The following is a description of a project at a large Canadian hospital utilizing coatings manufactured by Safe Encasement Systems.

Encasing Asbestos Fireproofing at a Major Canadian Hospital

At nearly 3 million square feet of total floor area, McMaster University Medical Centre (MUMC) in Hamilton, Ontario, is one of Canada's largest hospital and health care research facilities. The facility is owned by McMaster University, and operated by Hamilton Health Sciences, which also operates four other health care and research facilities in Hamilton. In spring 2003, the MUMC Engineering and Development Department started one of the largest projects of its kind ever – the encasement of several million square feet of asbestos-containing spray-on fireproofing. By spring 2004, the project was at the half-way point, and slated for completion by fall 2004.

This article describes the facility, the challenges associated with managing asbestos-containing fireproofing, and how encasement has simplified asbestos management and facilitated implementation of an ambitious infrastructure upgrade program at the site.

About the Facility

MUMC was designed by architect Eberhardt Zeidler, and built between 1969 and 1972. Zeidler is considered one of the leading architects of his era, having completed a variety of significant projects including Ontario Place, Toronto (1967-1971), the Eaton Centre, Toronto (1974-1981), the Walter C. Mackenzie Health Sciences Centre, Edmonton (1975-1986), the master plan for the Yerba Buena Gardens, San Francisco (1980-1984), Queen's Quay, Toronto (1979-1983) and Canada Place, Expo 1986, Vancouver.

MUMC is essentially a ten story-high structure comprised of four clinical floors, four full story "interstitial floor" (one located above each clinical floor), and two floors of mechanical penthouses (PHOTO 1). The basic footprint for the first eight stories is approximately 250,000 square feet, with the penthouses being about 125,000 square feet.

In the architect's original design vision, the most important concept that affected the physical form of the building was the need for flexibility in its structural and mechanical functions. To achieve this, the building was constructed of a steel superstructure, with vertical members positioned around the perimeter of the building in a number of vertical shafts, and horizontal members penetrating the interstitial floors. The interstitial floors also house all the mechanical and electrical systems, medical gas lines, and cabling.

As a result of this design, most of the floor area of the clinical floors can be configured in virtually any way. Placing the structure and building systems in the interstitial floors and shafts also meant that the building could be maintained, modified and repaired without impacting clinical floors.

Asbestos Fireproofing

As was typical of steel superstructure buildings constructed in the early 1970s, a sprayed-on cementitious fireproofing containing 10% to 15% chrysotile asbestos was applied to all of the structural steel (PHOTO 2). This is a rigid material, and is susceptible to age-related cracking, and displacement when subjected to impact. Fallen dislodged fragments can be crumbled or crushed to a powder.

The Challenges of Asbestos Management

The presence of asbestos in the fireproofing at MUMC was not really an issue until the *Regulation respecting Asbestos on Construction Projects and in Buildings and Repair Operations* came into force in Ontario in March 1986. Like similar regulations developed in the United States, the new Ontario regulation required building owners to survey their buildings to determine whether asbestos was present in building materials, and if so, to compile an inventory of such materials, periodically inspect, cleanup and repair any damaged materials. In addition, this regulation created three "types" of work operations involving asbestos exposure in buildings, construction and demolition work, and prescribed controls for each. This new asbestos regulation would have significant operational implications for MUMC.

Since all building systems at MUMC were located in the interstitial floors and shafts, maintenance workers and contractors entered into and worked within these areas on a daily basis. Often, work caused damage to the fireproofing. Over time, this resulted in the accumulation of an appreciable amount of spray-on fireproofing debris within the interstitial spaces.

In the mid-1990s, the Ontario Ministry of Labour (the occupational health and safety regulatory agency for the jurisdiction) decreed that all non-asbestos work performed within the interstitial floors at MUMC was to be performed in accordance with controls for a "Type 2 asbestos work operation", as defined by the asbestos regulation. This meant that all personnel entering the interstitial floors for any work – routine maintenance, equipment checks, repairs, etc. – were required to wear full body fibre-impervious coveralls, HEPA-filtered half-face respirators, use HEPA vacuums and wet wiping for dust control and clean-up, and follow basic decontamination procedures upon exiting the floors. The Ministry of Labour also required an extensive clean-up of the fireproofing debris that had been generated as a result of prior work activities in the interstitial floors.

These requirements had significant cost consequences for MUMC. The requirement for Type 2 controls led to 20% to 40% increases in costs for maintenance and repair work carried out inside the MUMC interstitial spaces. The use of asbestos abatement contractors for clean-up and containment of fireproofing debris was also adding up to millions of dollars.

Asbestos and the Future of the Facility

By the year 2000, concerns were being raised that the presence of asbestos fireproofing might comprise plans for the future of the facility.

When originally conceived in the mid-1960s, MUMC's planners anticipated the need for enlargement of the facility at some time in the future. To permit this expansion, the building was structurally designed and engineered to permit the construction of several additional floors on top of the building.

In the late 1990s, it was evident that there was a need for expansion of the facility, and for upgrades to building systems. However, virtually all of this work would either be carried out inside the interstitial spaces, or would otherwise impact on the interstitial spaces. The added costs for completing this work under Type 2 conditions were uncertain, but likely to be between $30 and $40 million. Moreover, after incurring these added costs, the asbestos-containing fireproofing would still be present.

The Search for a Solution

Faced with ongoing non-value adding costs for asbestos management, and the huge added costs for future expansion and infrastructure upgrades, MUMC looked for a solution.

Removal of asbestos fireproofing was considered, but this option was rejected when contractors provided budgetary estimates in the range of $80 to $120 million. The option of building a replacement facility was even briefly considered.

In 1999, MUMC management raised the question of whether the fireproofing could be coated with an encapsulant as a means of containing the asbestos and preventing future deterioration. MUMC's occupational hygiene consultant, Resource Environmental Associates Limited (REA), initially advised against this option. To work at MUMC, an encapsulant needed to have sufficient strength to protect the fireproofing from damage, yet be elastic enough to prevent age-related cracking. An encapsulant also had to be fire safe, and water based, since the release of large quantities of volatile organic compounds into the hospital environment was not an option. There were no products available in the Canadian marketplace that met all these criteria. MUMC then directed REA to determine whether a suitable encapsulant was available in the United States or Europe. Based on a reviewing virtually every coating system known to be used to encapsulate asbestos, REA settled on a water-based two-coat elastomeric encasement system that was developed and first utilized in California in the early 1990s.

The Encasement Product Evaluation Process

Approving the two-coat encasement system was a lengthy process. The first round of evaluation involved reviewed product safety data sheets, technical specification sheets, and laboratory testing reports, and comparison of the characteristics of the encasement coatings to a variety of other coating systems applied over asbestos. MUMC's consultant also examined samples of the raw coating products, samples of coating-encased glass bottles (which could be smashed with a hammer to shatter the glass while the encasement membrane remained sound and flexible), and they applied the coating system onto a variety of substrates (glass, wood, metal, concrete) to assess ease of application, curing time, and durability when cured.

Encouraged by the outcomes of the initial evaluation, a decision was made to visit encasement installations in the United States. In early spring of 2001, visits were made by representatives of MUMC and REA to several facilities in California where the coating system was first used in 1993 and 1994 to encase spray-on asbestos fireproofing over structural steel. They found these eight-year old encasement installations to be in excellent condition.

Following inspection of the initial installations, REA planned a field test at MUMC involving application of the encasement coating system onto a 500 square surface area of asbestos fireproofing. In advance of this field test, REA compiled a dossier on the encasement coating system for review by the Ministry of Labour, and invited the Ministry to observe the application process and in situ adhesion and cohesion tests. The field test was carried out in late spring of 2001. The field test made several significant findings. Firstly, air monitoring for asbestos fibre revealed that spray application did not cause airborne asbestos fibre concentrations in the area of application to increase (which meant that application did not present risks of dispersing asbestos fibre). Secondly, adhesion / cohesion testing in accordance with ASTM E736-00 found the encased fireproofing to be 100 to 200 times stronger than the non-encased fireproofing.

As a result of these findings, the Ministry of Labour made two key decisions: (1) encasement could be carried out under Type 2 as opposed to Type 3 conditions (the Ontario regulation stipulated Type 3 conditions for spray application of a sealant onto asbestos materials, and would have required poly enclosures, negative pressure, showers, and other control measures that were not required for Type 2 asbestos work); and (2) if all of the asbestos fireproofing at MUMC were encased, the Ministry would end the requirement for Type 2 precautions to be followed for non-asbestos work carried out inside the interstitial floors and shafts.

The field test results, in combination with these pronouncements by the Ministry of Labour, convinced MUMC and REA that encasement was technically feasible, and could be the solution to the many problems that asbestos fireproofing had caused for MUMC.

But at What Cost?

There was, however, still the question of how much it would cost to encase all of the structural steel in a 3 million square foot facility. There was no easy answer to this question. Encapsulation was not a common practice in Canada, and as a result, contractors had little experience on which to base cost estimates. In addition, the MUMC facility was not a typical building. As a result, it was felt that contractors would not be able to supply reliable estimates for budgeting purposes, and a decision was made to conduct a cost and productivity study.

Such a study was carried out in summer of 2001. An area of approximately 10,000 square feet within a MUMC interstitial floor was selected for encasement. Coatings were obtained, a contractor was selected and trained, and MUMC's consultant tracked all costs, work activities, and evaluated coating rate of coverage and labour productivity. On the basis of this study, REA concluded that all of the structural steel in MUMC could be encased for under $8 million CAD. At that price, the savings realized by the elimination of Type 2 requirements for non-asbestos work inside the interstitial spaces would yield a project payback for encasement in three to four years. More significantly, encasement would make it possible for MUMC's planned facility expansion and infrastructure upgrade projects to proceed without incurring the additional $30 to $40 million in wasted costs to carry out this work under Type 2 asbestos precautions.

The Project Goes Forward

In early 2002, MUMC prepared a funding proposal and business case for encasement, which was approved in summer 2002 by MUMC's Board of Directors and the McMaster University Board of Governors (which would share in project funding). As part of this process, the McMaster

Board of Governors referred the proposal to staff professors having expertise in building science, who in turn made their own independent appraisals of encasement, and ultimately endorsed the proposal. In winter 2003, planning for the full scale project began, and the project commenced in May 2003.

Several challenges had to be overcome in the first months of the project. The contractor (Total Environmental Services) had to develop skill and efficiency in application of the encasement coating (since no Canadian contractor had prior experience with this coating system), and it took time for the various steps in the process to become properly integrated. Much of the structural steel in the interstitial floors is beneath floors made of corrugated steel decking. Floor decking had to be removed, and the sub-floor had to be pre-vacuumed, prior to application of the encasement coating. It took time for the contractor's workers to understand the standards required by the consultant for debris elimination and uniformity of encasement coating application. Following encasement, the decking had to be re-installed. In addition, the interstitial floors are hazardous workplaces due to the presence of areas without flooring (which required use of travel restraint equipment for much of the work), congestion, and the presence of electrical, mechanical and gas systems. The challenging nature of the work, combined with the need for continual safety vigilence, led to the contractor experiencing a high rate of employee turnover.

Skills and efficiencies increased with experience, and by the end of 2003, the first phase of the project (that being 40% of the total floor area of the interstitial floors), was nearly completed.

Phase 2 of the project commenced in early 2004. As of March 2004, only one minor lost time injury had been experienced on the project, after nearly 40,000 person hours of work.

The encasement project has allowed facility expansion and infrastructure upgrades to move forward. A bridge to a new adjacent building has been built, linked to an encased area. Equipment for a co-generation plant is being installed in encased areas. New VAV boxes are being installed in encased areas. Starting sometime in late 2004, a new sprinkler system will be installed throughout the facility (which by that time will have been completely encased). And of course, work in encased areas no longer requires use of Type 2 asbestos precautions.

About the Author

John Murphy, BSc, MHSc, MBA, ROH, CIH is founder and president of REA, an occupational hygiene and environmental health and safety consulting firm with offices in Toronto, Hamilton, Ottawa, and Vancouver. The firm has acquired substantial experience with encasement of asbestos and non-asbestos friable materials, and is assisting several governmental and non-governmental clients on encasement projects. REA is the consultant for MUMC encasement project. For the past three years, REA has also been the official provider of occupational hygiene sampling and analytical services to the Ontario Ministry of Labour, which is the health and safety regulatory agency in Ontario.

Author's Reflections on the Project, Asbestos Removal and Encasement

This project has been highly successful from the perspective of all stakeholders. I think some of the key reasons for this have been the deliberateness and diligence of the process leading to the project, and the fact that the regulator – the Ontario Ministry of Labour – has been kept involved every step of the way. All of this was essential for the first-time introduction into Canada of a product system and asbestos management solution that had not been tried previously.

Our experience with this project has led us to conclude that there are many other opportunities for application of this technology to public and private sector buildings in Canada. This is an application that presents the potential for saving hundreds of millions of dollars, and really being a superior alternative to the current common practice of removal and replacement.

The project has also given me cause to critically reflect on the wisdom of the current common practice of removing asbestos materials and installing non-asbestos substitutes. I believe there are many situations where encasement is a much better option, and for this reason, my firm has actively promoted encasement as an alternative to removal and replacement. While there are certainly commercial motivations for our doing so, there are also substantive, principled reasons for our position, which I will explain herein.

It is probably not unfair to say that at present, the de facto philosophy of most Canadian building owners for managing asbestos buildings is to do planned removals. Sometimes these removals are a sensible and necessary part of a renovation, upgrading or demolition project. However, there are also planned removal programs that simply are not necessary for building use, operational, or safety reasons these are essentially discretionary removal programs). Discretionary removal has become an accepted practice, but in fact, the merits and demerits have received little in the way of scrutiny or open debate.

There are several features of discretionary removal that question its wisdom. In addition, it is a costly undertaking in comparison with encasement, and arguably delivers little in the way of health protection benefits. In many situations, asbestos removal and replacement diverts resources from other uses that could better benefit the health and welfare of workers and the public.

One issue requiring examination is the use of substitute fireproofing materials after removal of asbestos fireproofing. There is no certainty that many substitute materials being installed after asbestos removal are significantly less hazardous to workers or building users than asbestos. In fact, the health risk situation may be worse after removal and replacement with substitute materials, since the protective measures followed for work around asbestos are generally dropped in their entirety after asbestos is replaced with a substitute material. Yet, studies show that unprotected disturbance of substitute materials (such as man made mineral fibre, rock wool, fiberglass, treated cellulose, vermiculite, etc.) can cause the worker causing the disturbance, to experience short term exposures on the order of tens of thousands of fibres per cubic centimeter of air. So, even if the substitute materials are only 1/1000th as harmful as asbestos, exposures to substitute materials can still be hundreds of times more harmful than exposures to asbestos under an asbestos control scenario after encasement.

The problem is well illustrated by the current situation with mineral fibre – a common asbestos replacement material. In Ontario, mineral fibre now has an exposure limit of 1 fibre per cubic centimeter of air, which is equal to the exposure limit for asbestos in Ontario two years ago (since then, Ontario has lowered the asbestos limit by a factor of 10). In other words, many building owners are removing one hazardous material that is highly regulated and subject to strict controls (asbestos), and installing other hazardous materials that are not regulated nor subject to any protective controls.

It is far from certain that real health protection benefits are achieved by planned asbestos removal, followed by replacement with substitute materials. The removal operation itself presents risks of exposure to removal workers and building occupants, and in my experience, poor quality and poorly controlled removals seem to be the norm rather than the exception. And as noted above, the relative safety of substitute materials continues to be questioned.

Another dimension to this issue relates to the adequacy of asbestos-substitute as fire protection materials. Asbestos substitutes are generally inferior to asbestos as fireproofing materials. This issue has received some discussion in the recent United States Federal Emergency Management Agency (FEMA) report on the collapse of the World Trade Centre. The report notes that structural steel from the upper floors of the twin towers found in the debris of the collapsed building was largely free of fireproofing. Apparently, the non-asbestos substitute used on the upper floors was not sufficiently strong to resist the explosive blast and impact, leaving the structural steel exposed; thereby causing the buildings to collapse long before the two-hour designed fire rating.

The economic implications of discretionary removal also require discussion. The costs of discretionary asbestos removal are substantial in absolute terms, and in comparison with other alternatives (in the case of the MUMC project, the cost of encasement is believed to be less than 10% of the cost of asbestos removal and replacement). In addition to the costs of removal and replacement, there are the consequential costs associated with non-use of those areas of the facility undergoing asbestos removal, plus relocation costs, plus business disruption costs. These are not unavoidable, "must spend" costs. They can be avoided completely in many situations. A decision to encase asbestos fireproofing in these buildings, rather than removal and replacement, promises savings in the hundreds of millions of dollars, as has proven to be the case at our large hospital project, as well as many smaller scale projects we have managed.

With respect to current practices for removal of asbestos fireproofing and replacement with substitute materials, it is interesting to note that architects' specifications for asbestos fireproofing removal and replacement often require that the substitute material be coated with a polymer sealant. (In other words, the steps are as follow - remove the asbestos, respray those areas with an alternative fireproofing material, then spray a sealant over top of the new fireproofing). The sealant is applied mainly to preserve the structural integrity of the replacement fireproofing (many products are weak and readily fall off), and to control continual release of fibre (which causes dust problems in the building and impairs indoor air quality). Encasement involves application of a much stronger sealant directly onto the asbestos fireproofing. It eliminates many steps in the process, and allows the work to be carried out while the building areas undergoing work are still occupied. The sealant makes inadvertent damage to the asbestos fireproofing virtually impossible, completely eliminates fibre release and therefore exposure potential, and allows the asbestos material to remain in place without need for many of the troublesome re-inspection and regular cleaning operations associated with the old manner of managing asbestos in place.

Finally, despite it having become common accepted practice, and in fact, a practice recommended by many asbestos consultants, discretionary removal is not now, and to my knowledge never has been, a practice recommended by any recognized authorities. Governmental occupational and environmental health authorities (e.g. Health Canada, Ontario Ministry of Labour, United States Environmental Protection Agency, United States Occupational Safety and Health Administration, United Kingdom Health and Safety Executive, etc.) all have taken the position in the past three decades that discretionary removal is not warranted, nor advisable, and may in fact lead to greater population asbestos exposure than leaving asbestos in place under a responsible management program.

At some point in the future, the folly and wastefulness of discretionary removal and replacement will be recognized, and we in the occupational hygiene profession will have little justification for failing to speak out more loudly against many of the misguided asbestos control practices that are now commonplace.

- End -

Pictured above is front of Health Care Building (top) and fireproofing before encasement (lower).

Pictured below is a close-up of encasement (top) and a view of the structural steel after encasement (below).