combination of these fields of engineering, in addition to some facets of architectural expertise and construction. This lack of direct comprehensive training in building enclosure fundamentals emphasizes the need for professional development in this field of engineering.

In addition to maintaining an ongoing professional development program for building enclosure practitioners, APEGBC's Building Envelope Committee has considered some alternate approaches to ensuring quality and governing the practice of building

enclosure engineering. Two basic approaches have been considered; Accreditation and Practice Standards.

Accreditation – Develop and operate a program of accrediting and designating individual members as building enclosure engineers. This would be similar to the previous Building Envelope Professional designation but with enhanced technical education and experience requirements. A similar program would likely be developed by AIBC in recognition of the shared nature of this profession.

Practice Standards – Develop a standard of practice, or Guidelines, and rely on engineers to practice within their self identified areas of expertise. Existing APEGBC disciplinary processes could be used to address any situations where practice fell below the standard, and the Guidelines would be used as a primary benchmark for these situations.

There are clearly advantages and disadvantages related to the two approaches. The accreditation model offers a definable designation that can be recognized by the public and Authorities Having Jurisdiction (AHJ's). However, there is considerable administration and related costs associated with this model. The relatively small number of practitioners makes the administrative burden particularly onerous on a per member basis. Also, it is also perceived that the quality of the services provided was more and issue of consistency of application of good practice than individual competency or knowledge.

The key principle that has guided our approach to date is the fact that regardless of whether or not an accreditation model is eventually adopted, it is clear that practice guidelines are required. Both models need these guidelines as a benchmark. The focus of the APEGBC has therefore been on development of the Guidelines, and the decision regarding the need for formal accreditation has been deferred to a later time when the experience with members in this practice may or may not dictate the additional step of accreditation.

PRACTICE GUIDELINES

The intent of the Guidelines is to set out the standards of practice that an engineer should follow and meet when providing building enclosure engineering services for building projects. Progress on the draft guideline was slow for a number of reasons, not the least being that there are no widely accepted definitions of the practice of building enclosure engineering or minimum standards of practice for elements of it and developing guidelines required the application of a scarce resource; the volunteer time of a limited pool of practicing experts,. 2009 brought new imperative to complete the draft because the government of British Columbia made legislative changes allowing APEGBC to define and regulate the provision of specialty services. Some municipalities are also now pressing for a way to define who is competent to provide building enclosure expertise.

A review draft of Guidelines for Practice of Building Enclosure Engineering was released from APEGBC's Building Envelope Committed in January, 2011. This draft was submitted to the AIBC for comment with the intent of having the architectural association endorse the guidelines. A task group of the AIBC did provide some important comments on the initial draft. A revised draft of the guidelines was issued in September, 2011 which addresses most, but not all of the comments. As of January 2012, The AIBC has not responded to this draft.

While the endorsement of the AIBC is strongly desired, the plan is to finalize the Guidelines and have them issued to APEGBC members within the first few months of 2012

The full reproduction of content of the guidelines is clearly beyond the scope of this paper. As a result, the following sections provide a general layout of the guidelines and discussion regarding key aspects and professional expectations for each section of the guidelines.

Definitions

This seemingly innocuous section of the guidelines posed some key challenges. Definitions actually form the backbone of much of the discussion in the rest of the guidelines and therefore it is important to be clear in these definitions. As a fundamental starting point, the definitions are the same as, or are consistent with, those utilized in the building codes.

One of the more interesting aspects of definitions portion of the Guidelines is establishing a description of many of the types of projects. This is important because the type of project dictates the level and type of professional involvement required – work that must be done by architects, work that can be done by engineers and architects, and work that does not require the involvement of professional engineers or architects. Key definitions of project type descriptors in relation to the building enclosure include:

Maintenance - The actions taken periodically to sustain a desired or required level of performance. Maintenance includes cleaning, minor repairs, replacement of smaller components and activities that limit the deleterious effects to the building enclosure.

Rehabilitation - The process of undertaking a program of comprehensive and systemic reconstruction of the building enclosure assemblies and details, so that it can fulfill its originally intended functions. Rehabilitation programs are most often initiated because of premature failure.

Renewal - The process of undertaking a program of systemic reconstruction or replacement of aged elements of the building enclosure. Renewal programs are not associated with premature failure; rather the work is needed due to normal wear and aging associated with an element reaching the end of its service life.

Renovation - The process of undertaking improvements or changes to the building enclosure as a part of a more general program for the building related to changes in functional, performance or occupancy requirements rather than premature failure or the need for renewal.

Repair - The process of undertaking the reconstruction or replacement of specific elements of the building enclosure so that it can fulfill its originally intended functions. A repair is undertaken because of a premature failure, but is non-systemic (unlike rehabilitation) and therefore focused on one specific aspect of the construction, or is localized to one area of the building.

Introduction

The introductory section establishes context for the Guidelines.

Purpose of the Guidelines – Establish standards of practice that a building enclosure engineer should follow as the basis in fulfilling their professional obligations.

Scope of the Guidelines – Apply to the practice of Building Enclosure Engineering and specifically performance aspects of buildings governed by Part 5, 9 or 10 (energy performance section) of the applicable B.C. building codes. The Guidelines are also applicable to both new and existing buildings.

Compliance with these Guidelines – Failure to follow the Guidelines does not necessarily mean that a member has failed to meet their professional obligations. Comparison is required to the actions of a reasonable and prudent member in similar circumstances.

Qualifications of the Building Enclosure Engineer

The self governance model that is typical of professional engineering associations relies on members to provide services or practice in areas that they have the necessary competence, expertise and experience. Given the diverse backgrounds of building enclosure engineers it was necessary to define the core competencies in some detail. This part of the Guidelines therefore helps members to identify areas of competency so that members can direct their professional development and training activities accordingly.

In the event that it is decided that the accreditation model is necessary then this section of the Guidelines becomes the key criteria to be used in evaluating the qualifications of members for accreditation. Key core competency area headings from the guidelines are as follows:

- *Building Codes and Standards,* particularly sections of Parts 5 (Environmental Separation) and 9 (Housing and Small Buildings) associated with condensation control, heat, air and moisture transfer, but also Parts 3 (Fire Protection,

Occupant Safety and Accessibility , 4 (Structural Design) and 10 (energy conservation as they apply to the building enclosure design and performance.

- *Theoretical and Technical Knowledge* including the properties and behavior of materials, building physics (heat air and moisture transport) and the interaction of the building enclosure with other building systems.

- *Construction Document Preparation and Design Review* including assessing continuity of primary control layers, assessing compatibility of adjacent enclosure assemblies and providing appropriate levels of detail fro construction.

- *Investigation, Assessment and Testing* including knowledge of the applicability and limitations of test protocols and standards, as well as the appropriate use and calibration of testing equipment and instruments.

- *Construction Field Services* confirming substantial compliance with the construction documents and design intent or to identify the potential performance problems and areas at risk for water penetration, condensation, air leakage and heat loss.

Project experience in applying this knowledge is also essential. The Guidelines suggests the nature and duration of work experience that is considered appropriate as:

- three years' registration as a professional engineer with one year practicing in British Columbia,

- five years' of documented building enclosure experience demonstrating the core competencies listed above,

- a demonstrable effort to maintain knowledge over and above APEGBC basic continuing professional development requirements.

This section references an Appendix that lists key organizations and documents that a building enclosure engineer should be familiar with in their ongoing practice.

Guidelines for Professional Practice

This chapter is the technical meat of the Guidelines. It addresses the expectations of building enclosure engineers in the provision of a range of services. It focuses on the technical considerations and the tasks associated with addressing these considerations for a range of project types. There is recognition that while building enclosure engineers are commonly involved in construction projects (new construction or repair, renovation or rehabilitation of existing buildings), there a many other services that do not involve actual construction projects.

Construction Project Services. The industry has established well defined new construction project phases and design teams are quite used to working within this structure. A basic premise of the Guidelines is that this process also applies to most

renovation, rehabilitation and even repair projects. The steps may be abbreviated but they still exist. Interestingly, when you look at the tasks and details of the building enclosure engineer's involvement in construction projects as laid out in the Guidelines, particularly in a support role to an Architect as the primary designer of the building enclosure, it looks very much like how we define the commissioning process for the building enclosure. Furthermore, this process is not new to BC – it is already an integral and well established part of most new construction projects. Commissioning, in the British Columbia context, may simply be a relabeling of services that are already being provided.

The Guidelines describe project phases and the tasks associated with the involvement of the building enclosure engineer as follows:

- Conceptual or Schematic Design Phase
- Design Development Phase
- Construction Documents Phase
- Construction Procurement Phase
- Construction Phase
- Reporting

The tasks described in each phase are focused on moisture control performance issues and above grade-assemblies, as this has been the traditional focus of BC's building enclosure practitioners.

Key expectations or tasks for a building enclosure engineer include:

- Coordinate with the design team to establish the performance, functional, aesthetic and cost requirements of the building enclosure elements.
- Define and review with the design team, the building enclosure design criteria suitable for location and intended use and occupancy. These include interior and exterior environmental loads, control of air leakage, vapour diffusion, condensation and precipitation.
- Review drawings of enclosure assemblies (potentially including walls, glazing, roofs, balconies, decks, below and at-grade assemblies) and interface details between these assemblies to confirm that they can meet the established design criteria initially and over the long term with appropriate maintenance. Document the results in a format suitable to the design team and the client notifying of the design and construction team, regarding the implications and consequences of decisions and actions contrary to, or inconsistent with the provided advice.

- Verify that construction documents adequately describe the building enclosure elements and that the design can achieve the design criteria established in prior phases.

- In the construction phase, the BEE shall provide field review services for all building enclosure elements that the BEE has reviewed or designed in earlier phases. This can include, but not necessarily be limited to, the following:

    - Attend construction meetings, as required.

    - Assist in confirming, reporting and scheduling procedures for testing and field reviews.

    - Review of building enclosure-related shop drawings and other submittals for general conformance with the construction documents and the intent of the design.

    - Review reports provided by material and component manufacturers, as well as reports prepared by registered professionals who are reviewing building enclosure elements.

    - Visit the site at sufficient frequency and extent, to ascertain whether the work substantially complies with the construction documents and applicable portions of the building code. This would also include"

        - Assist in arranging and observing the mock-up and/or testing of key building enclosure elements such as wall assemblies or window installations.

        - Confirm that components and materials used are those specified in the construction documents.

        - Review the continuity of thermal insulation, moisture, air and vapour barriers.

        - Review drainage paths.

        - Review the acceptability of the moisture content of wood products.

    - Prepare and submit site visit reports outlining observations and deficiencies in the work and bring them to the attention of the applicable registered professional.

Other technical services that may be provided by building enclosure engineers within the project phase framework outlined above are described in the next section of the Guidelines.

Other Technical Considerations for Elements of the Building Enclosure and Building Enclosure Engineering Services. There are several technical service areas addressed by building enclosure engineers that may be considered additional or optional services in the context of a typical construction project. In addition, not all building enclosure engineers will have expertise to provide these services. For these reasons they have been discussed separately in the Guidelines with the assumption that if a Building Enclosure Engineers provides them must be able to demonstrate their qualifications independently and additionally to those of Building Enclosure Engineer. Services discussed include:

- *Separation of Dissimilar Indoor Environments* which is governed by Part 5 of Canadian Codes, and can be important but neglected aspect of some projects
- *Below-Grade Assemblies* which requires coordination with the professionals providing geotechnical, civil, structural and site drainage expertise.
- *Secondary Structural Elements* which typically addressed by professionals retained by the suppliers of enclosure systems
- *Snow and Ice Considerations* which is recognition as a area of special knowledge in BC
- *Acoustic Design* which is included in part 5 but is considered an optional specialty service normally provided by professional with a specialty in acoustics
- *Durability Documentation* as required by some specifications or programs such as LEED™
- *Heat Transfer and Energy Use Assessment*

Energy Use Assessment warrants some additional commentary. In the fall of 2009 British Columbia introduced new sections on the Letters of Assurance for energy utilization (Part 10/ASHRAE is actually how it is listed). This line item shows up on the list for all of the disciplines normally involved in energy aspects of a building project (Architect, Mechanical, Electrical). The building enclosure does not fit easily into this framework because while the enclosure is generally thought of as an Architectural item, the expertise associated with the determination of effective R-values, assessment of glazing system properties, has historically been part of the engineering world. However, while in most cases mechanical engineers have been comfortable addressing the overall building modeling and energy trade-offs, they have not been comfortable with the detailed analysis of effective R-values, U-Values and the materials, components and assemblies that comprise the building enclosure. This introduces a good opportunity for building enclosure engineers with appropriate expertise to provide support and bridge the gap between the Architects and mechanical engineers with respect to the energy performance characteristics of the building enclosure.

Other Services. This final section of the Professional Practice chapter of the Guidelines provides guidance related to services that are not directly related to a construction projects. Some of these services may ultimately lead to a construction project, such as investigative or condition assessment work, but initially this is not the case. These other services include:

- Building Asset Management Planning
- Targeted Investigations
- Second Opinion Engagements
- Warranty Pre-Expiry Reviews

Project Roles and Responsibilities

This section of the guidelines focuses on the relationship of the building enclosure engineer with the other professionals involved in construction projects including the architect, the building enclosure engineer's responsibilities with respect to the Authority Having Jurisdiction (AHJ), and accountability for the building enclosure design. There is a specific British Columbia context for much of the discussion in this chapter, specifically related to "letters of assurance" as accountability documents. This chapter also directly addresses the overlapping responsibilities of the building enclosure engineer and the architect. This has been an area of discussion, and sometimes controversy, in many jurisdictions. In British Columbia, the professional associations representing architects and engineers needed to respond cooperatively to the findings of wide spread building enclosure failures and the legislative initiatives reacting to those findings. The solutions reached in British Columbia may prove to be relevant to other locations. Even with the history of cooperation between the professions in BC, issues related to authorities and responsibilities in areas of joint practices remain at the core of most unresolved comment from the AIBC on the Guidelines

The roles and responsibilities for the various types of projects have been defined on the basis of competencies, but also reflect the requirements of the Architects Act and Engineering and Geoscientists Act in British Columbia. It is acknowledged that the broad knowledge base of architects is necessary to address all of the design criteria associated with the building enclosure in new building projects and renovation projects where the full range of design criteria need to be assessed. However, for repair and rehabilitation projects, many of the design criteria have been previously determined by the original design team. It is therefore acceptable for building enclosure engineers to lead and take responsibility for these types of projects, provided that the scope of the project is within their area of competence. Even with these more limited scope projects, a step has been identified that requires that an architect review the scope of the project for the purposes of identifying the need for any other design professionals – architects or other engineers.

It is because of the shared accountability and need to define when architects and engineers can or must be involved in projects that we have needed to define types of projects as discussed earlier in the Definitions section. The involvement of the building enclosure engineer is defined for 5 types of projects as follows:

- New Building Construction or Renovation Project
- Building Enclosure Rehabilitation or Renewals Project
    - with an architect as the Registered Professional of Record
    - with a building enclosure engineer as the Registered Professional of Record
- Building Enclosure Repairs
- Other Projects (condition assessments, investigations etc.)

SUMMARY

The guidelines are an attempt to define the practice of building enclosure engineering in a jurisdiction where the application of independent building science expertise is mandatory for many building projects and has become a recognized part the construction process. While written for a particular jurisdiction, the logic and contents of the guideline should be of interest to practitioners and building code authorities.

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