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BUILDING CONDITION ASSESSMENT PROGRAM – RISK EVALUATION AND LIABILITY MANAGEMENT

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1. CHALK RIVER LABORATORIES SITE HISTORY AND CURRENT STATE

Chalk River Laboratories (CRL) is a large nuclear research and development/industrial site operated by Atomic Energy of Canada Limited (AECL). The CRL site consists of a 70 hectare developed (industrial) site located within a larger undeveloped area (Supervised Area – 37 km^2, or 3700 hectares).

Construction of the CRL site started in 1944. The development and operating history includes the construction and operation of 7 research reactors and numerous associated supporting nuclear laboratories, including fuel fabrication facilities, research laboratories, test facilities, and waste processing facilities. Numerous other support facilities were also constructed, such as administrative and office buildings, manufacturing facilities, and buildings for essential services such as fire and security services. Altogether, the CRL site includes roughly 120 buildings (Figure 1), and the site continues to operate in the fields of nuclear research and development and medical isotope production.

Within this operating environment, a number of buildings, facilities, structures, and reactors (hereinafter referred to as buildings), have become redundant and have been shut down for various reasons. Redundant buildings are currently shut down within the operating organization and turned over to the decommissioning organization for decommissioning, but in the early years, in the absence of a decommissioning program, redundant buildings were most often simply placed into storage for an undefined period. As a result, there are a significant number of buildings at CRL that have been declared redundant (roughly 20, or 1400 m^2), particularly those constructed in the early years of site development. Further, with many buildings at CRL approaching the ends of their design life, a significant number of other buildings will become redundant during the next decade (an additional 20).

2. CRL DECOMMISSIONING PROGRAM – STRATEGIC PLANNING BASIS

2.1. Decommissioning Program Objectives

Decommissioning is carried out through AECL's Decommissioning Program, operated by the Decommissioning Planning & Operations (DPO) Division. One of the key objectives of the decommissioning program is to decommission redundant facilities/buildings in an optimally safe and cost-effective manner, and the underlying principles to meet this objective are:

- to minimize health and safety (worker, public), and environmental risks (HSE risks),
- to minimize decommissioning costs and business risks to site operations,
- to minimize future decommissioning costs, and

— to operate the program in a coordinated manner that benefits the continued effective operation of the site for many decades.

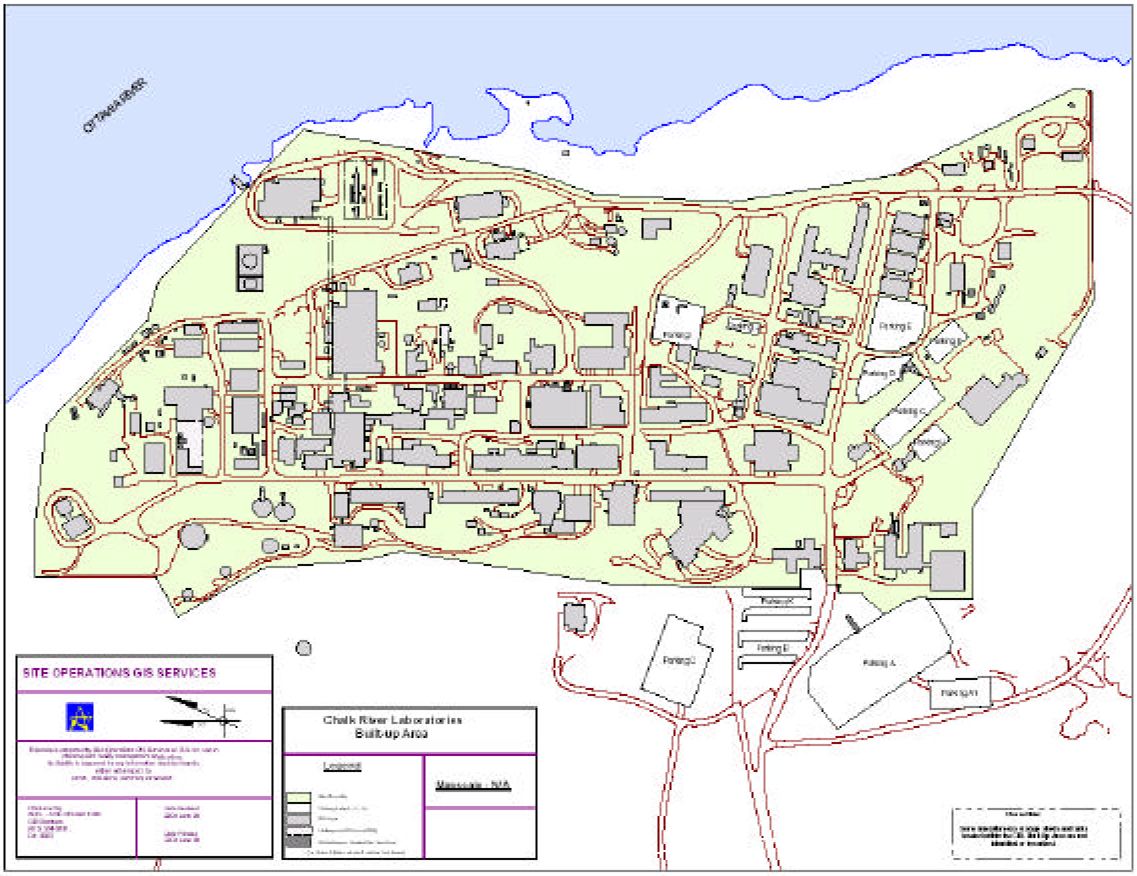

Figure 1. CRL Site - Developed Area (Controlled Area).

To meet the top-tier cost/risk optimization program objective, the DPO Decommissioning Program is risk-based. One of the key management tools is a "prioritization process", in turn supported by different types of technical evaluations, including the assessments conducted in the Building Condition Assessment Program. The prioritization process is a methodology that identifies, assesses and ranks (prioritizes) HSE and business risks in a systematic fashion. Through this process, major top-priority initiatives have been undertaken to reduce HSE risks and to make advancements towards achieving the desired end-state of the site.

2.2. Strategy and Planning Basis

A site-wide (CRL) Decommissioning Plan [1] provides the overall planning basis for the CRL site. It incorporates all facilities, infrastructure, services and properties at the site. Also included in the plan are "enabling facilities" that will be required in the future in order to carry out the work in a safe and cost-efficient manner (e.g., waste clearance facility, incinerator, waste disposal facilities).

In general, the CRL decommissioning plan employs the following decommissioning strategies:

- Prompt removal – from turnover to a decommissioned site in less than 2 years (e.g., administrative buildings and laboratories),
- Deferred removal – where prompt removal is either not possible, or where prompt removal is not optimal in terms of radiation exposures to workers, and
- *In situ* disposal – where predicted future doses are low enough that the costs involved in retrieving and repackaging the wastes are not justified (e.g., low-level waste management facilities).
- *Re-Use* – where the facility is being decommissioned to incorporate a new process installation.

With respect to the decommissioning buildings at CRL, *removal* is the ultimate strategy to be employed, hence the two options are prompt removal and deferred removal.

Progress is being made through the DPO Decommissioning Program in decommissioning the redundant buildings (within an operating site), but this progress has been limited because of constraints of resource, regulatory and technical nature. Because prompt decommissioning is more often not feasible, redundant buildings must be stored for some period of time before being able to proceed with final decommissioning. For this reason, the decommissioning program is structured around a three-phase approach:

- Initial decommissioning to prepare the building for storage (which involves establishing a safe, secure, storage state, including the removal of hazards and the modification of the building structure and supporting systems as needed), also known as "Phase 1 decommissioning", followed by
- Storage (with surveillance and maintenance), also known as "Phase 2 decommissioning", or "Storage with Surveillance" (SWS), followed by
- Final decommissioning (e.g., dismantlement), also known as "Phase 3 decommissioning".

As a result of this framework, there is a requirement to store redundant nuclear facilities and buildings for periods of time that can extend into several decades. This storage must be carried out in a safe and cost-effective manner, and as mentioned previously, this optimization is carried out from a risk-based strategic planning process that is supported by technical assessments.

3. CRL BUILDING CONDITION ASSESSMENT PROGRAM – SCOPE AND METHODOLOGY

3.1. General Framework

In keeping with the key objective of the DPO Decommissioning Program of optimising safety and cost, particular care must be applied in establishing safe, secure, storage states for the buildings. The Building Condition Assessment Program, aimed at ensuring that the buildings are, and continue to be, adequately safe over the storage period, provides the technical input to the decision process in optimising safety and cost. Through this program, each redundant building is subject to a series of three condition assessments:

- Building Structural Condition Assessments - evaluation of building envelope.

- Building System Condition Assessments - evaluation of building support systems and services, e.g., HVAC, electrical, fire protection.
- Building Storage Hazards Assessments - evaluation of the adequacy of protective barriers/controls for chemical and radiological hazard sources in the buildings, and hazardous events such as building fire and flood.

The purpose of the building structural and systems condition assessments is to evaluate the conditions of the buildings, identify the potential surveillance and maintenance activities over the SWS period (assumed, for assessment purposes, to be 50 years), and to estimate the associated costs. The purpose of the hazards assessment is to identify and characterize the building hazards present and to identify and evaluate the barriers and other means of controlling the hazards and limiting risks. The three assessments are interrelated, but the hazards assessment is the key document that establishes the building storage safety case, drawing upon information presented in the structural and systems condition assessments. The results of these assessments form the technical basis for risk-based prioritising and scheduling of decommissioning activities (as illustrated in Figure 2).

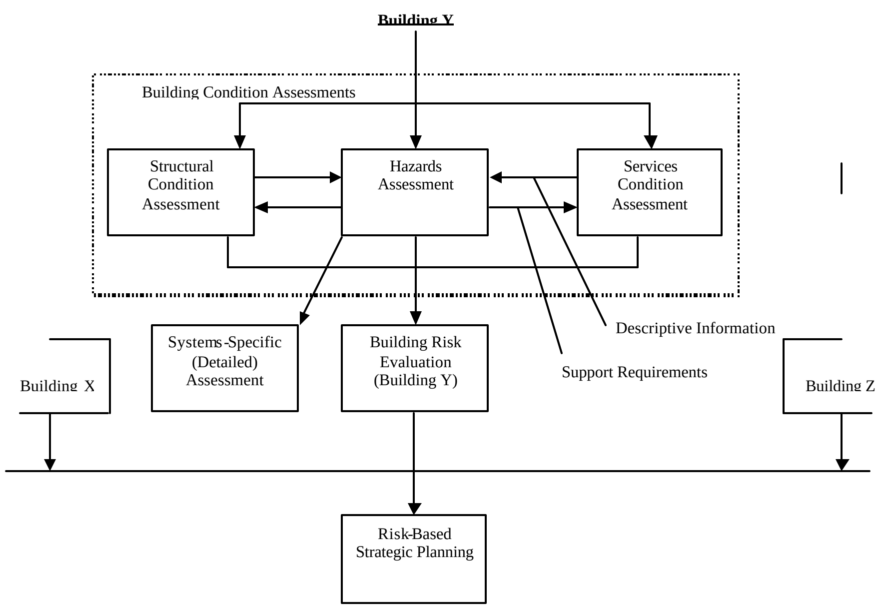

Figure 2: Building Assessment Model

3.2. Building Structural and System Condition Assessments

The structural condition assessments and system condition assessments are carried out in a similar manner, with similar objectives and deliverables.

<u>Assessment Objectives</u>

Safe storage is dependent upon maintaining the building envelope in a secure state (i.e., preventing water ingress, isolating residual hazard sources from the environment, and preventing unauthorized access) over the SWS period. As such, the key objective of the Building Structural

Condition Assessment is to evaluate the condition and related support costs of the building structural and architectural elements (i.e., the building envelope).

The key objective of the Building System Condition Assessment is to evaluate the condition and related support costs of the building systems, processes and equipment requiring continued operation/availability during the building storage with surveillance period. A secondary purpose of the assessment is to propose building storage states based upon the concept of minimizing the support services as much as possible, promoting savings in storage costs.

Assessment Scope

For both types of assessments, the depth of assessment is intended to be limited (cursory) in order to generate planning-basis information quickly. Accordingly, the condition assessment reports are intended to produce a *qualitative* appraisal of the condition of the building structural and architectural elements, identify only *significant* deficiencies, provide an *overview of the scale* of possible maintenance requirements for a SWS period assumed to extend up to 50 years, and produce a *ball-park* (order-of-magnitude) estimate of the costs of the anticipated surveillance and maintenance activities.

Assessment Methodology

For both types of assessments, the assessment methodology generally consists of the systematic process of collecting information characterizing the design and condition of the relevant building elements (whether structural and architectural elements, or building service systems), evaluating and ranking the condition of the elements based on the information collected, identifying maintenance or other actions necessary to maintain the building in an adequately safe storage state over the SWS period, and estimating the associated maintenance costs.

The information collection step involves reviewing engineering drawings, maintenance records, interviewing operations and maintenance staff, and conducting building inspections.

The evaluation includes characterizing the condition of the building elements as poor[1], fair[2], or good[3], identifying maintenance and follow-up assessment/analysis actions, and prioritizing the actions in terms of immediacy.

Assessment Documentation

The assessment reports (one per building) include discussions of methodology, findings (observations), recommendations, and cost estimates.

[1] The condition "poor" is defined as where the building element is not appropriate for current or ongoing usage, has significant service problems, is not functioning adequately, and requires a substantial investment applied in the immediate term to extend its service life for an additional 20 years.
[2] The condition "fair" is defined as where the building element is acceptable for current and intermediate term usage, has minor service problems, is in fair working order, and requires a limited investment applied in the near or intermediate term to extend its service life for an additional 20 years.
[3] The condition "good" is defined as where the building element is appropriate for current and long-term building usage, has no significant service problems, is in reasonably good working order, and requires little or no investment to extend its service life for an additional 20 years.

3.3. Building Storage Hazards Assessments

Assessment Objectives

As discussed previously, establishing and maintaining safe, secure, storage states for the decommissioning buildings is an important element in managing risks effectively. The objective building storage hazards assessment is to characterize the risks and to present recommendations towards risk-reduction. Essentially, the building storage hazards assessment documents the safety case for building storage over the SWS period.

Assessment Scope

The building storage hazards assessment considers all hazards (radiological and chemical) and considers not only hazards to workers in the decommissioning building, but also, as appropriate/applicable, hazards to other CRL staff, hazards to members of the public, and hazards to the environment. The assessment scope includes the identification and evaluation of the protective features that limit risks to the applicable exposure groups. The assessment scope is intended to be as simple as reasonably possible, with the depth of assessment being commensurate to complexity of the facility and the magnitude of hazards.

Assessment Methodology

The general methodology is described below and is illustrated in Figure 3: the methodology consists of a systematic process of reviewing the building structure and layout, reviewing the operational history (including upset and accident events), characterizing the hazard sources, then evaluating the hazardous events determined to be applicable to the building. From this assessment work, recommendations are derived: recommendations to reduce building risks, and higher-level recommendations associated with strategic planning, as necessary.

The types of information collected and reviewed in identifying and characterizing the hazards includes building operations records and correspondence, building safety and hazards documentation, condition assessment reports, building hazards survey data, and internal and external building hazards inspections. The intent is to collect as much data as reasonably possible to create an accurate characterization of all hazardous materials (radiological and chemical), worker hazardous conditions (industrial hazards), and initiating events that could involve the hazardous materials and/or challenge the means of hazards control. Characterization of hazardous materials involves determining their types and forms, their quantities, and their locations. The identification of initiating events includes identifying all energy sources, heat sources, explosion sources, flooding sources and any other potential sources of physical hazards within the building (i.e., internal hazards). Hazards resulting from natural phenomenon (e.g., earthquake, tornado, high winds) and events external to the building (e.g., vehicle impact, fire, flood) are also included in the identification of initiating events (i.e., external hazards).

With an accurate understanding of the nature of all hazardous materials present and potential initiating events, a list is derived of the potential exposure and release events representing normal conditions, anticipated upset conditions (abnormal conditions) and accident events.

With the exposure and release events identified, the potential consequences of the events are assessed and the protective features that provide hazards control are identified and evaluated in terms of effectiveness. Where multiple means of hazards control are available, the assessment of hazard controls can take the form of a barrier assessment. Where the potential consequences of the hazardous events are more significant, requiring more rigorous (redundant/diverse) means of hazards control, a "defense-in-depth" strategy for hazards control is appropriate. In any case, the process of identifying the protective features and evaluating their effectiveness (in achieving their safety objectives) is used to determine whether the risks of the hazardous events are adequately managed, or whether improved or additional measures are needed for further risk reduction. Where such opportunities for risk reduction are identified, recommendations are raised.

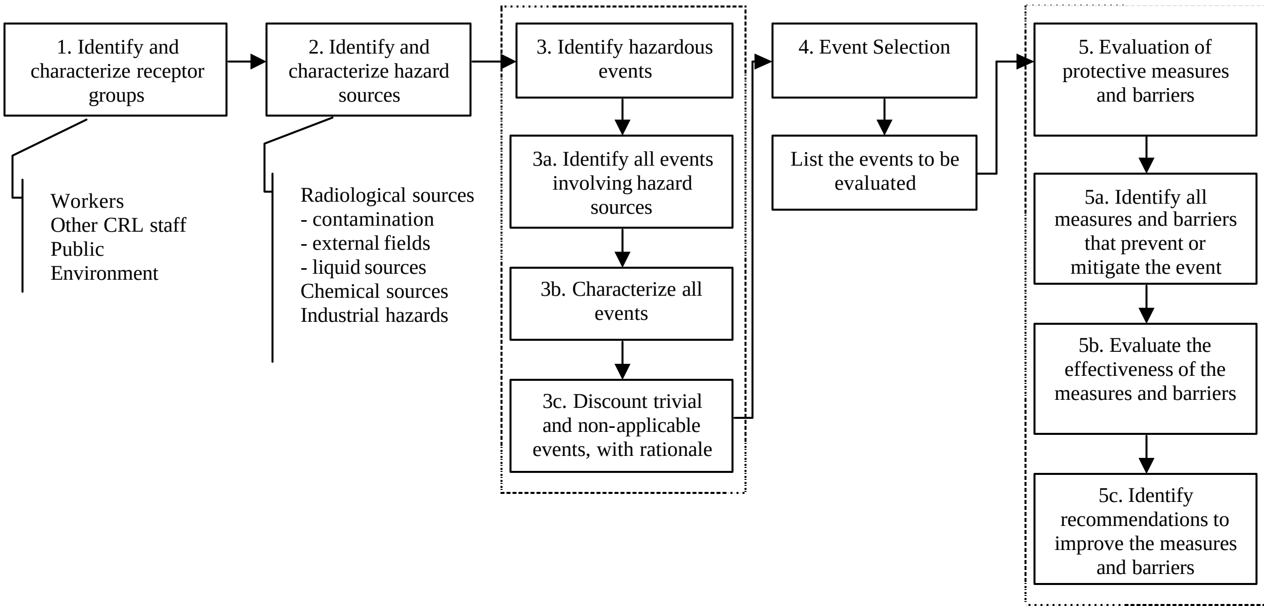

Figure 3: Building Storage Hazards Assessment Methodology

Assessment Documentation

The assessment reports include discussions of descriptive information (building structure and layout, operating history, decommissioning status), assessment methodology, assessment results, and recommendations.

4. CRL BUILDING CONDITION ASSESSMENT PROGRAM – PROGRESS, RESULTS, ISSUES, FUTURE DEVELOPMENT

4.1. Program Progress and Future Development

The Building Condition Assessment Program was initiated in 2001, and is nearing completion for the initial scope of roughly 20 buildings. All structural and system condition assessments are complete, and most storage hazards assessments are complete.

With the backlog nearing completion, the program can shift from a reactive mode to a proactive mode. This is, plans are in place for the development of a screening assessment methodology where, *before* a facility or building is turned over to decommissioning (i.e., while it is still in an operational mode), the building is subject to an initial screening inspection to identify the highest-level findings concerning building conditions (structural, systems, hazards). This assessment would essentially be a cursory building inspection carried out by a mutli-disciplinary team using evaluation checklists. The other objective of this inspection is to provide general guidance as to the target configurations of the building as it proceeds through the phases from operations to final decommissioning (i.e., determination of an acceptable safe shutdown state and interim storage state for the building).

This initial building inspection would not alleviate the need for further assessments – if the building is not slated for prompt decommissioning, the three condition assessments would be carried out in order to characterize the risks and costs over the SWS period.

4.2. Summary of Results

4.2.1. General Discussion

The deliverable from the Building Condition Assessment Program is a series of technical reports that assess the storage conditions of the decommissioning buildings. Within these reports are recommendations for improving the storage conditions; recommendations that lead to improvements in the storage safety case (e.g., reductions in fire and flooding hazards), and recommendations that lead to cost savings in maintaining the buildings (e.g., isolation of non-essential building systems). Within the 50 or so assessments completed to date, there are thousands of findings presented, and hundreds of recommendations for improving the storage conditions. Many of these recommendations have been considered "soft", but some have been more significant. The recommendations are provided to the Decommissioning Facilities Manager, who then acts upon them in priority sequence.

The buildings that have been assessed to date represent a wide spectrum of building types – in terms of construction (wood frame, concrete) and use (maintenance shops, fuel reprocessing labs, research labs, industrial process buildings, etc.). One general finding from the assessment work is that each building is truly unique in the pursuit of safety and cost optimization, and while general guidance towards attaining optimization can be derived, *each building must be assessed on its own merits*.

4.2.2. Key Findings

The one broad finding from the initial efforts to develop the program is the absence of national/international guidance on safe, long-term building storage. General guidance is available from the IAEA ("safe enclosure" [2] [3]) and other organizations, but this guidance does not go beyond stating the safety/risk management principles to be considered (i.e., technical elements are excluded). More-specific guidance is available from other organizations such as the US Army [4] and the US Department of Energy [5] [6], but the guidance either pertains to storage in other climatic regions, or the guidance only touches on technical elements such as humidity control in freeze-thaw cycles. One purpose for presenting this paper is to initiate a technical exchange concerning long-term building storage practices.

The following is a summary of the more significant, and more commonly-occurring findings and recommendations from the building assessments carried out.

Safety/Risk Findings

Maintenance of Building Envelope: the most important objectives in long-term storage of buildings should be to maintain the building envelope to prevent ingress of water (roof, windows) or animals, and to allow good air circulation (passive or active) to prevent humidity build-up. The better the envelope and the ventilation, the slower the degradation rate of interior and structural components and less chance for the spread of contamination.

Maintenance of Building Access Control: all building entrances (for vehicles, personnel, and service access) should be maintained in a securely locked state to prevent unauthorized entry. Lack of access control can result in unauthorized building use and changing storage conditions (e.g., storage of materials), and correspondingly, increased risks of upset events (e.g., fire from smoking).

Minimization of Services: the fewer services remaining in service, the lower the storage costs and risks; each system should be viewed as a source of costs (inspection, maintenance, and energy costs) and a source of initiators for upset events (fire, flooding).

Need for *Complete* Isolation of Systems: complete credit for system isolation can be attained only if the isolation is exterior to the building (e.g., isolation of electrical supply at the building disconnect or panel does not completely eliminate the risk of building electrical fire).

Minimization of Loose Debris: in addition to contributing to combustible loadings and creating industrial hazards, loose materials and debris (desks, book shelves, cabinets, etc.) can introduce unique hazards in certain circumstances. In one case, a filing cabinet had been converted into a ventilated radioactive source cabinet. In another building, a cabinet was found to contain crystallized chemicals that were considered highly explosive.

Minimization of Contamination Sources: optimization of long-term safe storage can be attained only if efforts to remove contamination sources (during phase 1 decommissioning activities) are as thorough as possible. The less fixed or loose contamination there is, the less the potential for the residual contamination to become mobilized over the storage period. Also, the less residual contamination there is, the more thorough the periodic inspections can be (i.e., less access restrictions).

Mobilization of Fixed Contamination: fixed contamination (e.g., sealed within paint or in concrete) can become loose if unfavourable storage conditions lead to concrete crumbling/spalling or paint peeling. The SWS building inspection program should include close monitoring for these indicators.

Gradual Mobilization of Loose Contamination: loose contamination in specific (isolated) zones can be mobilized gradually over time from air-flow within the building, and from animal ingress (e.g., birds, raccoons). The SWS building inspection program should include close monitoring for contamination spread (e.g., specified sampling/monitoring points), and the program should also include close monitoring for any indication for animal ingress, triggering prompt action to seal the entry points.

Rapid Mobilization of Loose Contamination: loose contamination in specific (isolated) zones can be mobilized rapidly from upset events/accidents such as flooding and fire. The hazards assessment should examine these events closely to ensure that these events are prevented or mitigated as much as possible.

Evaluation of External Flooding Events: flooding hazard evaluations should include external flooding events closely, such as improper grading around the facilities, and nearby external sources of significant size (flood diversion devices might be appropriate).

Close Evaluation of Building Fire Hazards: fire hazard evaluations should be carried out with close attention to the defense-in-depth principle – older buildings can represent significant fire risks if the detection/suppression systems are outdated or unreliable or absent. Other contributors to fire risk include the absence of interior wall coverings (bare wood), the dryness of the wood, the proximity of heat sources to wood elements, the absence of fire zone separation barriers, and the tendency for abandoned buildings to be used to store miscellaneous materials (loose combustible loadings). In the worst circumstances, a fire in an old abandoned building could be difficult to control, even with on-site response capability. Older buildings with large attic spaces and/or continuous basement areas (buildings with pier foundations) would further present challenges in controlling fires. Fire is also of concern because of the potential for residual contamination to spread – either from the combustion of contaminated materials or from the use of water to extinguish the fire.

Evaluation of Fire Protection Systems after Building Modifications: phase 1 decommissioning activities can include the removal of interior walls, or the creation of wall openings to promote natural air circulation. These modifications can interfere with the operation of fire detection systems (e.g., smoke dissipation could delay detection), hence the building fire protection systems should be evaluated closely after any modifications to building interior components.

Characterization and Evaluation of Chemical Hazards: the scope of characterization and evaluation work should include hazardous non-radiological contaminants, as some chemical agents used in the past can represent hazards to workers and can contribute to internal events such as fire and explosion (e.g., use of perchlorates, mercury).

Evaluation of Industrial Hazards: the evaluation of hazards to workers should include attention to industrial hazards, such as falling hazards (degraded elevated walkways), confined space, and air quality. Restrictions on access to parts of the buildings to protect workers can impact the scope of periodic inspections, potentially resulting in parts of the buildings not being subject to periodic inspection.

Value of "Safe Shutdown Documentation": documentation describing how a building was transitioned from the operational state to the safe shutdown state is of great value in the assessment process, because of the "as-built" nature of the records. Such documentation should be *required* of the operating organization. As mentioned later, the accuracy of records is a key issue in the building assessment process.

Cost Findings

Dominant Energy Costs: the most significant costs associated with the long-term storage of buildings are energy costs. At CRL, most buildings are heated with steam (through a centralized steam distribution system), hence steam costs are more significant than electrical costs (Figure 4). The focus of cost-optimization initiatives should therefore be the reduction of heating requirements.

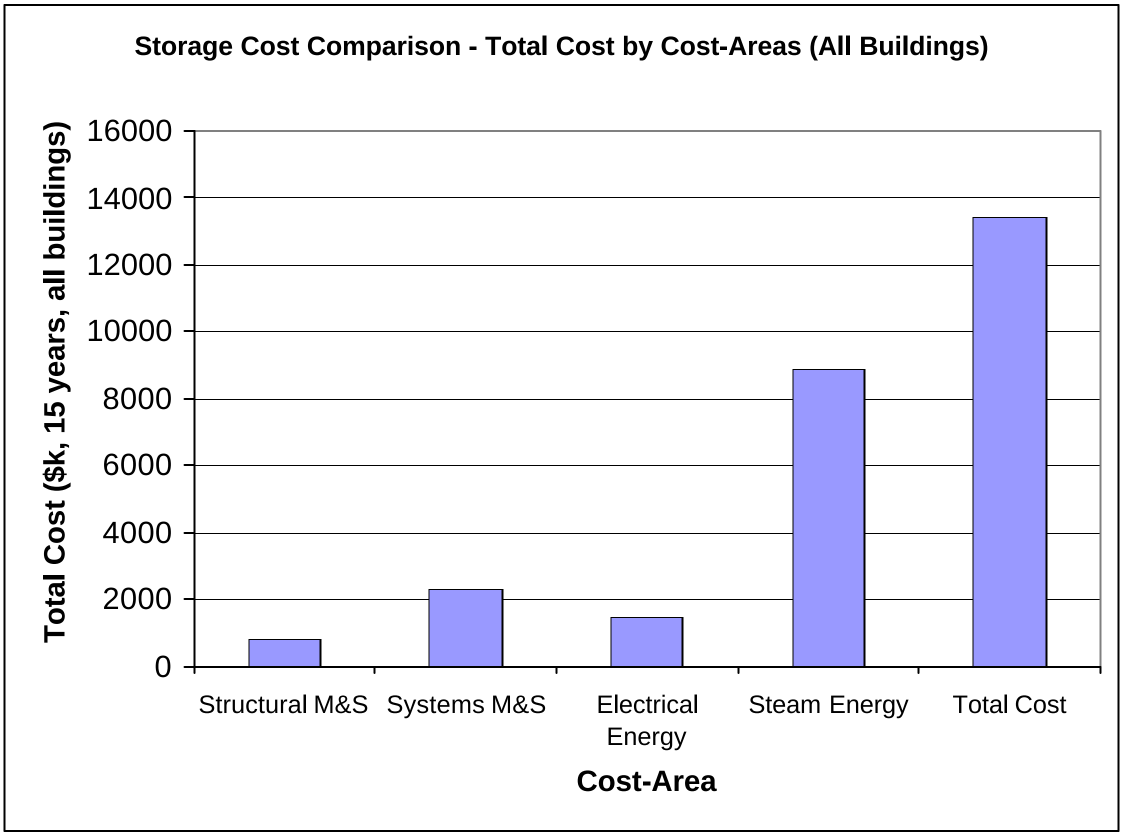

Figure 4: Cost Comparison of Different Cost-Areas

Reduced Costs from Alternative Storage States: storage costs can be reduced by reducing or eliminating heating requirements, and by isolating non-essential service systems. Different alternative storage states have been proposed for the decommissioning buildings, with simple (low cost) modifications leading to modest cost-reductions, and more-aggressive (higher cost) modifications leading to more-significant cost reductions (Figure 5). However, these proposed configuration changes must be reviewed closely to ensure that any conflicting risks are balanced (discussed later) and any impacts on monitoring and surveillance activities are reasonable.

High Cost Buildings: a comparison of total storage costs for all buildings shows that a few buildings represent a significant portion of the total cost. These buildings should be the focus of cost-reduction initiatives.

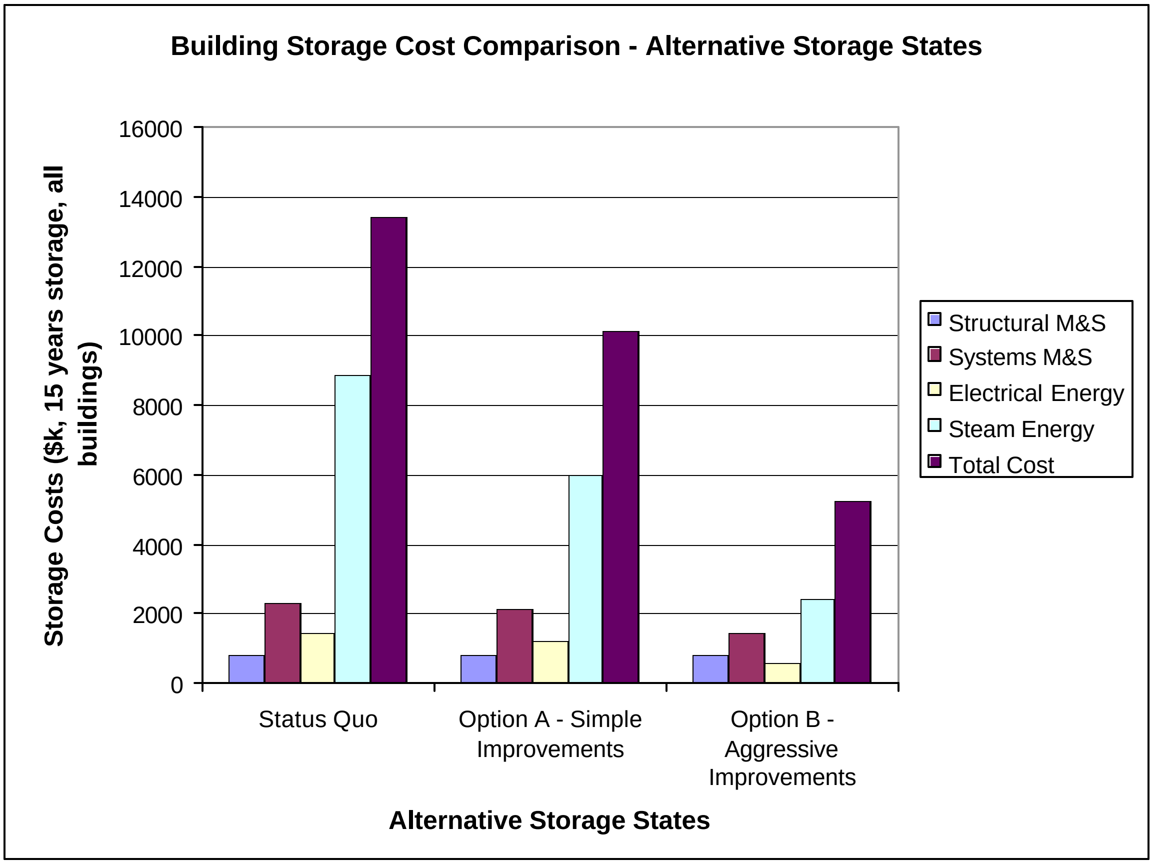

Figure 5: Cost Comparison for Alternative Storage States

4.3. Issues Encountered during Execution of Building Condition Assessment Program

4.3.1. Technical Issues

The management of hazards and risks inevitably results in alternative management approaches, in some cases with conflicting requirements. Key examples include:

Lighting/Electrical Requirements: adequate lighting is needed for periodic building inspections (industrial safety plus observation of storage conditions). One approach is to continue to use the building lighting systems, but continued use of the building electrical system can introduce fire hazards. The building electrical system can be upgraded to address the fire hazard, but this can be costly. Alternatively, good-quality portable lighting can be used during inspections (allowing complete isolation of building electrical systems[4]), but the use of portable lighting may not be as effective as ambient lighting.

[4] Note that a basic electrical service is required for fire detection systems; however, complete isolation can still be accomplished by installing the fire panel (powered component) in an adjacent operational building, with only detector lines running into/through the building under storage.

Active versus Passive Ventilation: ventilation is certainly required for humidity control, and may also be needed for contamination control, but if phase 1 decommissioning (hazard removal) operations are thorough, the contamination control requirement can be weak or absent. Where residual contamination exists in buildings, the optimisation challenge is whether the benefits of an active ventilation system are offset by the risks (electrical system, and fire risks) and costs (ventilation system upgrades, electrical system upgrades, energy costs, etc.).

Heating Requirements: heating may be required to prevent water systems (e.g., sprinkler systems) from freezing during the winter, and heating can also aid in the control of humidity. The piping freezing issue can be addressed by the use of dry sprinkler systems with local heating, and the humidity issue can be addressed by adequate ventilation. Continued use of heating introduces risks and costs, and can contribute to humidity problems (chronic steam leaks). Some buildings at CRL have been stored without heating for several decades without significant degradation, while others have not performed as well. The different performance of buildings highlights the fact that the performance factors are complex, and each building must be assessed on its own basis.

Several of the examples given above highlight the fact that at times there are conflicts in the approach to take when considering cost optimisation and safety optimisation. In the end, judgement must be applied to select the course of action to take. In making the final decision, the cost evaluation must consider all costs (near-term, long-term, indirect) and the safety evaluation must consider all safety aspects (near-term and long-term implications, potential for upset events, potential for conditions to degrade). Decision aids can be used to evaluate complex issues (prioritisation rankings, expert choice software, etc.), as can committee reviews, but in the end, it is judgement that is applied when resolving a conflict.

4.3.2. Implementation Issues

Access to Records: while steps have been taken in recent years to ensure that key records are securely retained [7], past retention practices have included the destruction of records such as engineering drawings, once they are deemed "obsolete", or other. As a result, one particular challenge is confirming certain characteristics of the buildings. Considerable effort can be applied in the pursuit of older records, and the challenge is knowing when to end the pursuit. This issue can have an impact on effort (cost and schedule).

Accuracy of Records: the accuracy of older records is another issue that should be evaluated carefully during execution. Reports or drawings have been found to be inaccurate and/or out of date. Best practice in this regard involves finding corroboration of the aspect in question, preferably by field verification. These verification steps, however, can add to the effort required to complete the assessments, affecting cost and schedule.

Specialized Skills/Capabilities: as is likely evident by the technical challenges (and the human behaviour issues discussed below), effective implementation is dependent upon the technical and inter-personal capabilities of the assessors. On a technical level, the ideal assessor would have strong knowledge of many different disciplines, including fire protection, electrical, HVAC, piping systems, etc., and be able to apply reasonable judgment in managing issues like those described previously. An obvious alternative to a single "jack of all trades" is a small multidisciplinary team.

4.3.3. Human Behaviour Issues

Human behaviour is another category of issues worthy of mentioning, as the human element has different impacts on the conduct of the assessments and the application of the results.

Creeping Scope: scope control is a key challenge in executing or managing a large assessment program. Depending on the nature of the assessor, the level of detail of the assessments (intended to be cursory) can wander in either direction, but the tendency is to increase the level of detail. Clearly written instructions, sample assessments (examples), and close supervision of the assessment work are key means of managing this issue. Maintaining continuity in the assessors and report reviewers are other means of minimizing scope creep.

Negativity from Intrusion and Criticism: the concept of a person external to an operations group collecting data and essentially searching for deficiencies can be stressful to some operations staff, especially where they take pride in what they have accomplished during operations and shutdown. This can lead to negativity and reluctance in cooperating with the assessors (cast as "outsiders"). This is not unusual for safety/risk assessment work, but the need for an assessor with strong (effective) inter-personal skills should be recognized when establishing any program that involves the safety review of existing practices.

Resistance to Change: there is a tendency to adhere to the "status quo" (i.e., resist change) even if sound technical arguments are presented in support of a recommended change. Where there are controversial aspects to the change (such as when conflicting requirements arise) the resistance to change is stronger.

Hear Say or Exaggerated Information: during the process of collecting information, "hear say" or exaggerated information can be encountered, which can either be detrimental to the analysis or can result in extended effort in researching the matters. Glorified stories and grandiose recounts of past practices and experiences, along with mis-information can result in inaccurate appraisals of conditions and hazards. The same effect can result from inflammatory language used in older reports (e.g., "massive spills", "severe contamination"), as often these accounts are not supported with quantifying information (data).

5. APPLICATION OF RESULTS INTO DECOMMISSIONING OPERATIONS AND STRATEGIC PLANNING

5.1. General Discussion

Strategic planning involves determining the near- and long-term activities and directions for AECL's Decommissioning Program. Prior to the inception of the Building Condition Assessment Program, strategic planning was also carried out on a cost and risk-prioritized basis, but with the costs and risks being better characterized as a result of the Building Condition Assessment Program, strategic planning is now carried out on a more-refined, defensible manner. Further, it is easier now to demonstrate how the strategic planning process (and execution of the decommissioning program) meets the fundamental objective of the program (to decommission redundant buildings in an optimally safe and cost-effective manner) and the underlying principles.

5.2. Risk, Hazard and Safety Aspects

The immediate, direct benefit of the Building Condition Assessment Program is the identification of deficiencies that, as they are addressed, will lead to marked improvements in the safety of the buildings, and reductions in liabilities. Improvements in the safety of decommissioning buildings will also lead to improvements in the safety of the CRL site, as these buildings are often situated in close proximity of operating nuclear facilities.

The improved hazards characterization of the buildings allows more accurate evaluation of the relative risks of the different buildings, which is then used to determine the risk-priority sequence of decommissioning activities. The most concrete example of this input to strategic planning is during the bi-annual prioritization initiative where risk rankings (based on the results of the Building Condition Assessment Program) are a key element of the decision/ranking process.

In addition to the technical benefits from the assessment program, execution of the program has promoted an increased awareness of risk/safety issues in the management of buildings. Managers and staff are now more aware of the key considerations in safe storage. As well, the evaluation of buildings under storage has led to improved understanding of the behaviour of buildings under long-term storage, and the lessons-learned are an input to management decisions.

5.3. Cost Aspects

Because all buildings are evaluated on the same basis (i.e., a default assumption of a 50 year storage period), the cost-implications of the buildings can be compared on an even basis, which allows the determination of the cost-priority sequence of decommissioning activities. The costing information provides rationale for the building decommissioning projects, especially where the upgrading costs represent a substantial portion of the decommissioning costs.

Where the decommissioning of certain buildings requires the construction of specialized waste processing facilities ("enabling facilities", such as a waste clearance facility, incinerator, concrete crushing plant, etc.), the cost-priority sequence information is used as key rationale for the strategic planning of when these enabling facilities are required to be in operation. Estimates of energy costs are used in a similar manner, particularly where it has been determined that heat must be maintained in the buildings over the storage period. The energy cost information is helpful in demonstrating why certain buildings should be decommissioned in the near term, and why certain enabling facilities are required in the same time-frame.

Another benefit from the storage costs estimating has been that the search for cost optimisation has lead to the development of broad alternatives to existing storage states. Most often the immediate improvement is simply the installation of new thermostats and the set-back of storage temperatures. For many buildings it is possible that heating can be partially or completely removed, with some modifications to systems such as sprinkler systems. With this aggressive approach, the energy savings for large, older buildings with limited insulation can most often offset the capital costs over periods typically less than 5 years. Nevertheless, any configuration changes intended to save costs (e.g., shutting down exhaust systems, boarding up windows, doors, and setting back temperatures or turning off heaters) should be evaluated closely to anticipate hidden or indirect costs such as regulatory compliance costs and monitoring and surveillance costs.

6. SUMMARY AND CONCLUSIONS

Although prompt decommissioning would be the preferable approach to take in decommissioning redundant buildings and nuclear facilities at CRL, in many cases this approach is simply not possible because of constraints of regulatory, resource, and technical nature. As a result, the DPO Decommissioning Program applies a three-phase approach to decommissioning: first, preparation for storage (hazard removal); followed by storage with surveillance for some period of time; followed by final decommissioning (dismantlement). In keeping with the key objective of the decommissioning program of optimising safety and cost, particular care must be applied in establishing and maintaining safe, secure, storage states for the buildings. The Building Condition Assessment Program, aimed at ensuring that the buildings are, and continue to be, adequately safe over the storage period, is a key source of technical input to the decision process in optimising safety and cost.

The Building Condition Assessment Program has proven to be a useful tool in characterizing the risks and costs of deferring the decommissioning of buildings. The immediate, direct benefit of the Building Condition Assessment Program is the identification of deficiencies that, as they have been addressed, have lead to marked improvements in the safety of the buildings, and reductions in liabilities. The improved hazards characterization of the buildings allows more accurate evaluation of the relative risks of the different buildings, which is then used to determine the risk-priority sequence of decommissioning activities. Strategic planning is now executed with closer attention to risk and cost objectives.

7. REFERENCES

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