5. Building Condition Assessment

The process of organizing and conducting a thorough building condition assessment is an important first step in every tower renewal project. The information gathered from existing records and field investigations serves many purposes. Original construction drawings of the building are necessary to estimate the effective thermal resistance values of the building envelope, and for quantity survey purposes to establish the areas of windows, walls, balconies and roofs. These data are also needed to perform energy modeling of the tower building. Energy and water consumption data are essential to performing accurate energy modeling that subsequently feeds into the cost-benefit analyses. A condition assessment of the building envelope is needed to itemize the repair work needed before the retrofit process can proceed. HVAC system and piping inspections are required to determine the extent of the upgrading work to be carried out. Simple, but important, procedures such as surveying the building to assess if it is plumb, level and square, assist in the development of appropriate details that can be adjusted if necessary to accommodate distortions in the existing building.

Building condition assessment is a procedure familiar to the building science engineering and consulting industry. It is commonly conducted for condominium buildings as part of the larger process of reserve fund studies, but will differ for existing tower buildings owing largely to the age of the buildings, and in many cases, a lack of detailed documentation in the form of drawings and specifications. However, the process of building condition assessment is the same in principle for all buildings and formal protocols have been established in Canada since 1993.1

In the publication, Protocols for Building Condition Assessment, Institute for Research in Construction, National Research Council of Canada, Ottawa, 1993, the condition assessment process is divided into eight categories: building structure, building envelope, mechanical systems, electrical systems, interior finishes, life safety, elevators, and function. Each section has its own building assessment protocol that defines the scope of the audit for that category, the audit procedure, and associated deliverables. Collectively, these eight protocols comprise the complete preliminary audit process.

Figure 5.1 positions the formal building condition process covered by these protocols within the broader context of condition assessment requirements for existing tower buildings. At the conclusion of the condition assessment process, a comprehensive report is prepared that can be referenced for energy modeling, cost-benefit analyses and eventually by the design team.

In cases where a recent condition assessment has been performed, it is not necessary to perform all of the procedures that are later outlined. Typically, critical elements are inspected to re-assess their condition. This is particularly important for structural elements and substrates to which overcladding elements and guards will be fastened. One critical item that will not usually constitute previous condition assessments of a building is the survey of building distortions. The Canadian experience in the latest techniques for assessing the plumb, level and square attributes of the building indicates these are widely available to conduct this survey efficiently and economically.2

It is also important to note the checklists that follow are comprehensive, across a broad range of building types, and not all of the items may apply to every tower retrofit project.

Figure 5.1. The building condition assessment procedure depicted above provides a systematic means of assessing the condition of the entire building, its components and equipment.
Condition Assessment Checklists
The checklists which follow are excerpted from the Institute for Research in Construction’s Protocols for Building Condition Assessment. They are presented somewhat differently from the order depicted in Figure 5.1 to reflect the more likely sequence to be employed, and/or the inspection expertise required. Competent and qualified professionals commonly have developed their own checklists and procedures that may differ from those outlined here.

**Building Structure**
- underlying soils
- footings
- foundations
- retaining walls
- walls
- columns
- decking
- guards/railings

**Building Envelope**
- beams
- trusses
- slabs
- shear walls
- elevator cores
- cladding
- joints
- roofs
- foundation walls and slabs

Mechanical and electrical systems may often be inspected by a single firm that has both engineering disciplines in-house, but it is not unusual for separate consultants to be employed. In either case, it is important to coordinate these two categories because they are often interrelated, or occupy the same chases and bulkheads.

### Mechanical
- heating, ventilating, air conditioning systems
- garage exhaust systems
- domestic hot and cold water supply
- sanitary equipment and sewers
- storm sewers and drainage
- fire sprinkler and standpipe systems
- specialized equipment such as garbage chutes and compactors

### Electrical
- electrical supply and distribution
- lighting
- emergency lighting
- standby power system(s)
- telephone and communications
- cable and satellite TV
- security

**Figure 5.2.** Checklists for the assessment of structure and building envelope provide a framework for a more detailed procedures to be carried out in the field.

**Figure 5.3.** Photographs of the deficiencies are important for documentation purposes. The deteriorated exposed slab edge depicted above must be properly repaired prior to overcladding. Design details for the integration of existing grilles with the overcladding may begin to be investigated. [Photo: Halsall Associates Ltd.]

**Figure 5.4.** For the purposes of tower retrofits, some of the items listed above may not apply. Often it is worthwhile performing a comprehensive assessment so that a complete, up-to-date record is available for future facilities management plans.

**Figure 5.5.** The service condition of the air-conditioning tubing depicted above is fair, but the penetration through the roofing system has not been properly addressed. This opportunity arises with roofing replacement where more appropriate measures may be employed, rather than relying on large quantities of caulking. [Photo: J. McBride and Sons Ltd.]
The assessment of interior finishes is not usually required for tower retrofits, since practically all of the work associated with overcladding takes place on the exterior. However, it is not difficult to combine an assessment of interior finishes when carrying out an assessment of the functional elements of the building.

The functional aspects of the building that should be assessed are listed in Figure 5.6. Barrier free access was not a Code requirement when most tower apartment buildings were constructed. The comprehensive tower retrofit offers an ideal opportunity to address barrier free access requirements.

Elevators are among the most critical services in tower apartment buildings. Their reliability and efficiency impacts the convenience of the building inhabitants. There is a significant potential for energy efficiency improvements with cost effective upgrades to older systems.3

The assessment of life safety measures in tower buildings is normally well regulated and up-to-date inspection reports will usually be available. Many of the passive architectural elements will have been addressed in the past as a result of changes to codes, standards and insurance requirements. The emphasis in most tower retrofit projects will be on active mechanical and electrical elements. Comprehensive tower retrofits are an opportunity to upgrade these elements and improve the life safety of the building.

**Figure 5.6.** Interior finishes and function are two categories of condition assessment that can be carried out simultaneously during the building inspection process.

Barrier free access requirements.

**Figure 5.7.** The inspection of elevators is a specialty field that can only be performed by licensed mechanics and certified inspectors. The list of items to be assessed is comprehensive and involves both safety and performance measures.

**Figure 5.8.** Life safety requires inspection and review by qualified personnel. A comprehensive assessment is recommended for buildings that have not been thoroughly inspected in the recent past.

**Note on IAQ Monitoring**

Indoor air quality is not strictly speaking a life safety issue, but it is becoming a wider health concern. The sampling of exhaust air expelled from tower apartment buildings represents an opportunity to perform indoor air quality monitoring of the existing operating condition prior to retrofit. Subsequently, after the ventilation system has been upgraded, another set of samples may be obtained and analyzed to determine if there has been any change in the indoor air quality. Mold problems in tower buildings are quite common due to ineffective ventilation systems and when the overcladding is completed, the airtightness of the building envelope will have been dramatically increased. Monitoring affords a means of adjusting ventilation rates to achieve acceptable levels of indoor air quality and avoid health problems and damage to interior finishes in suites that generate high moisture loads. Air quality monitoring is now a widely available and affordable service that provides objective third party test data to building owners and HVAC system designers.

The checklists presented here outline the basic scope of a building condition assessment. It is intended more as a guide to building owners and facility managers who are arranging consultants for this service so they may appreciate the scope of the work. Special features of the building may require additional inspection and review. Building envelope inspections and testing of the soundness of the substrate (pull-out tests) often require a swing stage to gain access to the entire building envelope area. In some cases, sections of piping may have to be cut out to determine the wall thickness and remaining service life, and this will necessitate a temporary shutting down of water and/or sewage services. It is important to notify building occupants when and where inspections are being performed to minimize the intrusiveness of the inspection process. Scheduling away from peak rush hours and meal times is advisable.
Infrared Thermography

An important diagnostic tool for building envelopes is thermography. The infrared inspection of buildings for heat loss was one of the first commercial uses for thermography and today it is a widely available service provided by specialty consultants in this field. Thermography can yield qualitative and quantitative analysis of electrical and mechanical systems, and the building envelope.

Thermography can be employed during the condition assessment process to establish a qualitative reference level of thermal performance for the existing building envelope. Then the overcladding can be thermographically analyzed after it has been installed to ensure it has been properly and consistently applied. In some parts of North America, performance-based pricing is used to adjust payments for building envelope retrofits. Contractors are paid the percentage of the stipulated sum based on the percentage effectiveness of the installed assemblies according to a mock-up constructed according to the specifications and thermographically analyzed in a climate controlled test chamber. Thermography is more commonly employed as a means of identifying deficiencies that can be remedied before the warranty period expires. It is important to note that thermography is not a substitute for proper quality assurance procedures conducted in the field by qualified inspectors, as there are many aspects of overcladding installation that cannot be analyzed using thermography. However, the thermal performance of the overcladding strongly influences the energy savings realized, and hence the cost effectiveness of the investment in a comprehensive tower retrofit.

Figure 5.9. This thermographic images indicates high rates of heat loss through exposed slab edges of a tower building. The intersection of the two corner shear walls produces the highest rate of heat loss because these act like efficient cooling fins. This image helps explain why interior retrofits of these buildings are not thermally effective. The thermal bridges denoted above by the red and yellow areas cannot be addressed by this insulation strategy. [Image: Boldstar Infrared Services Inc.]

Figure 5.10. Single glazed windows typically represent the highest rate of heat loss in a tower building envelope. The uneven construction of the opaque wall assemblies is evident in this thermographic image, revealing the potential of this technology for quality assurance monitoring purposes. [Image: Boldstar Infrared Services Inc.]

Figure 5.11. The baseboard heaters beneath the second storey windows are evident in this thermographic image. Much of the heating in tower buildings travels directly to the outside without improving thermal comfort in the living spaces. [Image: Boldstar Infrared Services Inc.]
Assessment Audit Methodology
Referring to the previously outlined checklists, the methodology for the conducting of audits and inspections is briefly described below. It should be noted this may actually differ between organizations conducting the assessments. The discussion that follows is intended to provide a framework for the assessment process and deliverables.

Design Document Review and Post-Occupancy Evaluation
The condition assessment team is responsible for obtaining and reviewing all documentation in the form of original project briefs, original and updated working drawings and specifications, maintenance and operation reports. All utility bills for water, electricity and natural gas should also be compiled for use during energy analysis. Post-occupancy evaluation is a term used to describe the process of interviewing inhabitants, facility managers and building superintendents, as well as measuring building environmental conditions. The purpose of this evaluation is to gain an understanding of the operations, performance problems, comfort issues, and any other information pertaining to the behaviour of the existing building.

Building Inspection
A number of building walkthroughs will be conducted by a variety of experts corresponding to the condition assessment categories described in the checklists. Special testing and monitoring may also be conducted as required.

Costing
In order to perform a meaningful cost-benefit analysis of the proposed tower retrofit, costing of all necessary repair and replacement work must be assembled. The cost of various overcladding, window replacement and mechanical/electrical equipment alternatives should also be estimated at this time so that accurate, up-to-date information is available for cost-benefit analysis of the entire comprehensive tower retrofit project.

Reporting
A complete report will contain, as a minimum, the items noted below. It should be organized for convenient reference and include all documentation gained during the document review and post-occupancy evaluation process. Digital files of the documentation, report and photographs should be attached to the report, suitable for archiving and future reference.

Description of Existing Building Category
The existing inventory of each building category should be described in this section of the report. For equipment and services, the type, age, manufacturer and model numbers should be identified, as applicable. Capacities for HVAC and electrical equipment must also be noted.

Component Condition Summary
An assessment of the operating condition and remaining service life of all components should be clearly summarized. Items that will not be affected by the comprehensive retrofit should be differentiated from those that may be upgraded or replaced.

Key Deficiencies and Cause
The items that are deficient and require repair prior to the comprehensive retrofit are identified in this section of the report. It is important to identify the cause of the deficiencies so they may be considered by the retrofit design team.

Recommended Repair and Replacement
Deficient and deteriorated components that need to be replaced must be identified and listed in order of priority based on life safety and consequential damages arising. This list should differentiate critical items to be addressed prior to retrofit versus items that can be repaired or replaced without affecting the scheduling of retrofit work.

Cost of Retrofit Components and Equipment
Unit prices for components and assemblies along with estimates of total retrofit costs associated with each retrofit measure are necessary to perform cost-benefit analyses, and to estimate a retrofit project’s cash flow requirements. The condition assessment team may have to consult with quantity surveyors, cost consultants and experienced contractors to obtain a reasonably accurate range of costs. Recent historical data on escalation rates for materials and labour should also be provided, where available.

Recommended Maintenance
There is no guarantee that the pro forma for the proposed tower renewal project will be feasible. This will depend on a large number of factors, and in some cases, it may be necessary for the owner to wait some considerable time before proceeding with the project. The recommended maintenance for the existing building is necessary to preserve its integrity. The recommended maintenance and recommended repair and replacement identified in the report will assist the owner in preserving the building asset regardless of whether or not the tower renewal project proceeds. This is the rationale behind conducting a comprehensive building condition assessment and having current information about the state of the building asset.

Condition assessment for buildings is akin to regular physical examinations for people. Small problems can be addressed before they become big problems. Mid to long-term planning to address deterioration and preserve the asset may be formulated well in advance of compliance orders by regulatory agencies. It is possible to go forward with complete knowledge of the available options.

Depending on the capacity of consultants employed by the owner to perform the conditional assessment, it may also be combined with the energy modeling and cost-benefit analysis. These may be integrated into a pro forma for the comprehensive tower retrofit. Regardless of the arrangements made by the owner in this regard, the completed condition assessment report and all supporting documentation should be conveniently packaged for archiving and future reference. This information is critical in the formulation of suitable design strategies for the site and building systems as discussed in the two chapters that follow.

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