INFORMATION MANAGEMENT FOR DECOMMISSIONING PROJECTS

A.N. LeClair, D.S. Lemire
Atomic Energy of Canada Limited
Chalk River, Ontario, Canada

ABSTRACT

This paper explores the importance of records and information management for decommissioning projects. Key decommissioning information and elements of a sound information management strategy are identified. Various knowledge management strategies and tools are discussed as opportunities for leveraging decommissioning information. The paper also examines the implementation of Atomic Energy of Canada Limited's (AECL) strategy for the long term preservation of decommissioning information, and its initiatives in leveraging of information with the application of several knowledge management strategies and tools. The implementation of AECL's strategy illustrates common as well as unique information and knowledge management challenges and opportunities for decommissioning projects.

1. INTRODUCTION

Sound management and preservation, and access to information to support decommissioning projects are important concerns in any industry. Adapted from the publication, *Nuclear decommissioning: planning, execution and international experience*, the following focuses specifically on the importance and key principles of information management for nuclear decommissioning projects.[1] The implementation of Atomic Energy of Canada Limited's (AECL) strategy for the long term preservation of decommissioning information[2] demonstrates the practical application of key principles and challenges in information management for decommissioning projects.

Planning for decommissioning at the first stages of a facility's life cycle is a key requirement for the safe and effective decommissioning of a nuclear facility and should include the establishment of a sound decommissioning-oriented records management system that flags key information for long-term retention. The information required for decommissioning may be explicit and appear in official company records such as engineering drawings, technical specifications, photographs or reports, tacit or 'soft' information in the form of personal knowledge, experience and insights, or data typically not formalized and captured as a record.

Without a strong records and information management culture throughout the lifecycle of the facility, opportunities to establish and maintain a comprehensive collection of information decrease as time progresses and the cost to recover the information will increase. For example:

- Key records may be misplaced, relocated or destroyed;
- Knowledgeable and experienced personnel are replaced by new staff without adequate knowledge transfer;
- Missing records may need to be reconstructed;
- Conservative approaches may need to be employed during decommissioning;
- More site/facility characterization and assessments will be required to gain knowledge of the site/facility;
- Higher safety risks to decommissioning staff executing projects because of unknown hazards.

Managing and preserving information is important given the length of time the facility exists and the nature and complexity of a nuclear decommissioning project. Therefore, a strong information management strategy is needed:

- To support safe decommissioning activities;
- To better identify and assess risk for more cost effective decommissioning;
- To make relevant information accessible at all times for decision support;
- To protect the environment by understanding the hazards;
- To preserve key information;
- To comply with statutory requirements;
- To provide tangible evidence of compliance and/or due diligence;
- To make information accessible to internal and external groups;
- To maximize opportunities to learn and improve decommissioning practices;
- To transfer knowledge for future decommissioning projects.

The importance of information in decommissioning is a lesson learned from past decommissioning projects, now reflected in legislation, regulatory requirements, international guidelines and standards.

2. INFORMATION MANAGEMENT AND PRESERVATION

2.1 Identification of key decommissioning information

The primary source of information for a decommissioning project is official company or facility records. Each phase of a facility's life cycle generates information pertinent to the various facets of decommissioning activities that is captured as a record, although, not all information captured during the facility's lifecycle is relevant to decommissioning activities. The practice of retaining all facility information with the hope that it will be useful for decommissioning might result in an inordinate quantity of documentation, which is often unmanageable and may overwhelm the fraction that is actually valuable information.[3] Therefore, it is important to identify a subset of key decommissioning information.

The selection of records for retention may vary from project to project. Records or categories of information may have differing levels of importance. Most effort should be devoted to the identification, maintenance and preservation of essential or critical records. The key records serve to support the following:

- Substantiating the integrity of a facility at each stage of decommissioning;
- Substantiating the decommissioning strategy employed;
- Estimating decommissioning costs and waste quantities;
- Defining work scopes;
- Enabling the identification, recovery, safe storage and disposal of radioactive material;
- Minimizing occupational radiation doses during decommissioning;
- Identifying shipments and the disposal locations of wastes;
- Documenting/recording key decommissioning activities;
- Verifying and validating that standards and statutory and organizational compliance requirements have been met.

The following lists the purpose of retaining various types and categories of records as part of key information for decommissioning projects:[3][4]

General Background: To understand the rationale behind the concept/design of the facility and obtain information on original greenfield characteristics, to support or determine remediation and end-state activities/objectives.

Design and configuration: To understand the building, its contents and surrounding physical characteristics.

Construction/commissioning: To understand the construction sequencing to plan for the dismantling/demolition and removal of large equipment.

Operations: To understand the nature and extent of contamination, and identify significant modifications to the facility during operations or information relating to previous accidents that might impact on safe and effective decommissioning activities. The process design, history information and radiation protection data to be used for deactivation, decontamination and dismantling.

Health, Safety and Environment: To estimate a facility's residual hazards for planning safe and effective decontamination, dismantling and remediation activities.

Licensing, legal and other governing documents: To understand controls, constraints, and provisions in place, as well as industry standards and practices, to identify hazards and protect workers, the public and the environment.

Decommissioning: To decide upon and communicate decommissioning strategy and rationale; to define, plan and execute activities; to record and demonstrate due diligence and compliance with statutory requirements; to transfer knowledge.

Waste: To understand and track the waste inventory generated by decommissioning, as well as to understand the associated risk, liabilities, and future decommissioning activities for the required waste facilities.

Other sources of information may include**:**

- Codes and data, either historical or collected in the process of decommissioning activities;
- Personal files and notes;
- Information from internal and/or external sources – information/knowledge database systems, reports, papers, articles, etc.;
- Oral, undocumented, histories of staff, regulator or public experience, knowledge and insights;
- Old newspaper articles, media video and audio recordings.

2.2   Records and information management strategy

A large volume of key decommissioning information will be identified and selected for retention throughout the facility's entire lifecycle, spanning decades to possibly 100 years or more. Such conditions necessitate establishing a comprehensive records and information management strategy that includes provisions for:

- Information management planning;
- Collection, receipt and capture;
- Organization and indexing;
- Use and dissemination;
- Maintenance, storage and protection;
- Backup and preservation;
- Disposition.

A sound records and information management system, though the facility's entire life cycle, from conception through to end state, must strive to ensure information is:

Legible and complete: Controls are in place during the capture of information to ensure information contained is legible and complete. Modifications to design are controlled and revision details promptly and accurately captured.

Traceable: Records and information are tagged, coded, dated and/or labeled in such a manner as to make them traceable back to the activities to which they relate.

Accessible and retrievable: Information is organized, indexed and stored in a way that assures easy and reliable access and retrievability. Hardcopy records are indexed and in order, and are stored in containers and locations with minimal physical obstructions to access. Electronic information contained in databases is categorized with standard metadata. Electronic files are saved in standard file formats and stored in areas allowing easy access using common hardware and software application systems. Information is disseminated and shared on user-friendly platforms and interfaces with easy search capabilities.

Access controlled: Mechanisms are in place to protect information from theft, loss, misplacement or misuse. Sensitive hardcopy and film records are locked in cabinets, offices or vaults; electronic files are stored in areas with managed access.

Document controlled: Information contained in formal documents is tracked and revisions are controlled.

Continuously managed & regularly inspected: A facility's lifecycle does not end at the time of closure. Records and information should be managed continuously beyond turnover to a decommissioning project, and through deactivation and decommissioning to the end-state and beyond. Records staff knowledgeable of the history of the facility and its records as well as the records and information management system should be retained throughout to ensure the integrity of the system and that the quality of the collections remains intact. Information should be regularly inspected.

Records retained and disposed: Records retention periods should be identified, retention schedules and disposition managed for all records in a collection. Information that is no longer required should be disposed to reduce volume.

Backed up and preserved for future use: Records and information are duplicated in another format, and originals and copies stored in separate locations. Records, regardless of format, are stored and preserved to protect them from agents of deterioration such as temperature, humidity, light, dust, fire and floods. Records and information retention periods are somewhat dependent on the decommissioning strategy employed. Reasonable expectation, however, is that essential decommissioning records and information will be retained and preserved for at least 40-50 years. A delayed decommissioning strategy will impose a longer retention period of possibly an additional several decades. Decommissioning strategy may change at any point of a facility's lifecycle. Therefore, a lengthy retention period should be assumed and preservation initiatives undertaken to ensure information will be available for future use.

Technologically independent format: One set of the collection or at minimum, the most critical information should be captured in a format that allows for access without reliance on technology. Examples of suitable formats would be paper or microfilm.

Convertible to other formats: Technology evolves and advances over time. Records and any information in electronic format are at risk of loss due to hardware or software incompatibility. Information available electronically, therefore, should be stored in a standard, portable format that can be reasonably and easily transferred and/or converted to new technology.

2.3 Knowledge management strategies and tools in decommissioning

Knowledge management comprises a set of strategies and tools designed to identify, create, represent, distribute and enable the adoption of insights and experiences. It involves managing and leveraging stores of explicit and tacit knowledge. Various knowledge management strategies and tools exist and provide numerous opportunities to leverage knowledge in decommissioning:

Knowledge repositories: The creation of customized databases provides the opportunity to access a repository of key decommissioning information, with opportunities to share information between projects. Information may be tagged with customized metadata, and search functions may range from simple keyword search to more advanced content searches. Databases may be linked to larger information systems, or incorporate information from external sources. A map of knowledge repositories within a facility or specific decommissioning project can be made accessible via a facility or group's intranet webpage.

Collaborative technologies and social software: Examples include websites, wikis, blogs, information portals, as well as collaboration and content management sites. Such technologies and software allow for the flow and exchange of both tacit and explicit knowledge between staff and external contractors during projects.

Expert directories: Offer the opportunity to identify and contact subject matter experts within decommissioning or any other relevant field, and/or key existing or former staff with tacit knowledge regarding a facility's activities during its lifecycle.

Storytelling/Oral histories: Provide a means for documenting and converting tacit knowledge into a more explicit and useable form of information. Conducting interviews and recording oral histories on a facility's activities prior to closure may prove valuable on occasions where insights and experience assist in confirming assumptions or providing context to past decision points. In a case where records and information have been lost or are deficient due to weak records management practices during facility operations, oral histories assist in filling gaps on unreported hazards or areas of contamination. Documenting tacit knowledge during any phase of a facility's lifecycle can be a valuable exercise.

Reviews and lessons learned: Involve the review and recording of decommissioning project activities, experiences and lessons learned for future opportunities for improvement. Other possibilities include the review of collected information and its synthesis into a concise report for future reference or training purposes.

Cross-project learning: Increases the potential for learning and improving upon decommissioning practices through sharing and exchanging of knowledge across projects, locally, nationally and/or globally.

Best practice transfer: Tacit and explicit knowledge may be documented in books, standards, regulations, guidelines, technical reports, papers, during exchanges at workshops, courses and conferences, as well as through global participation in associations and organizations dedicated to the nuclear industry. The capture of best practices in written form is particularly valuable in situations where a significant time lapse (decades) between major decommissioning projects will occur and the availability of knowledgeable staff diminishes.

3. INFORMATION MANAGEMENT AND LONG TERM PRESERVATION FOR DECOMMISSIONING PROJECTS AT AECL

Over the last decade Atomic Energy of Canada Limited's (AECL) decommissioning program has grown substantially, underscoring the need for a well-conceived records and information management strategy. The decommissioning program encompasses an array of facilities: prototype power reactors, research

reactors, fuel processing facilities, research laboratories, waste processing facilities, other ancillary structures, affected lands and waste storage areas. Program activities include long-term planning, assessing risks, monitoring & surveillance of buildings undergoing delayed decommissioning, executing decommissioning projects and remediating lands. Given the diversity of decommissioning projects and the large volumes of records accumulated over many decades, with pockets of information or collections located at various sites across the country, it became apparent that a strong records and information framework was needed to preserve essential information and make it available for planning and execution of safe and effective decommissioning activities.

3.1   Strategy for long term preservation of decommissioning information

Funded and supported by Natural Recources Canada's Nuclear Legacy Liabilities Program, AECL developed a records and information framework to preserve legacy decommissioning information with the following objectives in mind [2]:

- Identify which records and information are relevant to decommissioning;
- Systematically capture, assess, and archive information, and make key information available to staff to support ongoing decommissioning work;
- Provide a user-friendly, electronic search and retrieval database tool that makes key information accessible to staff, and promotes sharing of information within and between projects;
- Continually manage and enhance the records and information base as well as its support infrastructure to ensure long-term availability;
- Conduct special information enhancement projects that transform historic records into usable information for analysis.

Federal regulation requires nuclear facilities to retain their records several years past receiving a license to abandon. The implication for licensed nuclear facilities under delayed decommissioning strategy is that records will need to be preserved for decades, potentially 50 to 100 years or more. As a result, AECL's Liability Information Management (LIM) group was established and is currently implementing a strategy for the long-term preservation of decommissioning information that includes the following activities [2]:

1. Identify records of value essential for decommissioning;
2. Assess records collections for improvement requirements;
3. Organize the collection of information;
4. Backup decommissioning information electronically, archive it in the Company's electronic repository, and make key information available to staff;
5. Microfilm collections for long-term preservation (100+ years) and provide a technologically independent method to access decommissioning information.

A core team of information management staff, knowledgeable and experienced with AECL's historical records, supports the implementation of the records and information management strategy. The LIM staff plans and oversees collections improvements, perform special information searches (i.e. difficult to find records), execute customized archival projects, provide general advice and guidance on records and information management issues, and conduct reviews from records and other sources of information, condensing volumes of information into concise reports for future reference and training.

3.2   Legacy Records Collections Improvements

Large volumes of historical records exist for each facility turned over for decommissioning. Ideally, facility collections should be organized, indexed, stored, accessible and retrievable throughout its lifecycle. This is not the case in many instances, and the collection will most likely be fractioned, with pockets in various

locations. Also, collections will contain records of no value to decommissioning. The first order of business, therefore, is to locate all pockets of information and identify key subset of records pertinent to decommissioning. The Liability Information Management Office keeps track of facility collections by managing a master inventory spreadsheet that identifies key pockets of records, their volume, location and details on improvement actions.

Each pocket is assessed and inventoried by a team of individuals with a cross section of knowledge pertaining to the facility and to decommissioning to determine relevant content and what improvements are required to preserve the information and make it accessible for decommissioning projects. Once recommendations have been identified, archival projects are planned and executed. Hardcopy records are organized and scanned to electronic file, reviewed for relevance, verified for quality and completeness and archived in the Company's repository. The Liability Information Management Office facilitates the assessment, planning and execution of archival projects for many AECL facilities under decommissioning, including Gentilly-1, Douglas Point, Nuclear Power Demonstration (NPD), NRX and ancillary facilities, as well as decommissioning projects at Whiteshell Laboratories.

Figure 1. Scanning of Gentilly-1 history dockets

Some pockets of historical information reside in electronic format. With advances in technology, historical electronic records are frequently at risk and require conversion or migration to new formats, storage media or systems. The Liability Information Management Office also undertakes archival projects to migrate or convert electronic records to usable and more stable formats and storage systems to make this information accessible and retrievable for decommissioning projects.

3.3   Microfilming

AECL's Decommissioning and Waste Management's strategy for the long term preservation of information calls for the microfilming of essential decommissioning records. Employing a deferred decommissioning strategy with regulatory requirements to retain records several years past the licence to abandon, means a significant portion of nuclear site and facility records will have a lifecycle of 50-100 years or more. Historical records at AECL already date back 30-50 years. Microfilm is presently the only record medium that meets the need for preservation over the long term (100+ years). It also provides the added benefit of being technologically-independent. Information from microfilmed records may be accessed and retrieved with little more than a simple viewer.

For this purpose, the Liability Information Management Office established a new chemical based, microfilm processing facility on site for the preservation of its essential decommissioning records. Microfilm processing and quality control equipment was purchased, and existing building space was converted to accommodate microfilm processing, storage and inspection. A full set of operating instructions were developed and staff were provided training.

Essential decommissioning records in electronic file format are extracted from the Company's electronic records management system and written to microfilm. The film is then processed, inspected then packaged in archival quality containers. Two sets of microfilm are created. A master copy is stored in an environmentally controlled storage room to maximize preservation conditions. A working copy is available for accessing and retrieving information. Microfilm viewer/scanners facilitate the viewing of records on microfilm, with the versatility to print microfilmed images to paper and to scan existing microfilmed records to digital electronic file.

Figure 2. Decommissioning information on microfilm

3.4   Knowledge management initiatives

A cornerstone of AECL's decommissioning records and information management strategy is its knowledge management tool, the LIM Bridge - a customized database that permits easy and quick access to key decommissioning information, including photos, external sources of information and information systems. AECL's electronic records and document management system, TRAK, represents the Company's official repository for its records. The Liability Information Management database leverages various pools of information to maximize accessibility, retrievability and sharing of key decommissioning information across projects.

Information is tagged with metadata, allowing it to be searched and retrieved by various means (i.e., building number, document type, project number, etc). The description metadata field provides a summary of content that allows for the quick scan of documents. The LIM Bridge's interface is simple with several basic search features, a keyword search and a more advanced information search function. Currently, over 300 staff access the LIM Bridge, with new members added and provided orientation on a regular basis.

New knowledge management initiatives are currently underway or are being investigated. Recently, the Liability Information Management Office conducted a review of general and administrative records of waste management areas at Chalk River Laboratories since inception, dating as far back as the late 1940's. The contents of numerous records were synthesized and reduced to a concise overview report of waste management that will be used for future reference in subsequent planning of waste management area remediation activities, and for training new staff.

3.5 Challenges and lessons learned

3.5.1 Records and information management

Challenges in records and information management are not exclusive to decommissioning projects or the nuclear industry in general. Given the nature and complexity of a nuclear facility, however, the challenges may have a greater impact as such obstacles impede access to key information to support the planning and execution of safe and cost effective decommissioning.

The most common challenges are presented below [5]:

- Late realization of the need to start compiling key records to support decommissioning;
- Loss of institutional control of records (and institutional knowledge) critical to the success of the decommissioning process;
- Inability to access records due to changes in records storage technology;
- Maintaining duplicate records in at least two separate secure locations;
- The definition and identification of records that will constitute the project data package to document the process used for successfully completing decommissioning projects;
- Records where the quality, completeness and/or integrity of the information is compromised.

These challenges are frequently encountered by AECL. Other factors such as the number of nuclear facilities currently being decommissioned, records collections located at various sites across the country, and, changes to records and information management systems and processes over the years, add to the complexity in effectively implementing AECL's strategy for the preservation information.

3.5.2 Information management and electronic technology

Much effort has been placed by many facilities over the last decade to move towards electronic capture, storage, management, access and retrieval of information. This benefits decommissioning projects by making records and other sources of information easily accessible and retrievable via the use of advanced records and document management systems. However, it is not considered ideal for the long term retention and preservation of decommissioning information. The migration of large volumes of electronic files to new or different electronic storage media, a new electronic file format, software application or operating system poses risks due to loss, reduced quality, and partial or complete incompatibility with other systems or equipment.

This challenge was made evident during the 1990's when organizations moved towards standardizing file formats and software applications for the generation of documents. Conversions of an original file format to a standard format proved difficult and time-consuming. At this point in time, the ability to read any documents in original format not converted to a standard format, for example, old Wordperfect files (particularly documents with formulas or graphs), may not be possible. At minimum, special conversion applications as well as additional time, effort and technical expertise would be required to make older documents readable.

A recent records archival project of facility records conducted at AECL illustrates the challenge regarding the incompatibility of applications and systems. In the 1990's, over 36,000 NRX facility records were originally scanned into single page Tiff files where a standalone database provided all metadata about the file including which Tiff files made up the document, under a Windows 95 operating system environment and written to CDs . Over the course of several years, the Windows Operating System evolved and the information on the CDs became increasingly difficult to access and retrieve. As a result of the accessibility issues, the company executed the conversion of the electronic files to preserve the information. A conversion project was undertaken to 1) establish a virtual operating system environment, 2) verify the quality of the Tiff Image, 3) retrieve the Tiff files from CD, 4) recombine the single pages into complete documents, 5) convert to standard Portable Document File (PDF) format, and then 6) load and verify the information to the company's main electronic records management system. Fortunately, the conversion project was successful. The alternative would have been to re-scan thousands of records.

Presently, standard file formats exist, for example the PDF/A, and the evolution of applications and operating systems has slowed, providing opportunities for more stable and longer term preservation of electronic information. Technology will continue to advance, however, and the prospect of adapting and converting to a new standard in the future is probable. Microfilm, as a technologically independent method of preserving information, still remains an attractive and viable format for long term preservation of information.

3.5.3 Language and terminology

Other challenges exist, such as language used, differences in the use of terminology, abbreviations or undefined and obscure acronyms, posing barriers to existing as well as future generations of staff in understanding or for ease of searching and retrieving relevant decommissioning information. In Canada, documentation may be written in either official language – French or English. The majority of historical design and facility records supporting AECL's Gentilly-1, for example, are written in French. Decommissioning staff, at minimum, is required to be proficient in this language to read and interpret information in order to plan and execute decommissioning projects.

4.   CONCLUSION

The focus for decommissioning projects, in the area of information management and preservation, should begin with the establishment and implementation of a sound records and information management strategy. Information should be collected at early stages and properly managed and stored throughout a facility's lifecycle. Strategies and tools should be designed to make information easily accessible and retrievable, and ensure implementation evolves and improves as the facility changes. The use of technology for information and knowledge management should be encouraged to effectively store, access and share key decommissioning information. Strategies and tools should remain flexible and cost efficient as technology will evolve and advance over time. Migration to new technological systems, tools, formats and storage media will be inevitable. Knowledge management strategies and tools should be adopted as they are valuable to any decommissioning project to leverage key information and transfer/exchange knowledge to future staff within a facility, company and externally to national and international organizations to learn from and improve. Finally, sound planning and execution of safe and cost effective decommissioning projects depend on the access to key facility information. It's important to view records and information management as a necessary and integral part of a facility's lifecycle. Periodic education and awareness throughout the facility's phases helps to remind staff of the value and requirement to maintain and preserve key information for eventual decommissioning of a facility.

REFERENCES

[1] Laraia, M., editor, "Information management for nuclear decommissioning projects", *Nuclear Decommissioning: planning, execution and international experience*, Woodhead Publishing Ltd, (forthcoming 2011).

[2] Lemire, D.S., "Decommissioning information management in decommissioning planning and operations at AECL", *Waste Management, Decommissioning and Environmental Restoration for Canada's Nuclear Activities: "Current Practices and Future Needs", May 8-11, 2005, Ottawa Ontario*, Toronto, Canadian Nuclear Society, Ref. 5054.

[3] International Atomic Energy Agency,"Record keeping for the decommissioning of nuclear facilities: guidelines and experience", *Technical reports series no. 411*, Vienna, IAEA, 2002.

[4] Taboas, A.L., Moghissi, A.A., LaGuardia, T.S., editors, **"Decommissioning overview",** *The decommissioning handbook*, New York, American Society of Mechanical Engineers, 2004, Chapter 1, p. 1-1 – 1-28.

[5] Draper DG, "Decommissioning of nuclear facilities, record keeping", *The R^2D^2 Project: Workshop 2, The Basics of Decommissioning of Research Reactors*, *Manila, Philippines, October 16-20, 2006*, Vienna, International Atomic Energy Agency, 2006.