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# Record Keeping for the Decommissioning of Nuclear Facilities: Guidelines and Experience

INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 2002

RECORD KEEPING
FOR THE DECOMMISSIONING
OF NUCLEAR FACILITIES:
GUIDELINES AND EXPERIENCE

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# RECORD KEEPING FOR THE DECOMMISSIONING OF NUCLEAR FACILITIES: GUIDELINES AND EXPERIENCE

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# FOREWORD

The design and as built records from the beginning of the operation of a facility are essential for its safe and efficient operation. This set of records needs to be constantly updated and augmented during its operation and should include, for example, any modifications or additions to it, its operational history and details of any incidents that lead to unplanned contaminations of the systems and structures. The objective of final decommissioning should be considered from the earliest stage of the life cycle of a facility and requires focus on the acquisition and maintenance of the relevant records. In performing the detailed planning for the permanent shutdown of a facility a dedicated effort is needed to develop the strategy for the selection and management of the key records.

As published information and guidance on record keeping relevant to nuclear decommissioning is relatively scarce, more attention is needed on the management and organization of records. Experience indicates that a lack of attention to record keeping may result in a costly misallocation of resources and may present problems of safety. A few IAEA reports have marginally dealt with the records important for the decommissioning of nuclear facilities. No report, however, has so far been dedicated solely to this topic. In view of the increasing experience in decommissioning projects it is felt that now is the proper time to move from a case by case to a more systematic approach for the management of records. The objective of this report is to provide information, experience and assistance on how to identify, update as needed and maintain the necessary records to assist in the decommissioning of nuclear facilities.

An Advisory Group Meeting on this subject was held in Vienna from 26 to 30 March 2001. The meeting was attended by 12 experts from 11 Member States. The participants discussed and revised a preliminary report drafted by consultants from Belgium, Italy, Spain and the United Kingdom and by the IAEA Scientific Secretary, M. Laraia of the Division of Nuclear Fuel Cycle and Waste Technology. Other contributions were made available to the IAEA through a variety of sources. After the Advisory Group Meeting the text was revised by the IAEA Secretariat, with the assistance of three consultants from Canada, the United Kingdom and the United States of America.

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# 1. INTRODUCTION

The first records for a nuclear facility are produced and stored at its siting and conceptual design stage. Subsequent phases in its life cycle (i.e. its detailed design, construction, commissioning, operation and shutdown) will include the production and retention of a large variety of records (Table I). Design records, as built drawings and operational records are essential for the safe and efficient operation of any nuclear facility. This set of records needs to be constantly updated and augmented during the operation of a facility and should include details of any modifications to it, the fuel and waste management records, the radiological conditions, the operational records and details of any unusual events that may lead to the unplanned contamination of systems and structures.

Records from all the phases of a nuclear facility are important for planning its decommissioning. Although not all of these records need to be included explicitly in the decommissioning plan itself, the process of initial, ongoing and final planning utilizes the pertinent records for, and ultimately achieves, safe and cost effective decommissioning [1].

As the operating experience of a nuclear facility may be lost when it is shut down, one important element of planning is therefore to identify, secure and store the appropriate operational records needed to support its decommissioning. This process is preferably initiated during the design and construction phase and continues throughout its operation and shutdown. Part of the records inventory from the operation of a facility will become the records for its decommissioning, and it is cost effective to identify these records before it is shut down.

The published information and guidance on record keeping for the decommissioning of nuclear facilities is relatively poor compared with the information available on their technological aspects, which means that more attention is needed on the management and organization of records. While information on decommissioning technology is readily available, guidance on the management and organization of record keeping could be improved. Experience shows that a lack of attention to record keeping may result in an undue waste of time and other resources and may incur additional costs (Table II). The newly established Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [2, (art. 26 (iv))] recognizes the importance of keeping decommissioning related records. In addition, the systematic management of records is an essential part of quality assurance (QA) and is often a condition of a facility's licence. A good comprehensive decommissioning records management system (RMS) is one specific application of the broader concepts of the "protection of future generations" and "burden on future generations", as highlighted in the IAEA document Principles of Radioactive Waste Management [3].

A few IAEA reports, for example Refs [4, 5], have briefly addressed the records important for the decommissioning of nuclear facilities. However, no report has so far

TABLE I. DOCUMENTATION TYPICALLY COLLECTED AND ARCHIVED FOR DECOMMISSIONING

| | |
|---|---|
| Design, construction and modification data | The following design, construction and modification documentation are typically collected and archived:<br>— Site characterization, geological and background baseline radiological data;<br>— Complete drawings and technical descriptions of the facility as built, including design calculations;<br>— Construction photographs with detailed captions;<br>— Schedules of any construction modifications and their drawings;<br>— Procurement records that identify the types and quantities of the materials used in construction;<br>— Engineering codes;<br>— Equipment and component specifications, including pertinent information (i.e. the supplier, weight, size, materials of construction, etc.);<br>— Facility construction material samples;<br>— Facility design inventories of chemical and radiological material flow sheets;<br>— Quality certifications;<br>— Safety cases for the operation of the facility;<br>— Environmental impact statements;<br>— Pre-operational facility testing and commissioning records;<br>— Licensing documentation and operating requirements;<br>— Preliminary decommissioning plans. |
| Operating, shutdown and post-shutdown data | The following documentation should be collected and archived during the operation, shutdown and post-shutdown of a facility:<br>— The licence and licensing requirements;<br>— Safety analysis reports;<br>— Technical manuals;<br>— Details of environmental releases;<br>— Facility logbooks;<br>— Facility and/or site radiological survey reports;<br>— Operating and maintenance procedures and records;<br>— Abnormal occurrence reports;<br>— Decontamination plans and reports;<br>— Technical specifications (limits and conditions);<br>— Design change reports and updated drawings;<br>— Hazardous material inventories; |

TABLE I. (cont.)

| | |
|---|---|
| | — Process and service interfaces with other facilities;<br>— Process flowsheets, including for services;<br>— System, structure and component inspection records;<br>— On-facility waste management records;<br>— Site hydrology and groundwater contamination records;<br>— Records of equipment terminations (e.g. piping and cables) during operation and at shutdown;<br>— Records of staff leaving debriefings;<br>— QA records;<br>— Fuel geometry, performance (i.e. damage) and accounting records;<br>— Records of neutron fluxes and distributions;<br>— Records of waste management strategies and locations of waste;<br>— Records of radiation sources and their locations;<br>— Samples of irradiated and embrittled materials;<br>— Relevant laboratory test reports. |

addressed the subject in full. With the increase in experience of decommissioning it is timely to move from a case by case to a more systematic approach to providing assistance on this subject.

## 2. SCOPE AND OBJECTIVES

This report covers record keeping for the decommissioning of nuclear facilities. Nuclear facilities include large commercial facilities such as nuclear power plants or chemical nuclear facilities (e.g. for fabrication and reprocessing), but also include smaller facilities such as research reactors and medical, industrial and other research facilities. Special attention may be needed for these small facilities owing to factors such as the low priority given to decommissioning by research teams and the possibility of poorly recorded structural and operational changes. A focus on research reactors is also important because of their widespread distribution. Two IAEA TECDOCs [6, 7] address record keeping for radioactive waste management and disposal facilities, and therefore these areas are not covered in this report.

The objective of this report is to provide information, experience and assistance on how to identify, update as needed and maintain records to assist in the decommissioning of nuclear facilities, including for the decommissioning plan. This report is intended to be useful to policy makers, regulators, owners, operators,

TABLE II. CONSEQUENCES OF A LACK OF RECORDS FOR DECOMMISSIONING (EXAMPLES)

| Record | Consequence |
|---|---|
| *Design, construction and modification data* | |
| Site characterization, geological and background baseline radiological data | No target for the restoration of the site<br>Site termination surveys more technically difficult<br>More time, resource and equipment use required<br>Future litigation, owing to inadequate data<br>Significant regulator interface on the potential environmental, health and safety issues<br>Licence termination documentation potentially large and complex<br>Impact on decommissioning strategy and cost (i.e. significantly increased waste management)<br>Considered to be a significant issue for facilities handling naturally occurring radioactive material |
| Complete drawings of the facility as built and the technical description of the facility, including design calculations | Complicates the knowledge of and access to contaminated areas<br>Time and money spent on reconstructing the record and on calculations<br>The safety case may be delayed<br>Direct effect on the decommissioning strategy and an impact on time scheduling<br>Much more safety and environmental planning to deal with unknown situations and more contingency required, for example for resources and financing<br>Considerable increased regulatory interaction to clear the safety case<br>Cannot move to decommissioning without this data being available or reconstructed |
| Procurement records of materials during construction and through the life of the facility | An adequate theoretical assessment of neutron activation (for reactors) of materials is more difficult and hence waste cost estimates become difficult, which leads to considerably more sampling of the facility (this has implications for workforce safety and decommissioning costs)<br>Can affect the waste management aspect of the decommissioning strategy<br>Causes difficulty with estimating the potential dose uptake, which leads to conservative decommissioning strategies, which will affect decommissioning work packages |

TABLE II. (cont.)

| Record | Consequence |
|---|---|
| | Implications for the selection of decontamination techniques<br>More regulatory intervention by the regulators<br>Time, resource and cost implications for the strategy to be used, and a time delay |
| *Operating, shutdown and post-shutdown data* | |
| Environmental releases (over the life of the facility) | Lack of assurance on off-site and site contamination<br>Public concern potential and potential long term litigation<br>Will need regulatory intervention regarding previously unrevealed historical events<br>Will need to reconstruct data via extensive sampling<br>Potential to be forced to do cleanup operations that are not the responsibility of the facility<br>Unable to confirm adequately the baseline site characteristics<br>Potential difficulty in releasing land for other uses |
| Abnormal occurrence reports | The need to deal with unknowns, which can give rise to an unexpected operator risk, and will give the regulator, public and workforce a lack of confidence in the management of the decommissioning<br>Unexpected waste arisings and workforce dose and/or chemical exposure<br>Will impact upon the decommissioning strategy<br>Will cause delays<br>Will cause a substantial change in the strategy<br>Will increase time, costs and resources, which can impact upon the ability to release land |
| Records of terminations (disconnections, removals, etc.) of pipes, cables and vessels | Unexpected hazards arise<br>Lack of records will lead to a lack of confidence by the regulators, public and workforce<br>Potential for cross-contamination<br>Will interfere with the development of work programmes, and hence contingency will be required<br>Extensive surveys will be required<br>Additional waste generated |

**Note:** All these issues can affect contract bids. Inadequate planning contingency could lead to increased safety hazards, worker dose implications and a financial shortfall.

decommissioning contractors and other interested parties. Record keeping is an integral part of overall QA or quality management programmes, and this is emphasized in this report. This report also indicates the possible consequences of not maintaining adequate records.

This report describes the needs and the sources of the records for decommissioning (Section 3) and the process of identifying and selecting these records (Section 4). Section 5 considers the records from the decommissioning process itself and their retention, while Section 6 deals with QA, organization and responsibilities. The RMS is dealt with in Section 7 and the management of new records in Section 8. A summary of observations is included in Section 9. The report is complemented by an appendix and annexes that describe case histories.

# 3. DESIGN AND OPERATIONAL DATA REQUIRED FOR DECOMMISSIONING

## 3.1. GENERAL

The current convention is that the requirements for decommissioning are reviewed and incorporated into the design and operational procedures for a new facility. Accordingly, it is important that managing the records generated receives serious and proper consideration at this stage [8].

During the operation of a facility the information on the original design and modifications to it is normally maintained as a recoverable record. In addition, careful attention is given to the operational records of the facility, for example dose rate surveys, dose commitments, contamination maps, unplanned events and waste management records [9, 10]. It should be noted that these records will form the basis for the records needed for the post-operational phase, including the decommissioning phase.

For existing operating or shutdown facilities without a decommissioning plan, the establishment of a decommissioning plan and strategy is a high priority. This includes the consideration and identification of the records important for decommissioning.

Inattention to the proper identification and management of records from the design, construction and operation of a facility may cause delays during its decommissioning, increase costs and may affect safety and/or the environment; for example, the requirement to reconstruct information could require plant interventions and hence unnecessary exposures of workers to radiation. Some examples of the undesirable consequences of poor record management practices are given in Table II. To mention one example, the decommissioning costs for the Cintichem Research Reactor in the United States of America escalated to US $100 million, owing to the lack of records on the soil and groundwater contamination discovered during the actual dismantling work [11].

## 3.2. DECOMMISSIONING STRATEGY

The two most common decommissioning strategies are immediate dismantling and deferred dismantling. A combination of these options, known as phased decommissioning, which consists of periods of active dismantling interspersed with safe enclosure phases, is also common. A third strategy, on-site disposal, which is the permanent disposal of the facility, or parts thereof, within the site on which the facility operated, is generally used only in special cases.

Immediate dismantling is the strategy of active decommissioning being undertaken soon after the facility is shut down. For the purposes of planning and implementation it is important that a complete, up to date and validated set of records is available to those who carry out the decommissioning. In the event that the operational records needed for decommissioning planning are incomplete, the knowledge of key operational staff becomes an important component to improve and enhance the operational record. It is useful to have within an organization's management system a requirement to debrief key staff when the facility is shut down or when they cease working for it.

It is clear that record keeping for a deferred dismantling strategy involves long term record storage and that retrievability concerns are significantly greater than for immediate dismantling [12]. There may only be a few people with a detailed knowledge of the shut down facility at the beginning of its dismantling; debriefing staff at the shutdown of a facility, or when they cease working for it, is therefore particularly important for this strategy. It is important that the debriefing is structured, of good quality and is itself a well maintained record. For deferred dismantling, which may happen decades after the closure of a facility, the opportunity to debrief personnel will probably no longer exist when the decommissioning actually begins. Full reliance will therefore have to be given to the records assembled during the design, construction, operation and shutdown of the facility, and to earlier personnel debriefings. These records will have been stored for future use over a period of several decades. It is evident that issues such as legibility, preservation and retrievability over such long time spans are important for this strategy.

## 3.3. PRIMARY DATA SOURCES FOR DECOMMISSIONING

The main sources of data from which an RMS for decommissioning can be selected and assembled at the end of the life of a facility are:

— Design, construction and modification data;
— Operating, shutdown and post-shutdown data.

Typical questions concerning which design and operational records should be selected to support decommissioning are:

— Is the record needed to support and authorize the continued safe operation of the facility?
— Is the record needed to comply with a licence condition and/or other statutory requirement?
— Is the record needed to quantify and characterize waste on the site or to be sent for disposal?
— Is the record needed to provide information for future decommissioning activities?
— Is the record needed to support the long term care and maintenance of the facility and site?
— Is the record needed to preserve and/or record staff dosimetry and health records or for staff welfare?
— Is the record of a type that is neither directly related to operations nor decommissioning but that nevertheless needs to be retained?
— Is the record new data that has arisen since the last review of the records?
— Is the record likely to be needed to defend against any possible litigation?
— Is the record considered to be non-permanent?

### 3.3.1. Design, construction and modification data

The data usually generated during the design, construction and modification of a facility are given in Table I.

A baseline radiological, environmental and geotechnical characterization of the site for the proposed facility will normally be required for the purposes of its licensing.

A quantification of the natural activity in backfill soil and the building materials used in construction is an essential component in demonstrating compliance with future clearance and target cleanup levels. Samples of selected soil and construction materials for future analysis are also typically part of the records archive. This information is important for the future restoration of a site to its baseline condition.

Geotechnical surveys are normally carried out for structural reasons and to identify site hazards. These surveys provide important records, particularly for the purposes of the reuse of the site after the decommissioning process.

Full details of the design specification and information relevant to the siting, final design and construction of a facility should be retained as part of the information needed to assist in its operation and eventual decommissioning. This information should be maintained, reviewed and updated throughout the operational lifetime of a facility. The maintenance of an RMS used during this process is clearly a responsibility of the operating organization. As noted in Table I, such information may include as built drawings, models and photographs, the construction sequence, piping schematics, the details of construction, cable penetrations and repairs to or deviations in components and structures [13]. In addition, all relevant information relating to the environmental condition of a site prior to the operation of a facility is essential and relevant for any environmental impact study.

As a means of assuring adequate attention to maintaining up to date drawings, strong procedural emphasis on QA during the design and construction period is essential and should be extended throughout the operating phase and into the decommissioning (see Section 6). During the operation of a facility (Section 3.3.2) modifications to the buildings and systems will occur, which will lead to modifications to the design and construction records.

During the life of a facility it is important that the documentation be regularly and independently audited to assess specifically its fitness for decommissioning purposes.

### 3.3.2. Operating, shutdown and post-shutdown data

To facilitate a successful decommissioning accurate and relevant records should be kept during the operating phase of a facility. Table I outlines the records produced during the normal operation of a facility. These records include safety and licensing information, operational manuals and logs, maintenance records, radiological surveys, as well as any information pertaining to abnormal occurrences.

If these records have not been or are not being maintained it is desirable that such record keeping be initiated as soon as possible. These records should be organized so that those most relevant to decommissioning can be identified. It is important that data on modifications to a facility or its processes be recorded and maintained. In addition, the record of the final condition of a facility at shutdown is essential, in particular for identifying any systems that have been terminated or isolated prior to the decommissioning.

The records of maintenance are particularly important as they give information that includes:

— Special repair or maintenance activities and techniques (e.g. temporary shielding arrangements or techniques for the removal of large components);
— Details of the design, material composition and configuration of the facility as built and the location of all temporary experiments and devices.

It is recognized that documenting good practices during the operating life of a facility will also be valuable for decommissioning. Specific operational benefits realized during maintenance or refurbishment from the use of good practices such as minimizing radiation doses and from greater working efficiencies will also be relevant.

The experimental irradiation of specimens of selected materials used in the construction of the installation may assist in comparing measured and calculated activation levels for the final radioactivity inventory.

The management of records becomes particularly important at the end of the operation of a facility. If adequate attention has been paid to records management during design, construction and operation then the data for decommissioning will be readily available. If the recommended approach of continuous record keeping has not been properly implemented then immediate corrective measures are in order to identify and flag those records from all the records of the facility that will enable, when required, the transfer of information to the decommissioning RMS.

# 4. PROCESS OF SELECTING DECOMMISSIONING RECORDS

## 4.1. INTRODUCTION

Reaching the decommissioning stage of a facility will have a significant impact on the importance of the surviving records. It is clear that many of the records derived from the operation of a facility are not required for its decommissioning, but it is also clear that additional data may be necessary. Other records may need to be retained for legal reasons even though they may not be directly relevant to decommissioning. Creating the full set of records essential for decommissioning only after the shutdown of a facility is time consuming and difficult. Planning for decommissioning requires the relevant data of all stages of the life cycle of a plant (Table I) and the creation of new records. This normally includes radiological measurements (i.e. dose rates and contamination levels), a cross-check of the drawings of the facility as built and may include a three dimensional computer aided design simulation (Fig. 1). To minimize delays and profit from the experience of the operating staff it is preferable that most of these new record keeping activities be completed as early as possible, before the final shutdown of the facility. However, data may change during the remaining life of the facility (and characterization activities will have to be repeated). Some caution is needed when using historical data, as they might be obsolete or inaccurate (see Annex II).

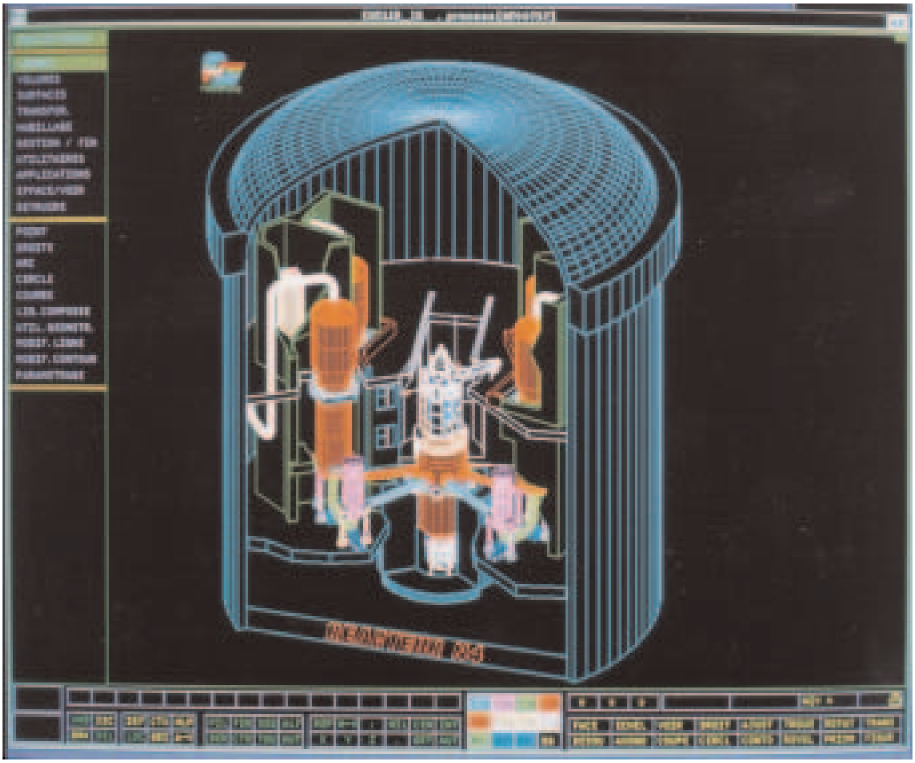

*FIG. 1. Computer aided design view of the reactor at the new N4 plant in France.*

### 4.2. ESTABLISHING THE RMS

There exists an opportunity to build a data collection and record keeping system to operate as part of an integrated facility information system for a nuclear facility at its design and construction stage, as noted in Section 3. Information is available from different sources (the operation of the facility, maintenance, radiological protection activities and waste management) and in several forms (as figures, images, samples and reports). An integrated facility information system can be designed to provide retrieval and manipulation of the data in a transparent way for its users. Records should be indexed by elements such as the classification of the records system, their type and their location. Further, it may be particularly helpful in any such database to flag data that may be of particular importance to decommissioning.

Scanning the hardcopy records required for decommissioning into an electronic RMS may provide enhanced search and retrieval capabilities, as well as providing a backup for the hardcopy records.

Figure 2 illustrates the typical elements of a computer based integrated facility management information system. A computer system can enable access to all categories of records. If records are in a hardcopy form, their storage location is important for their retrieval, whereas if records are in an electronic format they can be accessed directly and displayed.

It is important to audit an information system regularly to determine throughout the life of a facility if the system contains adequate data for its decommissioning (see Section 4.3).

## 4.3. SELECTION OF DECOMMISSIONING RECORDS

An initial decommissioning plan should be developed during the design and construction of a facility and should be regularly reviewed during its operation. In order to start decommissioning an overview decommissioning plan is usually required for the licence. A typical list of the topics to be addressed in this plan is provided in Ref. [1]. Subsequently, detailed work programmes should be produced to make choices on the

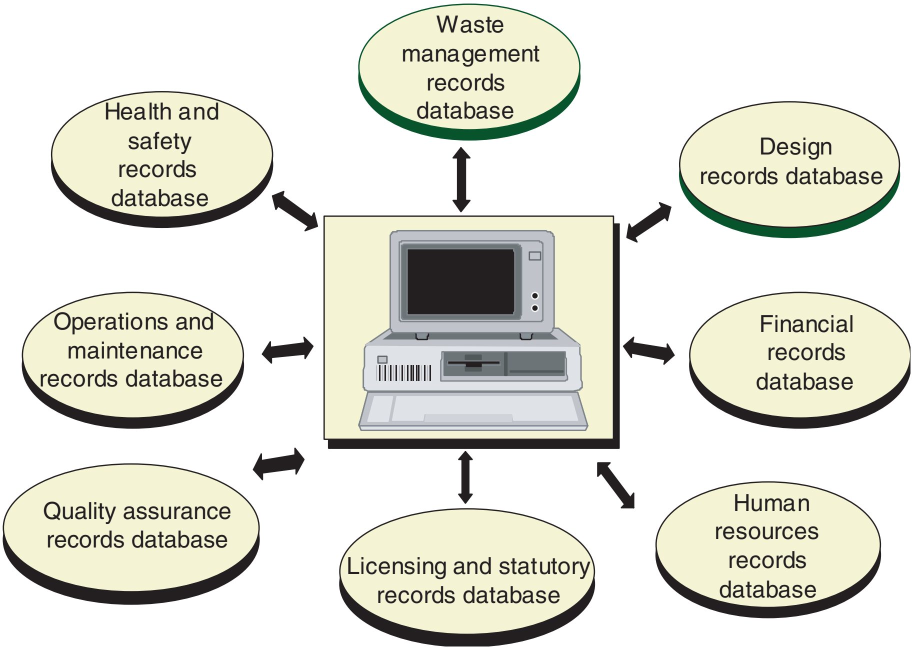


*FIG. 2. Integrated management information system.*

technology to be used, to develop a waste management strategy and to identify the resources that will be required. In addition, these plans contribute to the selection of the decommissioning records (Table III) — see Ref. [14] for further guidance. A validation of the documents and data to be utilized for decommissioning is essential for the safe and cost effective planning of the work programme. This process will in general entail a considerable reduction in the number of documents from those used for the operation of the facility. As an example, for the Brennilis decommissioning project in France it was estimated that the documents (including safety documents) useful for the decommissioning teams make up only about 30% of the initial documentation [15]. The selection criteria therefore are to identify the documents needed for decommissioning and waste management strategies, as well as those required by legislation or for addressing potential future litigation.

The selection is based on a review of the existing records and of their relevance on the basis of [16]:

- The statutory and regulatory requirements;
- Their support for engineering and the safety of immediate and future facility decommissioning activities;
- The operator's legal defence against possible future litigation.

A typical systematic selection process for records may benefit from reviewing the set of questions given in Section 3.3.

Records are selected for the purposes of decommissioning depending on a number of factors, such as the:

- Decommissioning strategy to be followed (see Section 3.2);
- Full availability of up to date as built design, construction, modification, operational and shutdown records or the need to reacquire any or all of these;
- Availability of the human, technical and financial resources, in house or through contractors;
- Legislative and regulatory aspects, including requirements for sensitive records, their redundancy, etc.;
- Characteristics of the facility, operational records, system specifications, main piping isometrics and supports, layout drawings, etc.;
- Radiological characterization data and records (see Figs 3–5).

## 4.4. AUDITING OF THE RMS

As noted in Section 4.2, it will be beneficial to audit regularly the design, construction and operational RMS to assess whether it properly manages the records

TABLE III. TYPICAL RECORDS REQUIRED BEFORE AND DURING DECOMMISSIONING

| | |
|---|---|
| Important records to be produced in preparation for decommissioning | The decommissioning strategy selection document and associated plans<br>The design, construction and operational records to be retained or transferred to the operating organization at the start of decommissioning<br>The decommissioning plan and subsequent amendments<br>The decommissioning project QA programme<br>Decommissioning safety assessments and reports<br>The work programme and associated work packages and records<br>Manufacturing and construction records as built, including engineering drawings for any installation or construction work done to assist, or as part of, decommissioning<br>Initial radiological survey reports<br>Environmental assessment reports, including environmental impact assessments<br>Project management plans<br>Funding and financial documents, including costs and schedules<br>Licensing documentation<br>The decommissioning organization |
| Important records produced during decommissioning | Engineering drawings that indicate the state of the facility on the completion of each defined decommissioning phase<br>Decommissioning team personnel radiological dose records<br>Radioactive and chemical material waste records and disposal records<br>Release material records<br>Photographs taken of the facility and site during decommissioning<br>Details of significant abnormal events during decommissioning and the actions taken<br>Project progress and status reports<br>Intermediate and final radiological survey reports<br>Routine surveillance, maintenance and monitoring records<br>The final decommissioning report |

*FIG. 3. In situ measurements being taken at a UK reactor.*

important for decommissioning. The auditing process is intended to ensure that proper records are flagged for inclusion or consideration at the time of decommissioning. The auditing team typically includes decommissioning specialists, information specialists and facility operations staff. In addition, the auditing should emphasize to the operational staff the importance of decommissioning and the need to manage the RMS properly. Well before the facility is shut down, a decommissioning team should be put in place to select the documents from the operational RMS needed to form the decommissioning RMS. Where necessary and ahead of the shutdown any gaps in the records should be reconstructed and any remedial action taken.

### 4.5. DOCUMENTATION PREPARED FOR DECOMMISSIONING

Typical decommissioning records required for and produced during decommissioning are listed in Table III. Other lists of records are given in the published literature, for example in Ref. [17]. For the termination of the nuclear licence other documents are typically produced and are listed in Ref. [1].

*FIG. 4. Control room for remote operations for the Japan Power Demonstration Reactor decommissioning project.*

*FIG. 5. Concrete samples (taken at various depths) from the reactor biological shield for an activation analysis for the Garigliano decommissioning project in Italy.*

Detailed decommissioning plans contain a description of the planned decommissioning activities. These plans include a description of the methods used to ensure the protection of the workers, the public and the environment against radiation and other hazards. In addition, an estimate of the waste expected to be generated during a project is included. A detailed radiological and material inventory is crucial to the planning of any decommissioning project. Information such as the levels and locations of contaminants and quantities of specific radionuclides present in the areas of the facility to be decommissioned is needed to develop these reports. Since a recent IAEA publication deals extensively with radiological characterization methods and techniques [5], a detailed treatment of this topic will not be repeated here. One special aspect is the topic of the characterization of inaccessible areas. Certain areas may not have been routinely accessible during normal operation, but workers may need to work in them during decommissioning operations. A knowledge of the radiological conditions in these areas, for example around the reactor enclosure or within the reactor bioshield, will serve to facilitate decommissioning by minimizing occupational radiation exposures.

Another input into the decommissioning plan is the records of spills or other unusual occurrences that took place over the operating life of the facility and that may have resulted in contamination that remains and that suggest potential locations of inaccessible or concealed contamination (e.g. under repainted surfaces or floors). Records of such events indicate conditions in a facility that could adversely affect health and safety and are therefore needed to assist in the progress of the overall decommissioning project. These records could be used to minimize radiation exposures during decommissioning activities. For example, the decommissioning records would contain information on radiation sources that could otherwise be overlooked after the period of operation, such as buried pipes, remote surface locations contaminated with radioactive material or multiple layers of paint that may conceal contaminants [10]. The generation and long term management of such records during the operation of a facility is important to assist in decommissioning.

Another important characterization aspect is that of waste management. It is essential that the location, physico-chemical content and concentrations of both the hazardous and radioactive waste stored at a facility or on its site be well documented and readily available. Of particular importance is waste and debris placed in temporary cells, pits or vaults. Details of modifications to the plant and maintenance experience include the records cited in Section 3.

It is also important that material test certificates and coupons be retained to assess the influence of radiation exposures (e.g. neutron activation). Activated or contaminated materials reports generated during the operation of a facility (e.g. during maintenance) are useful because of their applicability to future decommissioning (e.g. to validate activation codes).

Up to date information on the systems and components of the facility is essential. Undocumented changes will cause some filed drawings to be inaccurate. If as built drawings are poorly maintained or incomplete, they may need to be reconstructed and verified.

Typical applications of records for reactor decommissioning purposes are given in Table IV [18].

The decommissioning documents and records produced for legal and regulatory purposes play a key role in the process of records management. Typically they are identified in licensing documentation and in the decommissioning plan. Ideally these documents may serve purposes other than complying with regulations, for example for the engineering of decommissioning activities. It is recognized, however, that there will be some documents generated exclusively or primarily for legal and/or regulatory purposes. Depending on national legislation and regulations, decommissioning plans, or relevant parts thereof, should be submitted by the operating organization to the regulatory body for review and/or approval. Guidance on the drafting of decommissioning plans is given in Ref. [1], which contains a list of items to be considered for the final decommissioning plan. If the selected decommissioning option results in a phased decommissioning with significant periods of time between phases, a higher level of detail for the items identified in Ref. [1] may be required for the next decommissioning phase being executed. As a result of completing an individual phase of the decommissioning, some modification to the planning for subsequent phases may be needed. In such cases, subsequent sections of the decommissioning plan may require updating.

# 5. RETENTION OF DECOMMISSIONING RECORDS

## 5.1. RECORDS PRODUCED DURING THE DECOMMISSIONING PHASES

Some of the selected records will only be preserved for a limited period of time, owing either to current regulations or because they are related to the service life of equipment. Examples of the types of document produced during the decommissioning phases are given in Table III. The majority of these types of record are technical documents that relate to systems to be dismantled. They will be processed on a regular basis and are then either classified for further retention (for deferred dismantling) or discarded. Some of the benefits of creating an integrated decommissioning RMS are to [16]:

- Assist in substantiating the integrity of a facility at each stage of its decommissioning and dismantling;
- Assist in substantiating the manner and means of the decommissioning of a facility, including interim maintenance provisions;

TABLE IV. SAMPLE APPLICATIONS OF RECORDS FOR DECOMMISSIONING A NUCLEAR REACTOR [18]

| Design and construction information | Decommissioning application |
|---|---|
| Structural details, including concrete pour drawings, rebar placements, penetration locations (as built) | Demolition support: core drilling, blast placement, access considerations |
| General arrangement drawings | Material flow, traffic control and activity sequencing |
| Fabrication specifications of reactor vessel and internal packages identifying assembly and disassembly procedures, material specifications, construction details and arrangements, including vessel support and recirculation system interface details | Radionuclide activation analyses, disassembly and segmentation planning, automated cutter and manipulator designs and mock-ups, reactor cavity modifications |
| Nuclear steam supply system component drawings as built, arrangement drawings with supporting structural interfaces | Removal and disassembly procedures, rigging, transportation and disposal scenarios |
| Equipment and system specifications, manufacturers' as built and as installed associated arrangement drawings and piping layouts | Removal and dismantling sequencing and scheduling, system and equipment turnover and/or conversion for decommissioning operations |
| Construction aids: photographs, installation and placement records, scale models and mock-ups | Decommissioning and dismantling planning support |

— Estimate costs and waste quantities;
— Enable the identification, recovery, safe storage and disposal of radioactive material;
— Assist in minimizing occupational radiation doses during decommissioning;
— Identify shipments and the disposal locations of waste.

Once the decommissioning RMS has been established, operating protocols, methods and an organization to maintain it will be required. By training the personnel and building awareness of the work involved, any record produced by, transmitted to or received at the facility will be capable of being integrated into the RMS.

A strict observance of record management procedures to ensure the control and integrity of the original master copies is required to preserve the integrity of the system.

Periodic review and update operations should be performed, in order to:

- — Sort the temporary archives after each dismantling phase;
- — Include in the archives certain important documents, the significance of which was noted in the course of the decommissioning process.

The RMS created prior to the decommissioning is part of the project management system for the decommissioning operations. It also serves as a basis for the utilization of feedback from decommissioning activities.

### 5.2. RECORDS PRODUCED AFTER THE TERMINATION OF THE NUCLEAR LICENCE

An issue to resolve is that of which decommissioning records are to be preserved and for what period of time after the completion of the decommissioning. This matter needs to be viewed in the light of a possible transfer of ownership of the site after the final clearance. Also, once the project has been completed there must be a long term management of the knowledge base of the facility. Any caretaker responsibility, including keeping relevant records for potential litigation or other purposes, is then likely to be transferred to other institutions, as required by a State's laws and regulations. After a facility is decommissioned, the records may be required because of, among other things, new regulatory positions (e.g. on clearance levels) or the development of more advanced, higher resolution detection equipment. Typically the national regulatory body or another State institution would take over keeping the records from the operator of the facility. The duration of records control is usually determined by a State's regulations for records for, for example, occupational exposures and potential future liability. Other records may need to be kept for institutional purposes or other ad hoc reasons.

The same considerations are necessary for the long term preservation of decommissioning records, as discussed in Section 7.

## 6. QUALITY ASSURANCE

### 6.1. RECORD KEEPING AS PART OF THE QA PROGRAMME

The responsible organization will have a QA programme for a nuclear facility as an integral part of its management system. The QA programme should be modified at various stages (e.g. at the siting, design, construction, commissioning, operation and decommissioning of a facility) at a time consistent with the schedule for accomplishing stage related activities. In order to ensure that all activities are continually carried out under controlled conditions, the decommissioning QA programme is normally developed from the operational QA programme, and may overlap it [19]. For facilities not having a QA programme in place it is important that an ad hoc QA programme for decommissioning be developed before the decommissioning begins. Typical elements of a QA programme are [19]:

— A description of the QA programme;
— Personnel training and qualification;
— Quality improvement;
— Documents and records;
— Work processes;
— Design;
— Procurement;
— Inspection and acceptance testing;
— A management assessment;
— An independent assessment.

An RMS (see Section 7) is an important part of the overall QA programme for each facility. This system ensures that records are specified, prepared, authenticated and maintained, as required by applicable codes, standards and specifications. The RMS ensures that records are:

— Categorized and organized (e.g. Table I);
— Registered upon receipt;
— Readily retrievable;
— Indexed and placed in their proper location;
— Stored in a controlled environment;
— Corrected or supplemented to reflect the actual status of the plant.

The QA programme also provides some form of routine review of the quality and completeness of the records, based on the information required.

Further details on QA for record keeping are given in, for example, Refs [4, 5]. Some details on organization, responsibilities, the transfer of ownership, records with a special status and the loss of operational records are given in the following sections.

## 6.2. ORGANIZATION

During the design, construction, operation, shutdown and decommissioning of a facility a large amount of information will be generated and will require management.

With respect to the objectives of this report, there is also a need to identify clearly the organization(s) responsible for the RMS as early as possible in the life cycle of the facility.

Within some States there may also be a requirement that the regulatory body approves the specification of the minimum records required, their content and the procedures for any RMS.

The organization responsible for the RMS may be, depending on a number of factors, the operating organization, a department of the State, an agency or any other appropriate organization designated by law.

Figure 6 is presented as an example of an organization chart for records management during decommissioning. Regardless of the decommissioning strategy or intended programme, it is essential that an organization exists to administer and control the documents, as there will be a large volume of records at the time the facility is shut down.

It is useful to appoint a senior manager, with sufficient resources and authority, responsible for undertaking the management of the records and for administering the records archive. The procedures for records control should be overseen by a QA department or records management officer. A through-life auditing function should be ensured.

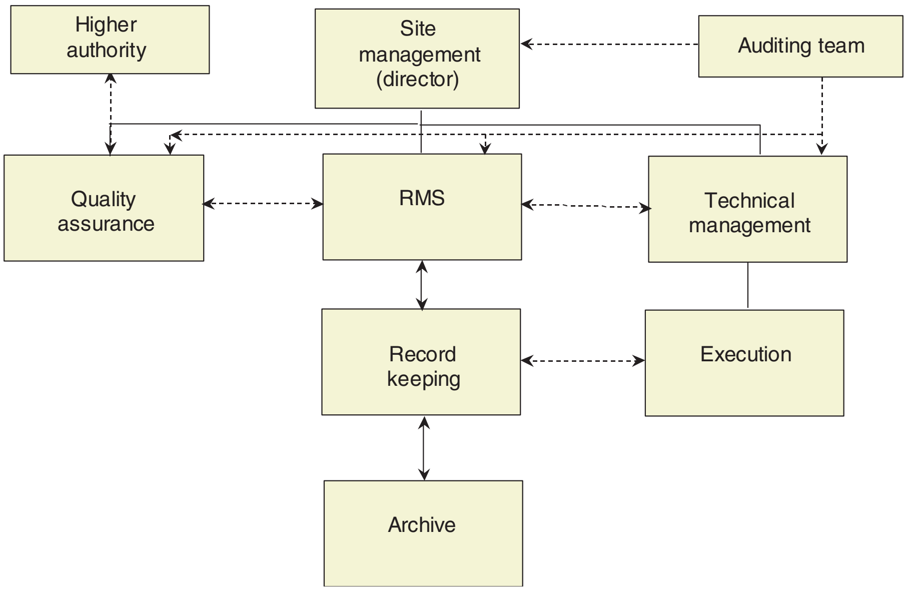


*FIG. 6. Organization chart for the management of decommissioning records.*

Further information on the practical aspects of records management during decommissioning is given in Section 7. An overall scheme for the organization and management for the decommissioning of large nuclear facilities is given in Ref. [4].

In many facilities the records management organization will already exist as a requirement of the licence for its operation. The organization for the administration of its records during the operation of the facility could be much larger and more complex than that required for decommissioning. In many cases this organization could be transferred to the decommissioning organization after the shutdown of the facility. This is desirable in order to facilitate some continuity in its organization and because the vast majority of the records for decommissioning will arise from the detailed design, construction and operating records archive. Where no proper records management organization exists (e.g. for very small facilities), then an organization will have to be created as a priority after shutdown to avoid the loss and dispersion of the records and to register the new records that will be generated.

### 6.3. RESPONSIBILITIES

To ensure continuity of the management of the records through time it is essential that the line of responsibility from senior management be maintained (see Fig. 6). The administration and management of the records is a direct responsibility of the management of the site. The QA responsibility is separate and, to give independence, encompasses all decommissioning activities, with the QA unit reporting to the site management or directly to a higher authority (e.g. a corporate body). The site management identifies within the organization who is responsible for defining, developing, operating and maintaining the RMS.

Different groups within an organization may use different RMSs (see Fig. 2), but there should be cross-references between them. Each record should be referenced uniquely, even if shared between systems.

The site manager ensures that appropriate QA provisions are applied throughout all of these tasks and ensures that the defined goals are achieved.

The responsibility for identifying and selecting the records for decommissioning is a technical function and lies with those who plan and execute the decommissioning strategy and activities. The responsibility for collecting, indexing, cataloguing, recording and archiving the records is an administrative function and resides with the records management group.

### 6.4. CHANGES IN OWNERSHIP OR MANAGEMENT

An issue that may be encountered is the transfer of ownership or management of a facility during its operational life. This may also occur after a permanent shutdown or during any phased decommissioning. Recent developments in the nuclear industry aimed at enhancing competitiveness may lead to organizational changes, such as a merging of operating organizations or transferring ownership from one operator to another. In some States a national authority (a national decommissioning operator) takes over from a former private operator at the time of the shutdown of a facility. These ownership or management transfers produce new responsibilities for record keeping and are often subject to an in-depth regulatory scrutiny. Under these circumstances the safety and cost effectiveness of decommissioning can still be ensured as long as the new operator has full access to and an understanding of all the existing records and provided that a continuity of the records management is maintained.

As one example, the US Nuclear Regulatory Commission (NRC) amended its regulations in 1996 to require that companies that transfer or terminate their licences must forward certain records to successor licensees or to the NRC [20]. The records affected by the new rule include information on decommissioning and off-site releases of radioactive material. Also affected are the records of waste disposal at locations other than a licensed radioactive waste disposal facility (e.g. by means such as incineration, release to sewers, on-site burials or accidental spills of material). Previous regulations required licensees to maintain such records but did not address what happens to these records when a company completes its activities and terminates its licence [21]. The 1996 amendments require a licensee to transfer the appropriate records to a new licensee if licensed activities are to continue at the same site. When all licensed activities on the site cease and the last licence is terminated, the records would be transferred to the NRC or, in the case of a disposal site, to the party responsible for the institutional control of the site, and a copy sent to the NRC.

## 6.5. RECORDS WITH A SPECIAL STATUS

There could be records that have a special status that limits their availability or distribution. These are typically designated as classified (e.g. for facilities transferred from a military to a civilian usage), confidential or proprietary records. The issue of proprietary research records may be sensitive, and special provisions may be needed to address these concerns without hindering timely decommissioning. It is important that a record of the existence of these records be made in the RMS, with a brief description given.

## 6.6. LOSS OF OPERATIONAL RECORDS

Despite QA provisions and other means intended to ensure records are preserved, accidents or incidents such as fires, floods, bankruptcy or human errors (e.g. the inadvertent deletion of electronic files) may result in a loss of those records important for decommissioning planning. In such cases knowledge may be regained to some extent through mechanisms such as an additional characterization of the site and facility, interviews with staff familiar with the affected systems or an assessment of systems at similar facilities.

In any case, it is felt that decommissioning planning and implementation may still proceed safely even under such circumstances. However, the caution needed in the planning of and in implementing decommissioning with unknowns will generally result in extra costs and delays. In some cases a trade off between extra characterization efforts and the need to decommission with significant unknowns may be in order.

# 7. THE RECORDS MANAGEMENT SYSTEM

## 7.1. GENERAL

An RMS is essential for the collection, cataloguing, maintenance and dissemination of records for the required timeframe, which could be several decades. The RMS needs to be established with written instructions, procedures or plans with QA procedures, and regular independent auditing is necessary at all stages.

Guidance on the information technology available for handling the information at nuclear facilities and the requirements for records management is available in several sources, for example Ref. [22].

The primary focus of a decommissioning RMS is to ensure that the relevant records are selected to support decommissioning and that the data sources are validated, as appropriate. This may include the preservation of the necessary information for the duration of the active institutional control period and, where necessary, beyond this period. The information may exist in many media forms (see the Appendix). Issues that need to be addressed through a system of documented instructions, procedures and plans, to ensure that the integrity of the information is preserved, may include:

- The requirements and responsibilities of all parties;
- The identification of records, including the validation of data sources;
- The transmittal, receipt and acceptability of the records;
- Record indexing and retrievability;
- Record retention classification;
- The record medium (e.g. paper, microfilm or electronic) and the primary and secondary storage locations;

— The protection of the records from adverse environments;
— Access control;
— The control of modifications to the records;
— The periodic reproduction or transfer between record forms;
— The national and international archives requirements.

Details of these aspects are given in the following subsections.

## 7.2. REQUIREMENTS AND RESPONSIBILITIES

The organization responsible for decommissioning (for example the site management) will generally be responsible for allocating record keeping responsibilities and approving the relevant procedures required by national legislation and/or regulations. Typical functions include:

— Taking decisions on which records are to be inserted in the RMS or on modifications to the existing records;
— Ensuring that access to the RMS is controlled;
— Maintaining the RMS and its records, including any required long term preservation;
— Providing input to and output from the RMS.

These functions will be carried out by various groups, including the decommissioning staff, QA staff and information management staff.

The allocation of these responsibilities will be specified in formal procedures. Depending on the subject, scope and strategic objectives of the actions associated with the RMS, the management may be involved in the decision making. Examples include decisions on granting access to specified organizations or establishing restrictions on access.

The group that manages the RMS includes those responsible for:

— Establishing the requirements for managing the decommissioning records;
— Managing the information, for example inputting record entries, modifying existing records or producing outputs upon request (usually information management reports);
— Maintaining the RMS system.

It should be noted that, although the RMS group is responsible for managing the physical records, it is the technical decommissioning group that is responsible for generating the documents and records and ensuring that this information meets the regulatory requirements. An example of an RMS organization structure is given in Ref. [23].

## 7.3. IDENTIFICATION OF RECORDS, INCLUDING VALIDATING DATA SOURCES

The existing operational and technical staff should be used as much as possible in the identification and verification of the records for decommissioning prior to the start of the actual work. The records that are typically collected and archived for decommissioning are shown in Table I. Section 3.3 and Section 4 also provide guidance on how to identify the records that will be important for decommissioning. Verifying the records is complex and needs to be established on a case by case basis by a decommissioning team, based on the type of information, the quality control applied to the original information and some verification, evaluation and review of the information. This verification process is normally supported by independent auditing.

## 7.4. TRANSMITTAL, RECEIPT AND ACCEPTABILITY OF THE RECORDS

Procedures for collecting, transmitting and incorporating information into an RMS should be established and should include provisions for verifying the acceptability of each record. It is important that each record be legible, official, accurate and complete.

## 7.5. RECORD INDEXING AND INFORMATION RETRIEVAL

A detailed records index that captures information from the operational RMS should normally be established as early as possible. It should be maintained as records are inserted in the RMS throughout the decommissioning process. It is important that accuracy be checked and validated through QA procedures.

The retrievability of information and hence keyword searching and record indexing are necessary components of an RMS. Indexing systems should link record attributes such as the title, date, subject, abstract, source of the record, keywords for the location of the record and other information. Information retrieval is taken to mean that once the record is located it can be accessed with existing tools and read. The timely retrieval of RMS information for decommissioning is directly related to the effectiveness of the selected indexing system. All these activities can be done manually without an automated system, but it is desirable to use automated systems for the enhanced search and access capabilities that they provide.

## 7.6. RECORD RETENTION CLASSIFICATION

RMS records may be subject to varying statutory periods of retention, based on their expected future use, or may have long term value as historical records. Such requirements should be considered when assigning a record retention classification. Each State typically establishes retention policies to ensure the availability and future use of information.

If records are classified with varying retention periods, the classifications and controls for assigning classifications are documented in instructions, procedures or plans. Controls may include periodic reviews to evaluate established classifications and, if necessary, to reclassify records. It is recommended and often legislated that duplicate backup copies of records be maintained and securely protected in a separate location. The disposal of redundant records should be subject to explicit, written procedures and controls to minimize the risk of inadvertently losing important information.

## 7.7. RECORD MEDIUM AND LOCATION

The organization responsible for the RMS normally establishes a set of documented instructions and procedures to control the process of the identification, collection and preservation of information. It is important that record archives be retained at least for the full decommissioning period in a secure system that minimizes damage, deterioration and loss. The retrievability and usability of records may be dependent on the continual review of and migration or conversion to new technologies. Knowledge of the location of records, including backup copies, is essential to ensure and demonstrate retrievability at any time.

The medium chosen to store the information should meet the following requirements:

— It should be capable of capturing and storing the required information;
— It should have physical and chemical stability so that legibility is preserved for the required timeframe;
— It should be capable of being easily copied or transferred to another medium, without loss of information;
— It should be retrievable over extended periods of time, as required;
— It should be readable and clear;
— It should be resistant to alteration by unauthorized individuals.

The Appendix and Refs [9, 22, 24, 25] provide details of media and retrievability, including a discussion of the advantages and disadvantages of the various record forms that may be chosen.

Most States currently require the management and storage of the original hard-copy records to meet their legal and regulatory requirements.

## 7.8. PROTECTION OF RECORDS FROM ADVERSE ENVIRONMENTS

Based on the record medium selected, appropriate controls can be established to protect records from deterioration due to, for example, temperature, humidity, light and micro-organisms.

The objective of storage is to give protection against loss due to a single event such as a fire, flood, tornado or earthquake. This protection can be accomplished by engineered protection such as a vault and/or the separate storage of a duplicate set of records in a secure separate location. Two independent and separately located archives are desirable (e.g. one at the plant and one at the company's headquarters). The consistency of the contents of each archive is crucial and should be ensured by regular reviews. Further guidance on the protection of records, disaster recovery and business continuation can be found in Ref. [26].

It is important that records be both protected and yet easily available to the decommissioning staff when needed. One possible method of achieving this is by having a tightly controlled and managed master or original hardcopy archive of all the required records, as well as another information copy that may be a hard copy or in an electronic information system.

## 7.9. ACCESS CONTROL

A formal control and access process can be established to obtain hard copies of drawings and documents. Methods of controlling access to records are established and documented to prevent the loss, destruction or unauthorized alteration of records. Controls include the identification of organizational responsibility for authorizing and controlling access to the records.

## 7.10. CONTROL OF MODIFICATIONS, REVISIONS AND THE ARCHIVING OF RECORDS

Controls should be established to identify the personnel authorized to make modifications to records and the conditions under which modifications may be made. Records should be distributed according to predefined distribution lists.

During decommissioning, certain records may no longer be required or be beyond their retention period. Procedures should be in place to demonstrate, to the site manager and possibly the regulator, that these records or documents, including QA or operating procedures, are no longer required.

### 7.11. PERIODIC REPRODUCTION OR TRANSFER BETWEEN MEDIA

Procedures for periodically ensuring the physical durability of the information contained in an RMS should be established and based on the record storage media used. The expected life for each record should be established and controlled to ensure that it is reproduced or the information transferred to another medium prior to the end of its expected life. Controls to ensure and verify the legibility and integrity of reproduced or transferred information should be established. Appropriate corrective actions should be taken to restore deteriorated records. For long term retrievability procedures should be established to ensure that the tools necessary for reading the records (for example microfilm readers and computer software and systems) continue to be available.

It is important that any loss of information during the reproduction of records be documented. This document may determine or estimate the extent and content of the lost data.

It should be noted that at the present time many regulatory authorities are reluctant to allow records to be stored solely on electronic media. Where hard copies exist there is currently a reluctance to allow primary paper sources of information to be destroyed.

### 7.12. NATIONAL AND INTERNATIONAL ARCHIVE REQUIREMENTS

Depending on the national archiving requirements of a State, it may be required to provide copies of specific documents to the national archives and/or follow other national and international archive guidelines.

## 8. MANAGEMENT OF NEW RECORDS

### 8.1. MANAGEMENT OF NEW RECORDS

New records will be generated continually during decommissioning through to the final facility or site release or reuse. Some records [1] may have to be retained after the release of the site, for example waste disposal and health records. Typical records arising from decommissioning are shown in Table III.

Based on the appropriate regulations, some records will be only temporary, for example work schedules and permits to work, while others will be permanent, for example radiological survey completion reports or health records.

One important issue for the management and organization of decommissioning projects is the interaction of all the parties involved. These parties include the operator of the facility, regulatory body, contractors, public and other stakeholders. Records are generated, requested or required by each party in the course of decommissioning. Figure 7 shows the typical relationship between decommissioning related activities and the regulatory body in the course of the life cycle of a facility, including the submission and approval of documents, where appropriate. Managing this cross-flow of information and the related records is a key responsibility and an essential part of an RMS. Information and guidance on the organization of decommissioning is given in Ref. [4].

The progress of decommissioning is documented by the management organization responsible. All the waste materials (i.e. radioactive, hazardous and non-hazardous) that were present at the beginning of the decommissioning should be properly accounted for and their ultimate destination identified. After each phase of decommissioning, as required, the operating organization may report to the regulatory body on the management and disposal of the waste generated during that phase. The report should also provide the current status of the decommissioning work at the facility or site and identify any anomalies observed during the phase. Moreover, information such as radiological surveys and personnel monitoring data should be reported to the regulatory body, as required.

Additional reasons for creating and maintaining the records generated during decommissioning include the potential legal and/or regulatory aspects, litigation concerns and information for other ongoing or future decommissioning projects.

New records should be typically managed in the same manner as historical records. The computer assisted management of decommissioning records will aid their real time acquisition (Figs 4 and 8).

### 8.2. MANAGEMENT TOOLS AND EXPERIENCE IN THE MANAGEMENT OF RECORDS FOR DECOMMISSIONING

A few examples of recent experience in the management of records are presented in this subsection. The best system for the management of records is that which works for the particular approach the project management finds is best suited to its needs. These examples are merely case studies of systems that have worked successfully in some States.

— The United States Department of Energy (USDOE) has developed a data information management tool for use on selected decommissioning projects. The

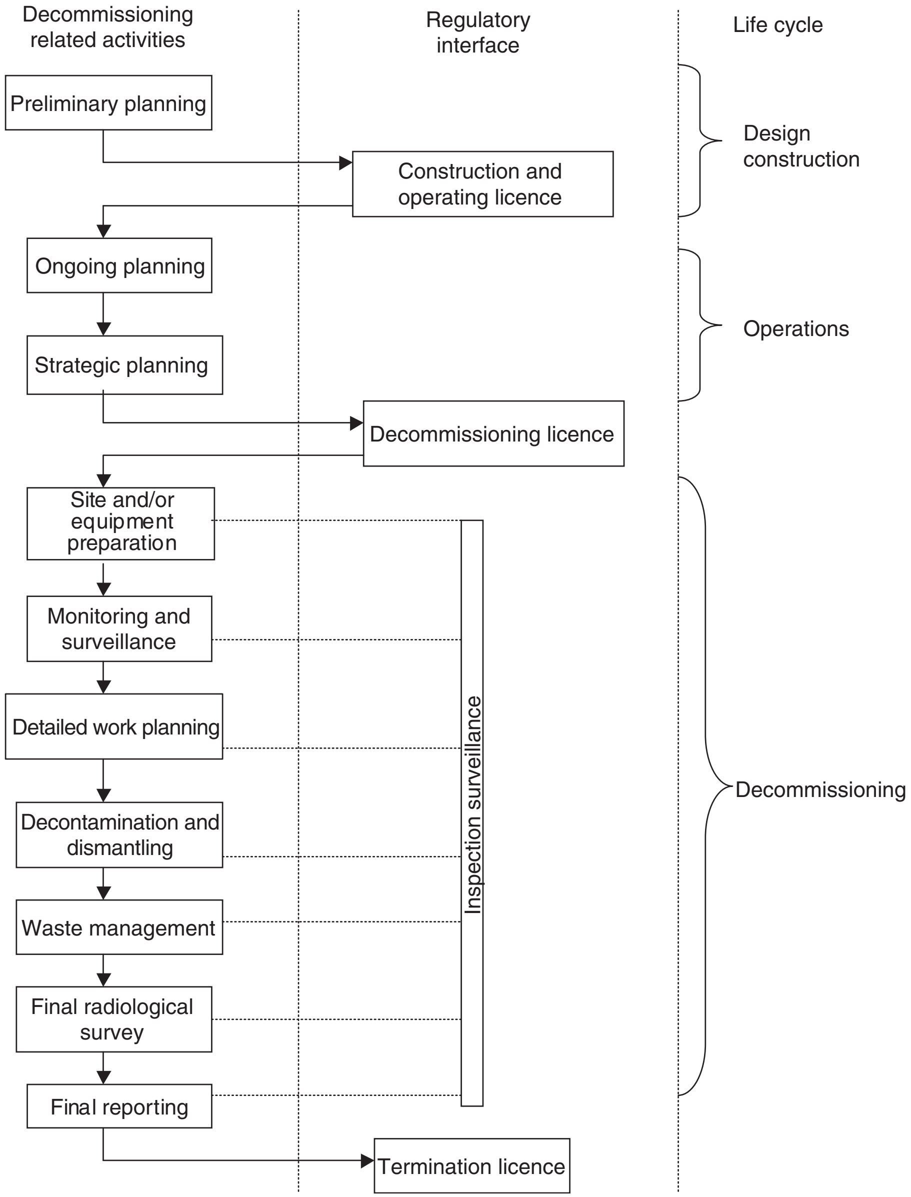


*FIG. 7. The decommissioning process.*

*FIG. 8. The radiological survey of a building for the Japan Power Demonstration Reactor decommissioning project.*

tool is called the System of Tracking Remediation, Exposure, Activities and Materials (STREAM). This technology is a multimedia database that consolidates project information into a single, easily accessible location for decommissioning work tracking. Information inputs can range from procedures, reports and references to waste generation logs and manifests, photographs and radiological survey maps. The STREAM system was successfully demonstrated at C reactor at Hanford, USA [27, 28], together with other software tools [29]. Especially when incorporated early in project planning, it is a systematic and cost effective tool for controlling and using project information. Issues and proposals for developing an integrated data management system for the USDOE's environmental restoration programme are extensively described in Refs [23, 30]. Reference [31] is a management guide for assisting USDOE personnel and contractors to achieve the minimum USDOE record keeping requirements and to establish standard record keeping practices.

— A code system for the management of a decommissioning project has been developed in Japan [32, 33]. Various data about the Japan Power Demonstration Reactor dismantling have been accumulated in a database. These data are being used for managing ongoing dismantling activities and verifying the code system for the management of reactor decommissioning (COSMARD) developed for forecasting management information and planning the future decommissioning of commercial nuclear power reactors. The components that make up the data sets are radiation control data, dismantling operations data and waste management data.

- A data management system was set up for the decommissioning of the main process building of the Eurochemic Reprocessing Plant in Belgium, which is able to process, for example, working hours, production factors and budget data for performance [34].
- The databases EC DB TOOL and EC DB COST have been developed within the framework of the European Commission's 1994–1998 Nuclear Fission Safety programme on Decommissioning of Nuclear Installations [35, 36]. The EC DB TOOL mainly contains technological data on, for example, dismantling tooling and associated filtration techniques, and the EC DB COST data for cost estimations and dose uptakes for unit operations.
- At the Greifswald nuclear power site in Germany a data management system called the Project Information System has been set up successfully to perform and control the world's largest ongoing decommissioning project [4, 37]. This information system comprises about 500 work packages and contains their required capacities and costs, the masses to be handled and radiological data. Logistics are important to maintain the complex material flow. The PC program ReVK has been developed to represent material and waste flow at the Greifswald site, exercise data control within administrative constrains, maintain bookkeeping, generate reports and manage transport and storage options. For radioactive waste and its final disposal, ReVK includes two other PC programs, AVK and AVK-ELA. The first is for controlling radioactive waste flow, the second is for final disposal purposes [38, 39]. Other software tools have been developed for the assessment of the required volumes and related costs for the disposal of decommissioning waste. A new development towards a more general management supporting system is given in Ref. [40]. Another development in Germany is given in Ref. [41].
- One example of record keeping on a specific US decommissioning project is a project involving the decontamination and decommissioning (D&D) of a plutonium fabrication facility at the Nuclear Fuel Services, Inc., facility in Erwin, Tennessee. In order to provide an accurate history of the decommissioning, every opportunity has been taken to utilize electronic monitoring, recording, retrieval and reporting. Waste items are tagged and tracked by a barcode from the moment they are removed from the process line to the time they are placed in waste drums for disposal. This audit trail provides a validation of facility characterization, provides real time material accountability control and assists in the management of the decommissioning effort. The records required for waste shipment, storage and disposal are generated by tracking based on information in the database [42].

Further practical record keeping experience for decommissioning projects is given in Annex I.

### 8.3. DECOMMISSIONING REPORTS

During decommissioning planning and in the preparation of decommissioning planning reports several new supporting reports and records may be required, for example environmental assessment documents, project plans, waste management plans and safety reports. As noted, in addition to new information, significant supporting historical records will also be required. Supporting records can be summarized and referenced in planning reports and managed in an RMS system.

At the completion of decommissioning a final decommissioning report that includes appropriate supporting records should be prepared. In accordance with the national legal framework, these records should be held and maintained for purposes such as the confirmation of the completion of decommissioning activities in accordance with the approved plan, recording the disposition of waste, materials and premises, and responding to possible liability claims. The records to be assembled should be commensurate with the complexity of the facility being decommissioned and the associated hazards.

The final decommissioning report, supported by the records assembled, should contain information such as that highlighted in Ref. [1]. This report provides the confirmation of the completion of the decommissioning. Any remaining restrictions on the site should be registered, as required by national regulations.

## 9. SUMMARY

### 9.1. GENERAL

This report recognizes that information will be produced, gathered, retained and maintained for decommissioning purposes, including that needed for long periods of safe enclosure before final dismantling. Such information is created progressively during all the phases of the design, construction, operation, shutdown and decommissioning of a facility, in accordance with a State’s regulatory obligations and requirements.

On the basis of experience and arrangements being made in some States, this report provides technical information for the identification, selection and management of the records that will be required to ensure that the objectives of decommissioning, including any safe enclosure phase and the final dismantling, are achieved.

This report addresses the need for identifying the content, structure and maintenance of an RMS necessary prior to, for and after decommissioning. Important records from prior to and after decommissioning should be preserved to assist future planning, safety assessments and remedial actions.

This report provides information and technical guidance that may assist States to achieve systematic control and ensure the availability of the information resources needed for decommissioning.

## 9.2. MAJOR OBSERVATIONS

The major observations of this report are as below.

- The main goal of an RMS is to provide the necessary, sufficient and up to date information for those who do the decommissioning and other parties to make informed decisions on planning and the implementation of decommissioning actions. There will be significant financial consequences if there is inadequate documentation to support decommissioning.
- The main sources of decommissioning records are the records of the design, construction, modification, operation and shutdown of a facility. Keeping these records typically will be the responsibility of the operator.
- Planning for eventual decommissioning should be considered during the design and operation of a facility, as by doing so the information will be readily available and transferable when needed.
- The preservation of the necessary information for the duration of the active post-shutdown phase, safe enclosure and final dismantling requires the early establishment and maintenance of an RMS.
- An RMS is desirable to facilitate safe and efficient decommissioning.
- Throughout the life of a facility the records archive should be frequently and independently audited, with decommissioning as a primary focus.
- An auditing process should identify gaps in an RMS and address the usefulness of the archives for decommissioning.
- Since technologies may change and knowledge of a facility may diminish, information may be less understood over time. It is therefore important that the information transferred to the future users be usable. Keeping control of records (and institutional knowledge) is necessary for the whole decommissioning process.
- Redundancy and diversity in an RMS are necessary for the effective management of the records.
- The media used need to be selected to ensure the durability, readability and retrievability of the information they contain.

## Appendix

## OPTIONS FOR RECORD STORAGE MEDIA AND RETRIEVABILITY

The information provided below was extracted from Ref. [24] and from other sources and has been further expanded upon.

### A.1. RECORD STORAGE MEDIA OPTIONS

Most of the current information on nuclear facilities is recorded on paper and in digital media formats. A decision will have to be made on the media to be used prior to gathering information for a decommissioning. A short review is presented below on the existing media. In addition, Table V summarizes the typical advantages and disadvantages of these storage media options. It is likely that more than one form of medium will be required to meet the storage, historical, legal, regulatory, cost and future use requirements.

Selecting storage media generally depends on the:

- Legal or regulatory requirements;
- Volume of documentation;
- Historical format;
- Type of documentation;
- Search retrieval requirements;
- Security of the records;
- Cost to implement versus the long term management cost;
- Timescale for retention, based on the decommissioning strategy;
- Suitability for future use and development.

Details of typical storage media are given in the following subsections.

#### A.1.1. Hard copy

Paper, which may be the most common medium for existing records, often cannot be expected to have a lifetime longer than a few decades, mainly because of the acidity of the pulp used to make the paper. The advantages of this medium are that it is already in a form suitable for storage, it is readable without tools and it is easy to copy. The disadvantages are that it may not meet the requirements of being readable over the long term without periodic reproduction and that it is a relatively bulky medium that requires large and costly storage facilities.

TABLE V. ADVANTAGES AND DISADVANTAGES OF VARIOUS STORAGE MEDIA
*(expanded upon from Refs [22, 24, 44])*

| Storage media | Typical lifetime (a) | Advantage | Disadvantage |
|---|---|---|---|
| Hard copy | 10+ | Original masters held<br>Difficult to alter or modify<br>Paper and copying mechanisms are available for the archive period<br>Legally acceptable | Controlled environment required<br>Large volume<br>Damage due to handling<br>Cumbersome copying<br>Easily lost or misfiled |
| Microfilms and microfiches | 100+ | Difficult to alter or modify<br>Easily duplicated<br>Compact storage<br>Legally acceptable in some States | Controlled environment required<br>Large volume<br>Damage due to handling<br>Cumbersome procedures for producing hard copies<br>Easily lost or misfiled |
| Magnetic tapes and disks | 5–10 | Compact, easy storage<br>Tape or disk easily duplicated with no deterioration of data<br>Accessible<br>Can be updated | Stored images can easily be altered<br>Controlled environment required<br>Damage due to handling and magnetic erasure<br>Hard copies required to be scanned to tape or disk<br>Legality unclear<br>Hardware and software require periodic updating (every 5–10 years) to ensure accessibility |
| Optical disks, compact disks and digital video disks | 100+ | Difficult to erase or alter<br>Compact storage<br>Easy remote access to data<br>Few environmental controls<br>Duplication with no deterioration of data | Hard copies required to be scanned to tape then disk<br>Legality unclear<br>Hardware and software require periodic updating (every 5–10 years) to ensure accessibility |

Special paper with an alkali reserve has a lifetime of several hundred years if conserved under specified conditions (i.e. no light, low relative humidity, minimal handling and acid-free physical contact). It is directly readable and easy to copy, but it is necessary to choose the optimum paper and printing material combination to ensure that the required performance will be achieved. The disadvantages are mainly linked to the constraints of the conservation conditions and its bulk, as described above for normal paper. The US regulations for the long term permanence of paper documents are given in Ref. [43].

### A.1.2. Microfilm and microfiche

Microfilms and microfiches can be expected to have an average life of 100 to 200 years. The advantages are their relatively small storage capacity requirements and direct readability with simple magnifying tools. The disadvantages are that special tools are required for copying from these media. In addition, owing to degradation concerns, the maximum number of replications of microfilm is small and handling of the films should be minimized. Another disadvantage is that transferring information from microfilm to other media has been shown to decrease the quality and readability of the output information.

### A.1.3. Magnetic tape or disk

Magnetic tapes or disks have a life of the order of typically 5 to 10 years, or even less depending on their usage. Their advantages are that they have a large storage capacity, they have widespread use and their rapid retrieval and copying capabilities. Their disadvantages include a short life that requires high maintenance (control and copying) and controlled environmental requirements. For readability reasons it is necessary to maintain the format and configuration of hardware and software. Another option is to, on a regular basis, upgrade the hardware and software and migrate the information. A potential disadvantage compared with microfilm or paper is that in some States the integrity of the data is considered insecure. Magnetic tapes or disks may not be admissible as legal documents since undocumented changes can be made easily and data may be destroyed by magnetic fields. Magnetic disks are easier to access than magnetic tapes.

### A.1.4. Optical disk, compact disk and digital video disk

Optical disk storage as a magnetic disk or tape may involve scanning the hard-copy record to a digital format and transferring it to the optical disk. A comprehensive indexing system is incorporated in the process that allows records to be retrieved in a timely manner when required. Optical disks themselves can have a durable life in excess of 100 years. Optical disks have the same advantages as magnetic disks. Their current evolution in the market seems to show that they have a promising future in the short term. The disadvantages are in principle the same as those for magnetic disks, but in practice it is more difficult to make undocumented data changes. Like magnetic disks, a disadvantage of optical disks is the uncertainty of their readable lifetimes, since their readability is dependent upon the lifetime of the hardware and software tools used to access the information they contain, which is typically of the order of 5 to 10 years. Optical disks have been selected as the long term RMS at Hunterston nuclear power plant (NPP) [16]. Recent advances in optical disk storage technology have significantly increased their storage capacity and reduced the cost per megabyte of storage.

## A.2. MANAGEMENT TOOLS FOR INDEXING AND RETRIEVABILITY

The choice of management tool for indexing and retrievability is directly related to the choice made for the storage media.

For paper and microfilms one option available for searching for an archived document is to use a storage classification system that provides a list of all the categories of archived documents and their locations. This is the simplest tool and has the advantage of not requiring electronic support, but it is inefficient since the search can only be made with a limited number of search criteria. This system requires a substantial team to catalogue the documents.

For paper and microfilms a more effective system is to develop an RMS that contains all the index parameters and document locations. It is then necessary to foresee and accommodate the evolution of the RMS (both for hardware and software). An RMS will require a substantial team to catalogue the documents.

If the records exist only on digital media then the system is completely reliant on the use of electronic tools for its management, and different types of software may be required to manage text and images. The disadvantage of this option is that there is a need to maintain all the electronic systems over long periods of time. The advantage is that search and retrieval is quick and simple. It is likely that this option will require the transfer of the computer files to another electronic system, adaptation of the digital data to new technology and the maintenance of the consistency and the compatibility of the different parts of the system. It should be noted that where records only exist on digital media regular electronic backups are very important.

Additional information can be obtained from Refs [9, 44].

## A.3. EMERGING TECHNOLOGIES

### A.3.1. Scanning and optical character recognition

To improve the access and retrieval of historical records, as well as to provide additional backup capabilities, records are often scanned and converted into a computer or digital image format. If the original record is in a typed format it can then be processed through an optical character recognition program that will capture and convert the full text of the record into a digital format, which can be stored in an RMS. This then allows for the full text searching of all records in the RMS.

### A.3.2. Digital records

Digital records are often captured or scanned from their original native format (i.e. a word processing, database or paper format) and stored in two widely used formats: TIFFs or the Portable Document Format (PDF).

The TIFF image format is a high resolution image storage format. If this digital storage method is used the RMS may need an additional method to store the unformatted text to allow for a full text search.

The PDF format combines both a high resolution image format and a full unformatted text within the same file. Special PDF search tools are required for a full text search.

# REFERENCES


[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Decommissioning of Nuclear Power Plants and Research Reactors, Safety Standards Series No. WS-G-2.1, IAEA, Vienna (1999).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Measures to Strengthen International Co-operation in Nuclear, Radiation and Waste Safety (a) Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, GOV/INF/821-GC(41)/INF/12, 22 September 1997.

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Principles of Radioactive Waste Management, Safety Series No. 111-F, IAEA, Vienna (1995).

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Organization and Management for Decommissioning of Large Nuclear Facilities, Technical Reports Series No. 399, IAEA, Vienna (2000).

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Radiological Characterization of Shut Down Nuclear Reactors for Decommissioning Purposes, Technical Reports Series No. 389, IAEA, Vienna (1998).

[6] INTERNATIONAL ATOMIC ENERGY AGENCY, Maintenance of Records for Radioactive Waste Disposal, IAEA-TECDOC-1097, IAEA, Vienna (1999).

[7] INTERNATIONAL ATOMIC ENERGY AGENCY, Waste Inventory Record Keeping Systems (WIRKS) for the Management and Disposal of Radioactive Waste, IAEA-TECDOC-1222, IAEA, Vienna (2001).

[8] WORLD NUCLEAR ASSOCIATION, Decommissioning of Nuclear Facilities — Record Keeping (2001), http://www.world-nuclear.org/wgs/decom/intro7-record.htm.

[9] INTERNATIONAL ATOMIC ENERGY AGENCY, Data Collection and Record Keeping for the Management of Nuclear Power Plant Ageing, Safety Series No. 50-P-3, IAEA, Vienna (1991).

[10] NUCLEAR REGULATORY COMMISSION, Records Important for Decommissioning of Nuclear Reactors, Draft Regulatory Guide, Task DG-1006, NRC, Washington, DC (1989).

[11] ADLER, J.J., GLANDER, L.A., "Cintichem decommissioning experience: The final chapter" (Proc. 1996 Decommissioning Conf. Captiva Island, FL, 1996), TLG Services, Bridgewater, CT (1996).

[12] UNITED KINGDOM ATOMIC ENERGY AUTHORITY, "Data gathering and retention", Care and Maintenance Guidance Document, Rep. AECP 1085, UKAEA (1998), Section 14.

[13] DADOUMONT, J., MASSAUT, V., KLEIN, M., DEMEULEMEESTER, Y., "Decommissioning of a small reactor (BR3 reactor, Belgium)", Decommissioning Techniques for Research Reactors, IAEA-TECDOC-1273, IAEA, Vienna (2002) 31–48.

[14] NUCLEAR INFORMATION AND RECORDS MANAGEMENT ASSOCIATION, White Paper on Records Required for the Decommissioning Phase of Nuclear Utilities, Draft 2000, NIRMA, New York (2000).

[15] KERARON, Y., TANGUY, I., "Documentation as a support and memory of dismantling operations", Dismantling of Nuclear Facilities (Proc. Int. Conf. Avignon, France, 1998), French Nuclear Society, Paris (1998) 607–617.

[16] ROUGH, A., “Compilation of the decommissioning archive record for Hunterston ‘A’ power station”, Nuclear Decommissioning (Proc. Int. Conf. London, 1995), Mechanical Engineering Publications, London (1995) 275–284.
[17] NUCLEAR ENERGY SERVICES, Decommissioning Plan for the University of Kansas Training Reactor, NES, Danbury, CT (1992).
[18] NUCLEAR REGULATORY COMMISSION, Identification and Evaluation of Facilitation Techniques for Decommissioning Light Water Power Reactors, Rep. NUREG/CR-3587, NRC, Washington, DC (1986).
[19] INTERNATIONAL ATOMIC ENERGY AGENCY, Quality Assurance for Safety in Nuclear Power Plants and other Nuclear Installations, Code and Safety Guide Q1–Q14, Safety Series No. 50-C/SG-Q, IAEA, Vienna (1996).
[20] NUCLEAR ENERGY COMMISSION, NRC Amends Regulations on Record Keeping Requirements, Note No. 96-72, Office of Public Affairs, Washington, DC (1996).
[21] NUCLEAR REGULATORY COMMISSION, Evaluation of Terminated Nuclear Material Licenses, Rep. NUREG/CR-6592, NRC, Washington, DC (1999).
[22] INTERNATIONAL ATOMIC ENERGY AGENCY, Information Technology Impact on Nuclear Power Plant Documentation, IAEA-TECDOC-1284, IAEA, Vienna (2002).
[23] LOCKHEED MARTIN ENERGY SYSTEMS, Environmental Data Management Implementation Handbook for the Environmental Restoration Program, Rep. ES/ER/TM-88/R1, Environmental Restoration Data Quality Program, Oak Ridge Natl Lab., TN (1996).
[24] JENSEN, M., Conservation and Retrieval of Information: Elements of Strategy to Inform Future Societies about Nuclear Waste Repositories, Nordic Council of Ministers, Copenhagen (1993).
[25] BURNHAM, S.L., “Electronic document management meets environmental restoration recordkeeping requirements: A case study”, (Proc. 40th Int. Assoc. Records Managers and Administrators Ann. Conf. Nashville, TN, 1995), Association of Records Managers and Administrators, Lenexa, KS (1995) (CD-ROM).
[26] NUCLEAR INFORMATION AND RECORDS MANAGEMENT ASSOCIATION, Required Records Protection, Disaster Recovery and Business Continuation, Rep. TG21-1998, Rev. 1-2000, NIRMA, New York (2000).
[27] UNITED STATES DEPARTMENT OF ENERGY, System for Tracking Remediation Exposure, Activities and Materials, Rep. DOE/ER-0367, USDOE, Washington, DC (1998).
[28] UNITED STATES DEPARTMENT OF ENERGY, Decontamination and Decommissioning Focus Area, Annual Report 1997, Rep. DOE/FETC-98/1055, USDOE, Washington, DC (1998).
[29] DUDA, J., et al., “Field demonstration of improved D&D technologies at Hanford C reactor”, Waste Management ’98 (Proc. Int. Conf. Tucson, AZ, 1998), Arizona Board of Regents, Phoenix, AZ (1998).
[30] LOCKHEED MARTIN ENERGY SYSTEMS, Electronic Document Management System Analysis Report and System Plan for the Environmental Restoration Program, Rep. ES/ER/TM-158, Delphi Consulting Group, Boston, MA (1995).
[31] UNITED STATES DEPARTMENT OF ENERGY, OHIO FIELD OFFICE, Records Management Program: A Management Guide, USDOE, Washington, DC (2001).

[32] SUKEGAWA, T., et al., "Waste characterization in decommissioning the Japan power demonstration reactor by computer code systems", ICONE 3 (Proc. Int. Conf. Kyoto, 1995), American Society of Mechanical Engineers, New York (1995) 1779–1784.

[33] YANAGIHARA, S., et al., "Systems engineering approach to planning and evaluation of nuclear power plant decommissioning", ICONE 5 (Proc. Int. Conf. Nice, 1997), American Society of Mechanical Engineers, New York (1997).

[34] TEUNCKENS, L., et al., "Decommissioning of the main process building of the former Eurochemic reprocessing plant", Decontamination and Decommissioning (Proc. Int. Symp. Knoxville, TN, 1994), United States Department of Energy, Washington, DC (1994).

[35] PFLUGRAD, K., et al., "Collection and sharing of data and experience from EC funded decommissioning projects", Nuclear Decommissioning '98 (Proc. Int. Conf. London, 1998), Professional Engineering Publishing, London (1998) 331–341.

[36] EUROPEAN COMMISSION, European Thematic Network on Decommissioning of Nuclear Installations, http://www.ec-tnd.net (access restricted).

[37] STERNER, H., RITTSCHER, D., "The Greifswald decommissioning project — strategy, status and lessons learned", Nuclear Decommissioning '01 (Proc. Int. Conf. London, 2001), Professional Engineering Publishing, London (2001) 235–254.

[38] GRUENDLER, D., HARTMANN, B., KAFFKA, E., "Documentation system for radioactive wastes arising from decommissioning of nuclear power plants", Conditioning of Radioactive Operational and Decommissioning Wastes (Proc. 3rd Symp. Hamburg, 1997), KONTEC Gesellschaft für technische Kommunikation, Hamburg (1997).

[39] GRUENDLER, D., WRINGER, W., "Data processing system for tracking and documenting radioactive wastes and residues", Radioactive Waste Management and Environmental Remediation (ICEM '97) (Proc. Int. Conf. Singapore, 1997), American Society of Mechanical Engineers, New York (1997).

[40] BAECKER, A., SCHULZ, R., "Decommissioning management system used in the Greifswald project", Radioactive Waste Management and Environmental Remediation (ICEM '01) (Int. Conf. Bruges, 2001), American Society of Mechanical Engineers, New York (2001).

[41] COMMISSION OF THE EUROPEAN COMMUNITIES, Dokumentationssystem fuer den Abbau von Kernkraftwerken, Rep. EUR-9343, CEC, Luxembourg (1984).

[42] HUNT, R.A., PAINE, D., WEST, M.L., "Decontamination and decommissioning of a plutonium fabrication facility", Waste Management '91, Vol. I (Proc. Int. Conf. Tucson, AZ, 1991), Arizona Board of Regents, Phoenix, AZ (1991).

[43] NATIONAL INFORMATION STANDARDS ORGANIZATION, Permanence of Paper for Publications and Documents in Libraries and Archives, Rep. ANSI/NISO Z39.48-1992(R1997), NISO Press, Bethesda, Maryland (1992).

[44] UNITED STATES DEPARTMENT OF ENERGY, Radiological Control Manual, Chapter 7, http://tis.eh.doe.gov/docs/rcm/ch77.html.

# BIBLIOGRAPHY

BAYLISS, C.R., COPPINS, G.J., PEARL, M., "Software tools for environmental restoration — the nuclear site and game", Nuclear Decommissioning (Proc. Int. Conf. London, 2001), Professional Engineering Publishing, London (2001).

BIRRINGER, K-J., FRITZ, P., HENDRICH, K., "First step of remote dismantling of the Wiederaufarbeitungsanlage Karlsruhe (WAK)", Nuclear and Hazardous Waste Management (Spectrum '94) (Proc. Int. Top. Mtg Atlanta, GA, 1994), American Nuclear Society, LaGrange Park, IL (1994) 1570–1575.

HIGH, N.M., FISKE, L.E., "Documentation of decontamination and decommissioning activities using geographic information system", Proceedings of the Topical Meeting on Best of D&D… Creative, Comprehensive, and Cost Efficient (Proc. Int. Top. Mtg Chicago, 1996), American Nuclear Society, LaGrange Park, IL (1996) 100–104.

SANDIA NATIONAL LABORATORIES, Long-term Spatial Data Preservation and Archiving: What are the Issues?, Rep. SAND 2002-0107, Sandia Natl Lab., Albuquerque (2002).

TAYLOR, J.B., An Assessment of the Records and Documents Required for Efficient Liabilities Management, DTI–LMG Safety Issues Task Force, BNFL, Risley (2001).

UNITED STATES DEPARTMENT OF ENERGY, Records Schedule for Environmental Records, USDOE, Washington DC (1999).

WILLIAMS, M.S., CARMEL, P.G., "What you don't know can hurt you", Waste Management '00 (Proc. Symp. Tucson, AZ, 2000), Arizona Board of Regents, Phoenix, AZ (2000) (CD-ROM).

## Annex I

## EXAMPLES OF NATIONAL EXPERIENCE

The examples provided in this annex range from national policies and programmes to the detailed organization of decommissioning both small and large facilities. Both approaches are useful to provide practical guidance on how decommissioning projects are planned and managed in various States. The examples given are not necessarily best practices, rather they reflect a wide variety of national legislation and policies, social and economic conditions, nuclear programmes and traditions. Although the information presented is not intended to be exhaustive, the reader is encouraged to evaluate the applicability of these schemes to a specific decommissioning project[1].

[1] National annexes reflect the experience and views of their contributors and, although generally consistent with the guidance given in the main text, are not intended for specific guidance.

## Annex I.A

## BELGIUM: RECORD KEEPING CRITERIA AND EXPERIENCE FOR DECOMMISSIONING PURPOSES

### I.A–1. INTRODUCTION

The dismantling of nuclear installations can be considered a material production process. The objective of this process is to minimize waste generation and/or to recycle material to the greatest extent possible. Depending on the nuclear characteristics of the installation and the need for the preservation of public health in the recycling of material, the safety authorities, the Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS) and the producer all place different requirements on material processing. These requirements concern the traceability of the material (administratively, as well as physically), the final destination of the material and the free release measurements or characterization of the material. These requirements turn the process into a complex material flow process.

To meet the above mentioned requirements, the following requirements need to be met:

- All relevant information about the dismantled material should be obtained;
- The loss of necessary information should be avoided;
- The dismantling approach should be standardized so that each person knows his or her responsibilities;
- The different treatment methods should be described to ensure their proper use;
- The different characterization and contamination measurements should be described and validated to ensure that the measurements are accurate and that the destination requirements are met;
- There should be an organizational description of the selected work so that there is a clear overview of the process;
- The public should be assured that the process used is conducted within the national and international legal framework.

Since dismantling can be considered a production process, the management of the BR 3 reactor chose to implement a QA system that complied with ISO 9002. In addition to a QA system clarifying the different actions and responsibilities of the operators in order to obtain the different goals of material flow management (MFM), there is another advantage of having a QA system. With QA accreditation the MFM process is controlled by an independent organization that ensures the proper use of the applied flow management.

This annex explains how the production process is managed. The explanation is presented using a practical example from the BR 3 dismantling project. Related to the processing of this batch, a traceability report (Fig. I.A–1) created by a computerized database demonstrates how the processing of each batch of waste material is handled.

***BR3-96-009-K*** ***Cleaning***

Total Weight : 249 kg | Status : 7 | Location Batch | Removed

| VS-nr | Weight | Description | Origin | Contaminated after C1 | Contaminated after C2 | Sum |
|---|---|---|---|---|---|---|
| 258 | 249 kg | Metal beams | | 125 kg | 0 kg | 249 kg |

| | | | |
|---|---|---|---|
| Date of treatment | 06-01-97 | Doserate (contact) | |
| Date C1-measurement | 08-01-97 | Doserate (1 meter) | |
| Date C2-measurement | 07-02-97 | Date of characterization Q2/SGS | |
| | | Reference of characterization | |
| Date of approval evacuation | 13-02-97 | | |
| Destination | Scrapyard | | |
| Reference of evacuation | FR97/001 | | |
| Date of evacuation | 10-03-97 | | |

***Destination of contaminated parts***

***BR3-97-001-RS*** ***Melting***

Total Weight : 227 kg | Status : 5 | Location Batch | C1/A11

| VS-nr | Weight | Description | Origin | Contaminated after C1 | Contaminated after C2 | Sum |
|---|---|---|---|---|---|---|
| 258 | 105 kg | beams recovery | BR3-96-009-K | 0 kg | 0 kg | 105 kg |
| 258 | 22 kg | beams recovery | BR3-96-010-K | 0 kg | 0 kg | 22 kg |
| 258 | 83 kg | supports RC-filters, support DTC, metal tube | BR3-96-002-S | 0 kg | 0 kg | 283 kg |

| | | | |
|---|---|---|---|
| Date of treatment | | Doserate (contact) | 5 μSv |
| Date C1-measurement | | Doserate (1 meter) | < 1μSv |
| Date C2-measurement | | Date of characterization Q2/SGS | 03-04-97 |
| | | Reference of characterization | MET97042 |
| Date of approval evacuation | | | |
| Destination | Melting | | |
| Reference of evacuation | | | |
| Date of evacuation | | | |

***BR3-97-002-RZ*** ***Sandblasting***

Total Weight : 171 kg | Status : 7 | Location Batch | Removed

| VS-nr | Weight | Description | Origin | Contaminated after C1 | Contaminated after C2 | Sum |
|---|---|---|---|---|---|---|
| 258 | 20 kg | Beams | BR3-96-009-K | 0 kg | 0 kg | 20 kg |
| 258 | 30 kg | Beams | BR3-96-010-K | 0 kg | 0 kg | 30 kg |
| 258 | 30 kg | Cable run | | 0 kg | 0 kg | 30 kg |
| 258 | 91 kg | support DST | | 0 kg | 0 kg | 91 kg |

| | | | |
|---|---|---|---|
| Date of treatment | 09-05-97 | Doserate (contact) | |
| Date C1-measurement | 14-05-97 | Doserate (1 meter) | |
| Date C2-measurement | 30-05-97 | Date of characterization Q2/SGS | |
| | | Reference of characterization | |
| Date of approval evacuation | 22-09-97 | | |
| Destination | Scrapyard | | |
| Reference of evacuation | FR97/003 | | |
| Date of evacuation | 10-10-97 | | |

*FIG. I.A–1. A sample traceability report for the BR 3 decommissioning project in Belgium.*

## I.A–2. PRACTICAL EXAMPLE

This annex details how a dismantling task was executed on the BR 3 decommissioning project with a practical example of the dismantling of the recovery loop. It describes the different steps in the production process and the different movements of the material batches. This example shows how traceability for each processed batch is maintained through the use of a strict record keeping regime.

In order to enlarge the usable space in the shipping area of the BR 3 building it was necessary to remove most of the recovery loop. Before the dismantling process began the person responsible was required to write dismantling instructions that describe what is to be dismantled, who will do the dismantling (the composition of the dismantling team), the necessary mechanical and electrical connections (lockout/tagout), the safety requirements (industrial, nuclear and radiological) and the projected collective personnel radiation exposures. Also, a first destination was given for the different types of dismantled material.

Once the dismantling instruction was approved by the Health Physics Group, the dismantling team manager and the QA co-ordinator, the dismantling operation could begin. In the example given here the reference number of the dismantling instruction was VS-258.

During actual dismantling work the dismantling team collects all the necessary data concerning the progress of the work and the difficulties encountered. The dismantling team is responsible for ensuring that all the relevant information about the batches of the dismantled material (what is in the batch, the weight of each item and the corresponding reference number of the dismantling instruction) is given to the MFM. The MFM then assigns a unique number to the batch (which is the basis of its traceability) and from then the MFM takes over the responsibility for the batches. After finishing the dismantling job and collection of all the data, the dismantling team can write its dismantling report and the team is then ready for the next dismantling job to proceed.

Once the batches are under the responsibility of the MFM they are responsible for the route of the batches in the material flow and the collection of all the necessary data. It is impossible to explain all the different possibilities for the batches in this material flow, owing to its complexity. Therefore, as an example, one batch (BR3-96-009-K) is followed through the material flow (Fig. I.A–1), which demonstrates how traceability is maintained.

During the dismantling of the recovery loop the dismantling team filled batch BR3-96-009-K with 374 kg of iron beams. This material was removed according to dismantling instruction VS-258 (Fig. I.A–1).

Before the dismantling instructions are written the destination of the material is discussed, when possible, with the MFM. The destination for batch BR3-96-009-K was free release as scrap metal and the decontamination method was to be manual cleaning

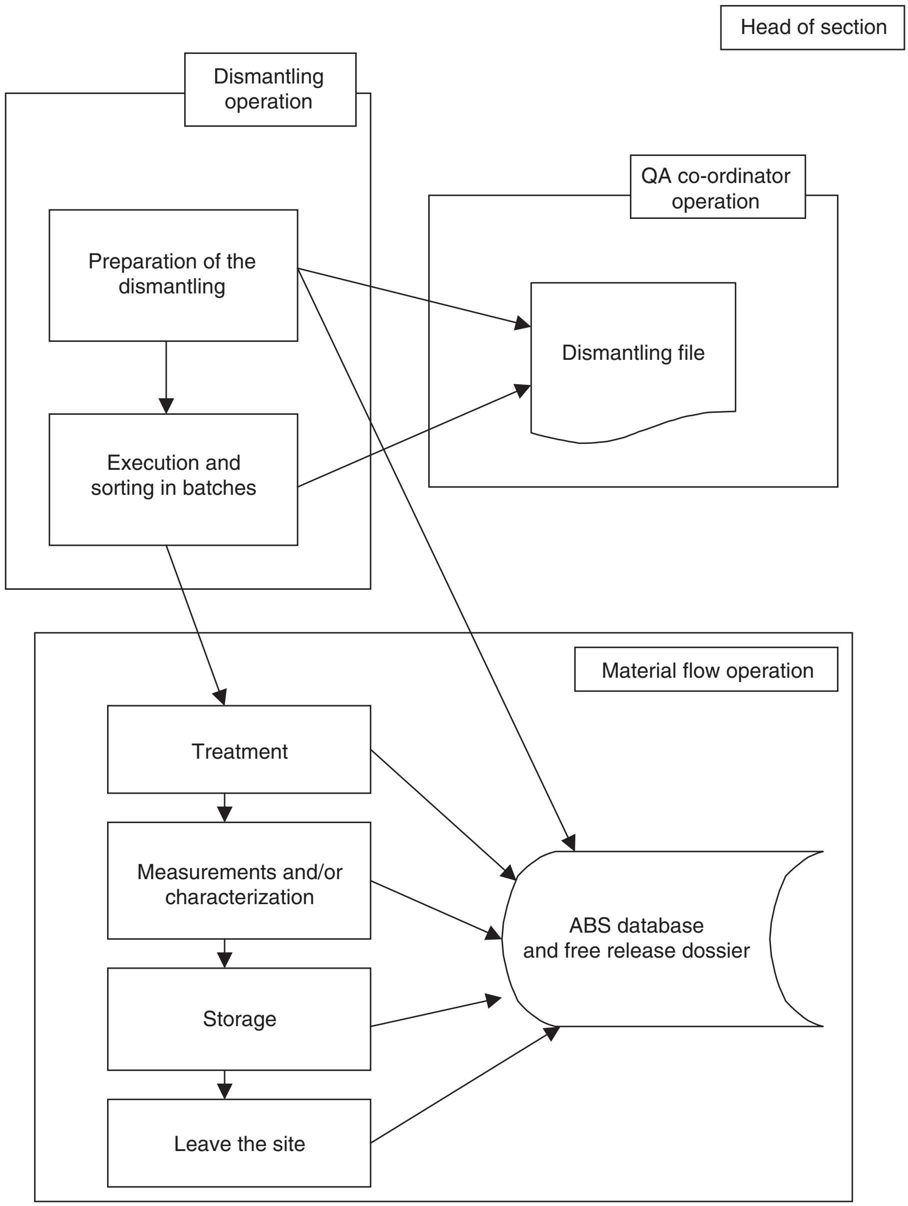


*FIG. I.A–2. Schematic representation of information management during dismantling.*

(which is designated by the K in the batch identification number — see Fig. I.A–1). According to the SCK•CEN free release procedure the total surface area has to be measured twice. As can be seen at the top of the traceability report (Fig. I.A–1), the cleaning of the batch was performed on 6 January 1997 and the first free release measurement was performed on 8 January 1997. Based upon this measurement, 125 kg of material was ‘disapproved’, which means that the β–γ contamination level exceeded the free release level of 0.4 Bq/cm$^2$. The remaining fraction (249 kg) underwent the second free release measurement on 7 February 1997 and fulfilled the free release limit. On 13 February 1997 the Head of the Health Physics Group gave his approval to move this fraction to the scrapyard. This was completed on 10 March 1997.

The disapproved fraction of 125 kg was split into two separate batches. First, 105 kg was placed along with other disapproved fractions in batch BR3-97-001-RS for melting and recycling for the nuclear industry. On 3 April 1997 the Low Level Waste Assay Q2 (produced and developed by Canberra) characterized the batch and showed that the requirements for melting were fulfilled, at which point a demand for removal was requested from the Technical Liability Service. Meanwhile the batch was stored in a buffer storage container (in this case container C1, at position A11).

The remaining 20 kg was placed (among others) in batch BR3-97-002-RZ for possible free release after sandblasting (a second cleaning operation). The batch was sandblasted on 9 May 1997 and, after two free release measurements, on 14 May 1997 and 30 May 1997, the authorization for the release was given by the Health Physics Group on 22 September 1997; on 10 October 1997 the batch was sent to the scrapyard.

The database can track precisely all batches of waste material and produce other reports, such as listings of the contents of all the batches that were sent to the scrapyard with a certain transport on a certain date. Figure I.A–2 summarizes the information management steps taken during the BR 3 dismantling.

## BIBLIOGRAPHY TO ANNEX I.A

DEMEULEMEESTER, Y., MOERS, S., MASSAUT, V., “The way for a better management of the material flow generated by a dismantling: The implementation of a QA system in the PWR dismantling project”, Radioactive Waste Management and Environmental Remediation (ICEM ’99) (Proc. Int. Conf. Nagoya, 1999), American Society of Mechanical Engineers, New York (1999) (CD-ROM).

DEMEULEMEESTER, Y., et al., “The implementation of a QA system in the BR3 PWR dismantling project”, Waste Management ’99 (Proc. Int. Conf. Tucson, AZ, 1999), Arizona Board of Regents, Phoenix, AZ (1999) (CD-ROM).

DEMEULEMEESTER, Y., et al., “The management of the material flow generated by the dismantling of a nuclear reactor: Approach and experience gained by the dismantling of the BR3 PWR reactor A”, Melting and Recycling of Metallic Materials from Decommissioning, Doc.XII/013/98-EN (Sem. Nyköping, Sweden, 1997), European Commission, Luxembourg (1997).

## Annex I.B

## CANADA: RECORD KEEPING FOR ATOMIC ENERGY OF CANADA'S DECOMMISSIONING PROJECTS

### I.B–1. OVERVIEW

Atomic Energy of Canada (AECL) has carried out a variety of decommissioning projects on several reactors and nuclear facilities throughout Canada. Such projects have included the Nuclear Power Demonstration reactor at Rolphton, Ontario, the National Research Experimental Reactor at Chalk River Laboratories, the Gentilly 1 NPP in Quebec, the Tunney's Pasture radioisotope facility near Ottawa and the Douglas Point Nuclear Generating Station in Bruce County, Ontario.

A records management programme is currently under development for the Whiteshell Laboratories Decommissioning Project. Whiteshell Laboratories is a nuclear facility that was established in the 1960s for scientific research and development related to the CANDU reactor system. AECL has taken the decision to terminate its nuclear research activities by December 2001, and the nuclear facilities on the site will be decommissioned. The facilities include several buildings, laboratories, a reactor and many other nuclear installations. Record keeping is a significant part of the decommissioning process and an overall system is being developed to integrate the historical, current, monitoring and surveillance records.

A variety of techniques was used to identify the key elements and processes necessary for a decommissioning records system. Benchmarking was used to determine what has been done in Canada, particularly for the facilities at Douglas Point and the National Research Experimental Reactor facility. This was followed by identifying the regulatory requirements. A literature search assisted in the assembly of background information on decommissioning records systems and decommissioning records series. The scope of the record keeping requirement was also established. It was determined that it would be necessary to maintain certain record series on the site, while others would logically be handled elsewhere within AECL's system. A high level working model was developed that provides a basis for the types of information and record to be stored in the system. Determining the record retention and disposal requirements was also required, as it is important to save critical records and discard others that are inconsequential. QA measures for the system are being addressed and the system will be designed to be ISO compliant. Finally, a plan is being developed for the information archive, which is needed to be in place for up to 100 years. The requirement for a records system needs to be greater than 100 years if an in situ disposal option is selected for the Whiteshell reactor (WR 1) or the solid low level waste is to be maintained in trenches at the site waste management area.

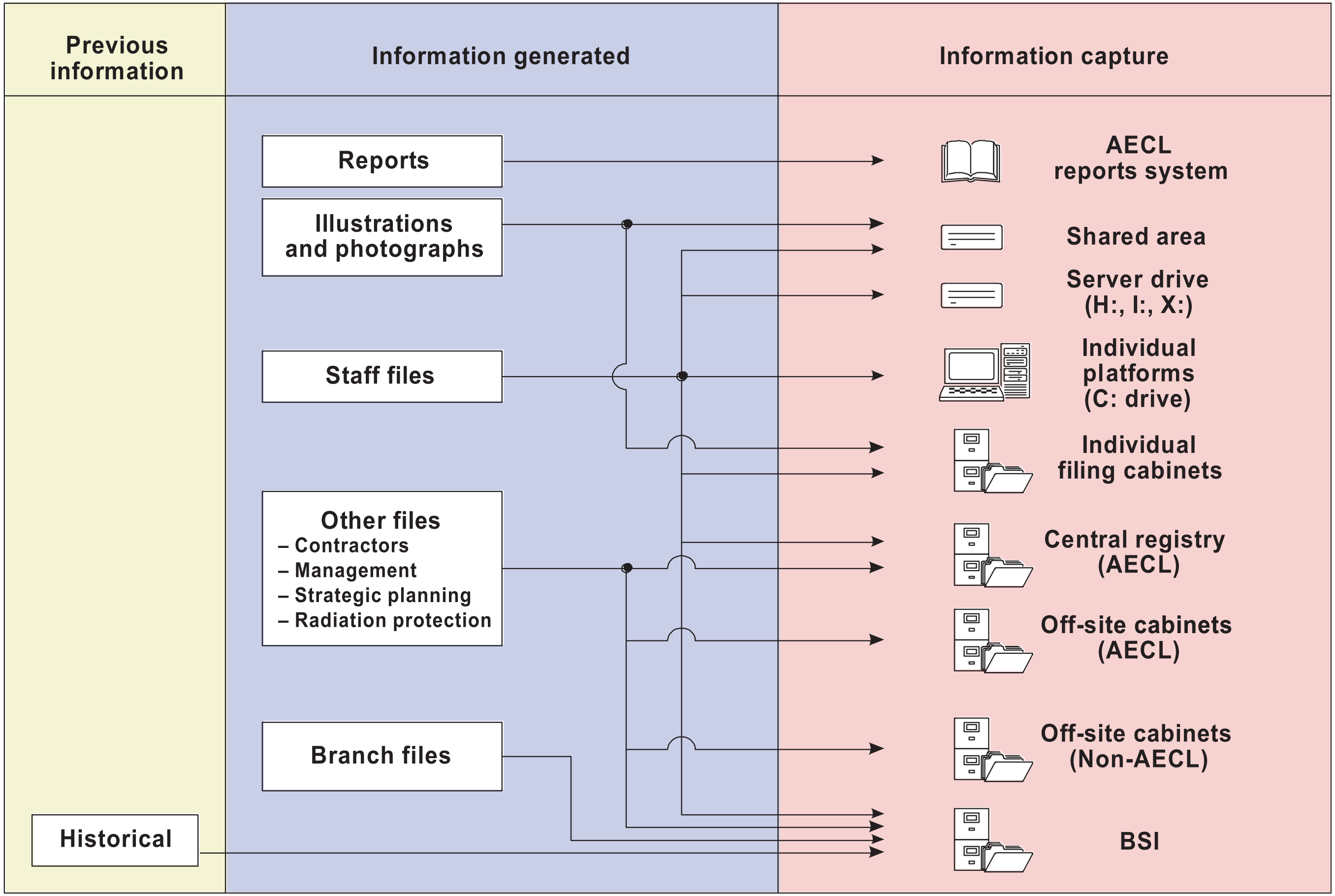


*FIG. I.B–1. The current method to capture record streams.*

The implementation of a decommissioning records system is being done during the first phase of decommissioning, while the staff, infrastructure and knowledge of the laboratories and other facilities are still available at the site. The final phase of decommissioning will be completed following 50 years of monitoring and surveillance.

## I.B–2. EXISTING STATE OF THE RECORDS AND INFORMATION MANAGEMENT

The existing state of the records and information management for the decommissioning project is shown in Fig. I.B–1. Information capture is shown on the right portion of the figure, while the main methods of information generation are shown on the central portion. The left side of the figure shows historical information.

There is a large amount of historical information available on the Whiteshell Laboratories facilities, including drawings, design information, reports, papers, memoranda, operating records, waste manifests, radiological protection information and survey records, internal reports and photographs. This information is the basis for the radiological, geotechnical and environmental characterization of the site. In addition, data and information are being collected and stored to support the documentation needed for regulatory purposes. For example, a key regulatory requirement before the decommissioning process begins is the preparation of a comprehensive environmental assessment report, which is an evaluation of the impacts of the decommissioning actions on the environment. The other documents that are being written for regulatory purposes include detailed decommissioning planning documents for the various nuclear and radioisotope facilities on the site.

As shown on the lower right portion of Fig. I.B–1, historical supporting information and data are being collected and catalogued using AECL's Basic Subject Index (BSI) system. These records are maintained in a hardcopy form and are filed at AECL's design office. The decommissioning team believes it is necessary to collect these items immediately, otherwise it is likely that this information will be lost.

A large quantity of project information is currently being generated by the decommissioning team. This is shown by the series of boxes in the centre column of Fig. I.B–1. Information capture is mainly controlled by individuals and is scattered throughout many different systems. The only exceptions are high level correspondence (captured in a central registry), branch files (captured by the BSI) and reports (captured under AECL's reports system).

Project information exists in the form of hardcopy (paper) records, computer files, database records, figures, images, photographs and reports. Some of these project data are generated while executing a specific project. Other information and records are generated from routine operations such as shipping radioactive material, performing radiological surveys and shipping radioactive waste for storage at the Whiteshell waste management area. Files and information are also generated by other persons at Whiteshell, but they may be kept outside the D&D team, at other AECL sites and even outside the company. AECL's reports system provides the vehicle for published reports. It is expected that key reports prepared during and/or from decommissioning will be sent to the Publications Department for printing. However, many other reports are currently being maintained by individuals on the project.

The main capture systems (e.g. shared area server drives and individual platforms) for project information and records are shown in the right column of Fig. I.B–1. In the short term, in spite of the fact that records are widely distributed, most items are retrievable and information is traceable to source records. However, over time it is anticipated that key information will become increasingly difficult to find and obtain. This is mainly due to staff attrition and the potential loss or deletion of information over time. A large effort is currently underway to keep project information, but it is not consistently indexed. It is generally in a non-retrievable form for most people, except for those who are intimately familiar with such information.

## I.B–3. PROPOSED SYSTEM FOR RECORDS AND INFORMATION MANAGEMENT

Figure I.B–2 provides a map of the generation of information and an initial solution for information and records capture for the decommissioning project. Information capture is shown on the right portion of the figure, while the main methods of information generation are shown on the central portion. The left side of the figure shows the information previously captured, with historical information being included in this category.

Historical information (see the lower part of the figure) will be transmitted through the BSI and moved into the Whiteshell Decommissioning Records System (WDRS). An alternative pathway for historical information would be via a staff transmittal directly into the system.

Published reports (see the upper part of the figure) will continue to be routed through AECL's formal system. However, other valuable published information, such as conference papers, consultants' reports and papers written with other agencies, may never make it into AECL's formal system. These would be captured by staff transmittals or through the project system.

The basic elements of the WDRS are shown on the right part of the figure. These include a project registry, a transmittal logging system and work requests, BSI numbers, annual housekeeping, transmittal numbers and the storage and retrieval system.

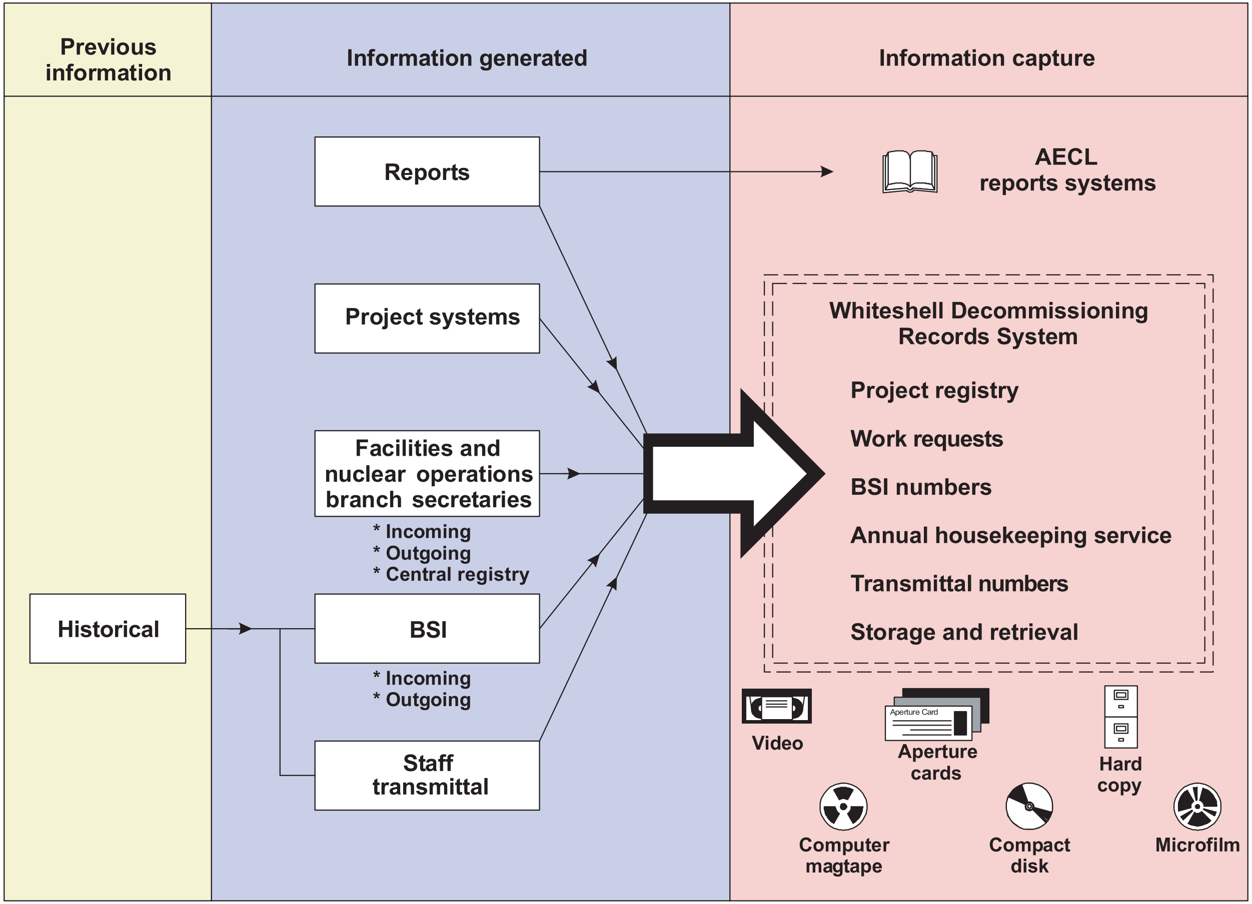


FIG. I.B–2. The proposed method to capture decommissioning record streams.

BSI numbers are controlled by the system operator to ensure that they are consistent with AECL's overall decommissioning system. Projects will also be given numbers and names that are consistent with those assigned for use in the corporate accounting system. It is suggested that a work request will be completed by the appropriate project manager at the time of opening all significant decommissioning projects. A project will be assigned a series of subfiles. Typical material that will be kept in the subfiles includes logbooks, calculations, spreadsheets, correspondence, meeting minutes, drawings, contract terms and conditions, and final reports. At the closure of the project the manager will be responsible for ensuring the submittal of a complete set of files back into the WDRS.

Information will be stored on a variety of media formats, which may include roll microfilm, aperture cards, compact disks, videos, computer magtape and hard copies. Most records will be maintained in duplicate and stored at separate locations and hence any loss of information through fire or other circumstances will be avoided. Microfilm may be used as the media of choice for certain records (e.g. waste management records) because they will need to be accessed and used far in the future. The issue of the readability of computer records will be addressed. This is a significant problem as many of the graphics and text based information generated earlier than about five years ago is no longer readable with the current software and operating systems. Another function that the WDRS provides is an annual housekeeping service. On an annual basis, persons will be required to clean out their files and submit their information to the WDRS. Finally, the records system will develop procedures for maintaining project QA manuals and controlled documents.

## I.B–4. PROCESSING HISTORICAL RECORDS

A simple flow chart (Fig. I.B–3) was developed for processing historical records. A package of related historical information would be assembled by an originator. For example, such a package might include all the published and unpublished information related to a specific nuclear facility.

The package will be reviewed to ensure information is complete, accurate and that it needs to be archived over the long term. Once it is determined that the information is worthy to be maintained and the indexing information assigned to the package is accurate, the record package will be processed. Processing includes acceptance of the package, placing the material on to an appropriate media format, verification that the duplication on to the new media was done accurately, indexing the database and labelling storage media in such a manner that it facilitates the retrieval of information.

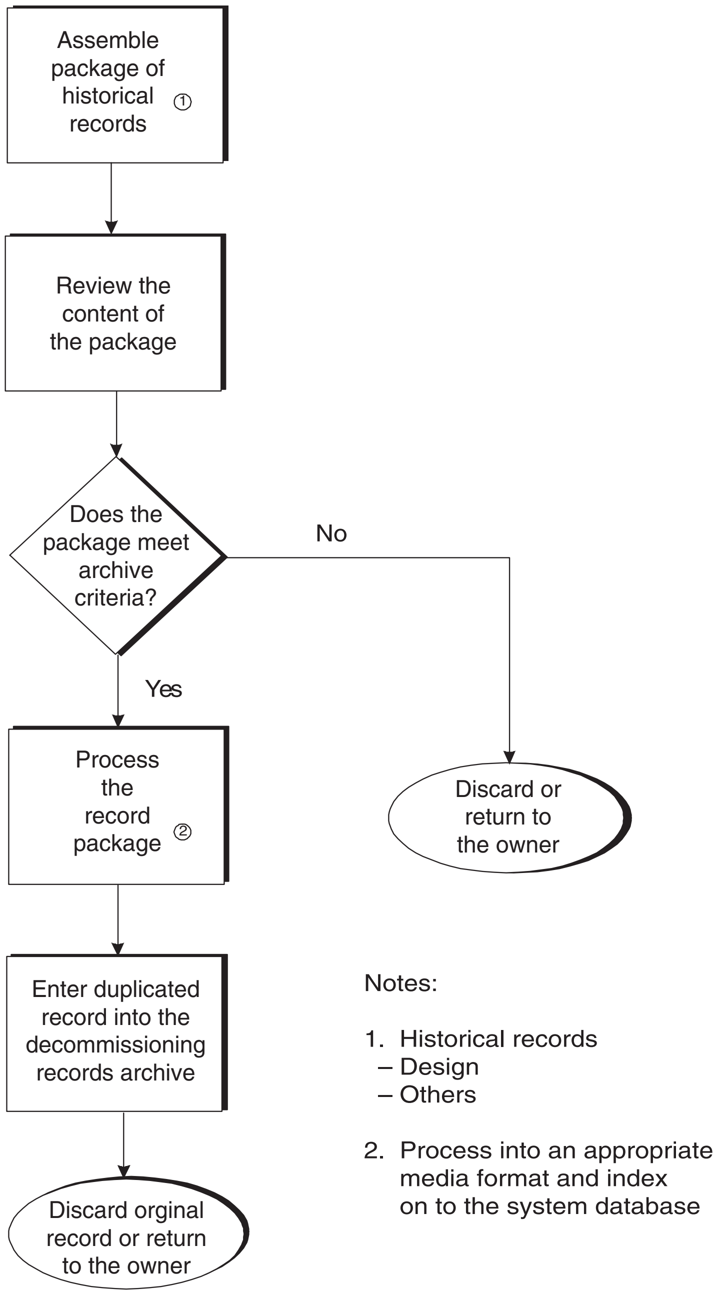


*FIG. I.B–3. Flow chart for packaging and processing historical records.*

## Annex I.C

# CUBA: RECORD KEEPING FOR THE DECOMMISSIONING OF A MEDICAL FACILITY

## I.C–1. INTRODUCTION

In principle, the typical records required for and produced during the decommissioning of small medical facilities are the same as for larger nuclear facilities. However, the level of detail required, the quantity of information and the management methods for compiling the information could be very different. This is consistent with the use of a graded approach — the larger and more complex the facility the larger and more complex the record files.

In the example presented in his annex the records required for the D&D project were gathered after the facility was shut down and just prior to the commencement of the decommissioning.

In 1999 the D&D group of the Centre for Radiation Protection and Hygiene (CPHR) performed the decommissioning of a small medical facility in Havana. The facility had been used for brachytherapy and had been shut down after 40 years of operation. In the early years of the use of radioactive material in Cuba, just as in other countries, the quality of the controls and waste management practices was of a considerably lower standard than in use today. As a result, for this facility no predecommissioning records were available and hence this information was accumulated through an additional detailed characterization of the facility.

In Cuba there are specific regulatory record keeping requirements for the shutdown and decommissioning of small facilities. These are covered in article 46, Chapter IV, of Resolution 25/98 [I.C–1].

The essential records required for and generated during the decommissioning of the National Institute of Oncology and Radiobiology (INOR) brachytherapy facility are detailed in Fig. I.C–1.

## I.C–2. DECISION TO DECOMMISSION

The INOR facility used $^{226}$Ra radiation sources for brachytherapy. Owing to technical obsolescence and safety considerations the brachytherapy facility was eventually shut down. In May 1997 INOR requested that the CPHR evaluate the existing radiological conditions and carry out the decontamination of the rooms and the formal decommissioning of the brachytherapy facility to allow for its removal

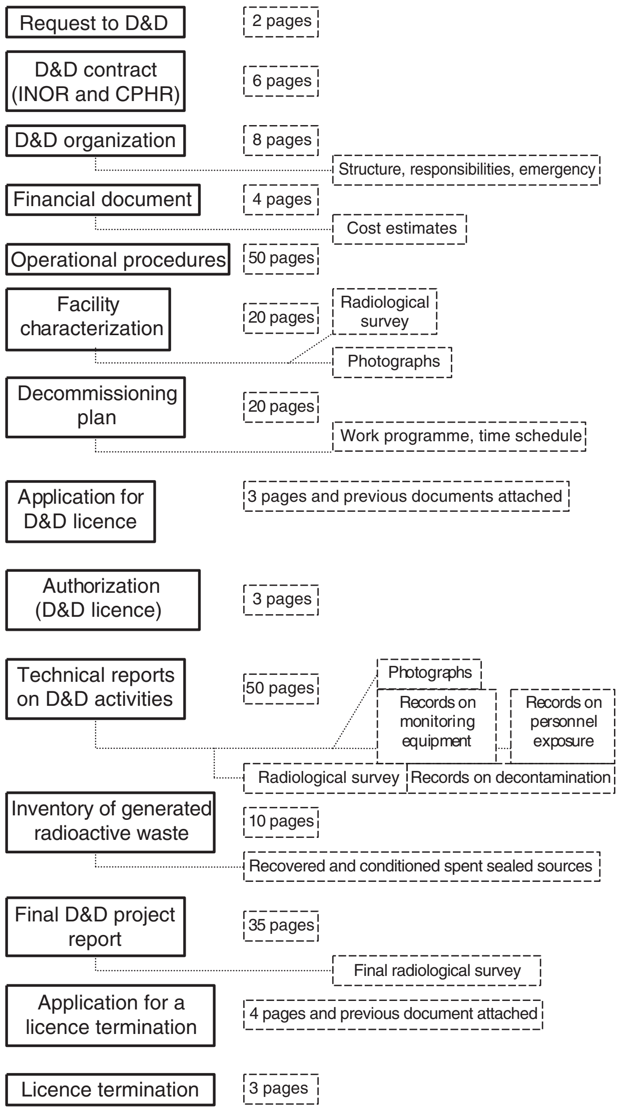


*FIG. I.C–1. Records produced before and during the decommissioning of the INOR brachytherapy facility in Havana, Cuba.*

from regulatory control. Figure I.C–2 is an organizational flowchart showing the interactions between the parties involved in this decommissioning project.

The documents involved at this stage were:

— A request to carry out the decommissioning (with poor background information);

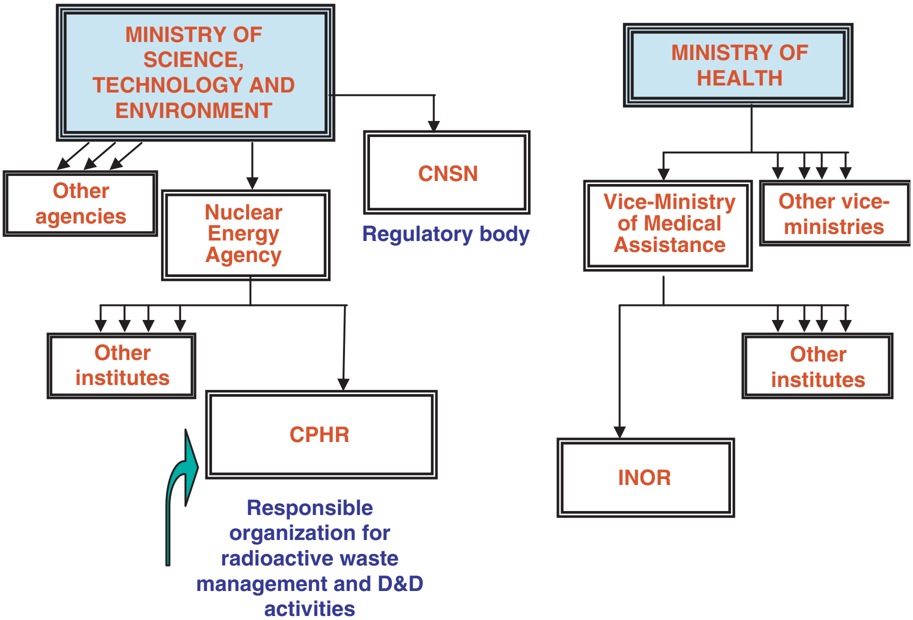


*FIG. I.C–2. The stakeholders in the decommissioning of the Cuban facility.*

— A contract between INOR (the licensee) and the CPHR (the D&D organization).

## I.C–3. LACK OF INITIAL INFORMATION FOR DECOMMISSIONING PLANNING

Although operational record keeping requirements are at present well implemented at nuclear facilities, the experience presented here with an older shut down facility is different. The INOR brachytherapy facility was constructed and operated well before current record keeping requirements for safety (and eventual decommissioning) were promulgated.

The contaminated areas were isolated for over five years. The personnel who worked at the facility eventually retired and important records and institutional knowledge for the decommissioning planning were lost.

No drawings, design information, photographs or other records that reflected the as built and as modified conditions of the facility were available. No information on operational incidents, radiological surveys or material inventories was maintained during the operating life of the facility for use in its eventual decommissioning.

The start of the D&D project was significantly affected by this lack of information and data. As an example, although some spills of radioactive material occurred over the operating life of the facility and residual contamination remained, no records of such events were available. In addition, the inventory of spent sealed sources was not accurate. This decommissioning team was therefore faced with a lack of current, accurate and reliable records.

Over 20% of the duration of the total project was dedicated to reconstructing a minimal amount of critical information to analyse the D&D strategies and prepare a decommissioning plan.

Some initial project activities, such as surveys of the contamination of the facility and dose rate surveys, or the study of the construction characteristics of contaminated areas, would not have been necessary if proper construction and operational records had been kept. All these operations led to an additional unnecessary exposure to the D&D personnel and was not in keeping with the minimization of radiation doses.

## I.C–4. INITIAL DECOMMISSIONING PREPARATIONS

The organization of the D&D project, including responsibilities for each activity, was defined and documented. The licensee retained the legal responsibility for achieving safe decommissioning. The project manager from the CPHR was in control of the day to day activities until the facility met the conditions to be delicensed. The record keeping process was the responsibility of the D&D organization. One member of the decommissioning staff was appointed to be responsible for receiving, collecting, maintaining and updating all the relevant decommissioning records.

The decommissioning plan specified provisions to mitigate the consequences of potential and credible incidents during the decommissioning process. Medical personnel from the INOR hospital were also trained on the correct treatment for radioactively contaminated personnel. An emergency plan was also included in the decommissioning documentation.

A document detailing financial assurances for decommissioning, including a detailed list of related cost estimates (Table I.C–I), was prepared and included in the D&D documentation.

From the start of the project planning it was clearly necessary to specify the end state objectives, such as the decontamination levels to be achieved, of the D&D. An official document containing the criteria for the unrestricted release of the brachytherapy facility after decommissioning was established by the national regulatory authority, the National Centre for Nuclear Safety (CNSN), and was an important part of the project decommissioning documentation.

TABLE I.C–I. COST BREAKDOWN OF THE DECOMMISSIONING

| Cost item | Total cost during D&D (%) | Percentage of total cost | | |
|---|---|---|---|---|
| | | Planning | D&D activities | Final survey |
| D&D staff salaries | 25 | 35 | 60 | 5 |
| Supplies and materials | 20 | 6 | 92 | 2 |
| Equipment | 5 | 18 | 80 | 2 |
| Anti-contamination clothing | 10 | 5 | 95 | — |
| Waste management | 30 | 2 | 98 | — |
| Licence cost | 7 | 50 | — | 50 |
| Services cost (e.g. dosimetry) | 3 | 20 | 70 | 10 |

A set of detailed operational procedures covering all project work activities was prepared by the CPHR and was included in the decommissioning documentation package.

The documents involved at this stage were:

- — The decommissioning organization (the structure, responsibilities, emergency planning and resources);
- — Financial documents (including cost estimates);
- — The operational procedures.

## I.C–5. RADIOLOGICAL CHARACTERIZATION OF THE FACILITY

The brachytherapy facility is a small part of a larger non-nuclear (hospital) facility. There were four separate rooms on the third floor used for the treatment of patients and a storage well used for the storage of the radiation sources. The storage well consisted of a hole 10 m deep with concrete walls. The bottom 1.5 m was filled with sand and contained 60 PVC pipes, each 10 m long and 1 mm wide. Radium sources were placed within lead containers and were raised and lowered through the PVC pipes using wire cables.

The characteristics of the rooms, equipment and devices, such as their materials of construction, volumes, shapes and accessibility for disassembly, were reviewed in planning the work. The characterization of the facility also included drawings and photographs that would be useful in the context of the D&D.

A characterization survey was performed in sufficient detail to provide data for planning all further decommissioning activities. The radiological parameters (i.e.

total surface activity, removable surface activity and exposure rate) were documented in a detailed report. A radiological map of the facility was prepared before and updated during the decommissioning.

The characterization of the facility was used to provide sufficient data to develop a decommissioning strategy for the project.

The documents involved at this stage were:

— The facility characterization report (the construction features, initial radiological survey report, etc.).

## I.C–6. PREPARATION OF A DECOMMISSIONING PLAN

The information collected during the physical and radiological characterization activity was used for performing the detailed planning of the decommissioning activities. A detailed schedule was prepared, which included all the decommissioning activities. It was estimated that all the activities would be performed over a one month period. The procedures used for all work were prepared, reviewed by a technical team, commented on and finalized for field implementation.

In selecting a decommissioning strategy various factors were considered, such as the future use of the facility, the availability of a national waste treatment and storage facility and the technical feasibility of the strategy.

A decontamination process was selected taking into consideration a variety of parameters, such as the type of contamination, the material of construction (e.g. metal, asphalt, concrete, soil, wood) and the type of surface (e.g. rough, porous, painted, plastic), among others.

The CPHR prepared a detailed decommissioning plan, reviewed and approved by INOR and, in addition, approved by the CNSN. The decommissioning plan was required to be flexible and adaptable, owing to the lack of operational records. The D&D labourers were allowed to modify the plan based on actual field conditions as the work progressed.

A description of the waste management activities to be performed was also included in the decommissioning plan. The procedures for locating, handling and the identification, characterization and conditioning of radiation sources, as well as the criteria for segregation and the management of radioactive and non-radioactive material (waste), were considered in the development of the decommissioning plan. The reasons for removing the facility from service, and the planned uses of these areas after decommissioning, were also explained in this document.

The documents involved at this stage were:

— The decommissioning plan (including the work programme, decommissioning activities and time schedule).

## I.C–7. APPLICATION FOR A DECOMMISSIONING LICENCE

The D&D plan prepared by INOR and the CPHR for obtaining the decommissioning licence contained all the necessary information to ensure an adequate understanding of the scope of the decommissioning project.

In order to perform the required decommissioning activities the hospital requested and received authorization (based upon its decommissioning plan) from the CNSN in the form of a licence for decommissioning. This is a task specific authorization document that contains the requirements and conditions to be met for the D&D work to be performed.

The documents involved at this stage were:

— An application for a decommissioning licence (including all the licensing documentation);
— An authorization for decommissioning by the regulatory authority (a licence for decommissioning).

## I.C–8. CONSIDERATIONS FOR SAFETY AND RADIATION PROTECTION

Workers were monitored using personal dosimeters during the decommissioning. In addition, the crew members who participated in the decommissioning were monitored with a whole body counter to ensure there were no internal uptakes. Each operator used two extremity dosimeters, a whole body thermoluminescent dosimeter and an ionization dosimeter.

A dose rate monitor and a surface contamination survey were used in the work area and for checking progress on the decontamination of objects. These monitors were calibrated and verified in the CPHR Secondary Laboratory of Dosimetric Calibration. These records were also kept as part of the D&D documentation package.

Tasks involving radiation exposures were carefully planned in advance and the expected worker doses estimated. The estimation of accumulated dose for each activity was performed prior to the activity. These records were used for planning the decommissioning work and were included in the decommissioning records package.

The documents involved at this stage were:

— A technical report on the D&D, including (1) decommissioning team personnel radiological dose records (Table I.C–II), (2) dose rates and surface contamination records and (3) occupational exposure estimates for each activity.

TABLE I.C–II. D&D TEAM PERSONNEL RADIOLOGICAL DOSE RECORDS

| D&D crew member | Radiation dose in hands (mSv) | | Internal dose (mSv) | Effective dose (mSv) |
|---|---|---|---|---|
| | Left | Right | | |
| A | 2.00 | 4.00 | 0.002 | 0.66 |
| B | 0.34 | 0.37 | 0.001 | 0.70 |
| C | 0.22 | 1.76 | 0.003 | 0.13 |
| D | 2.95 | 2.66 | 0.003 | 0.41 |

## I.C–9. DECOMMISSIONING IMPLEMENTATION

Dismantling and decontamination activities began on the first floor. The first task was the recovery of the stored radium sources from the well. Dismantling was necessary in order to gain access to the sources and to facilitate the size reduction of the contaminated materials. The dismantling strategy used was very basic and used conventional equipment. The first decontamination activity was vacuum cleaning to avoid the spread of contaminated dust. The main contaminated spots on the floor were then cleaned with a 5% detergent solution. Other more specific decontamination reagents were used as needed, for example EDTA solutions. It was necessary to dismantle part of the floor in one of the rooms because of contamination. The levels of surface contamination both before and after each decontamination activity were recorded using standard forms (Fig. I.C–3). Where a report of surface contamination measurements was prepared, the information was processed according to Ref. [I.C–2], as shown in Fig. I.C–4.

Contaminated items were placed into different waste containers according to their physical and radiological characteristics: one container for compactible solid radioactive waste and another container for non-compactible solid radioactive waste. The inventory of waste was routinely updated. The non-radioactive waste (cleared materials) was managed as ordinary (municipal) waste.

The next step was to remove the parts of the wall that were contaminated with fixed contamination. First, the wooden lid of the well was covered with nylon in order to avoid the spread of contamination. Scabbling of the wall was done with multiple passes until the contamination was reduced to acceptable levels. After each step the surface contamination was measured and reported on a standard survey report form (Fig. I.C–3).

The next step was to remove the wood from the top of the well. In order to avoid the possible contamination of the well and the pipes inside, dust was removed with a vacuum cleaner. All pieces of wood removed from the controlled zone were carefully monitored and the data recorded.

| Description of the Contaminated Surface | | | Surface contamination [cps] | | Decontamination | | | Equipment:<br><br>Date: |
|---|---|---|---|---|---|---|---|---|
| **Room** | **Floor, wall, object** | **Grid** | **Before Dec.** | **After Dec.** | **Dec. Solution** | **Dec. Method** | **Dec. Factor** | **Remarks** |
| 3 | Table | --- | 200 | 5 | Detergent 5% | Mechanical | 40.0 | --- |
| | | | | | | | | |
| 1 | Floor | F1 | 350 | 5 | Detergent 5% | Mechanical | 70.0 | Under the washbasin |
| 1 | Floor | F4 | 600 | 5 | Detergent 5% | Mechanical | 120.0 | --- |
| | | | | | | | | |
| 3 | Wall | A1 | 80 | 40 | Detergent 5% | Mechanical | 2.0 | Grid of 20x20 cm.<br><br>1st decontamination (absorbent paper) |
| | Wall | A6 | 950 | 900 | | | 1.1 | |
| | Wall | A7 | 1000 | 800 | | | 1.3 | |
| | Wall | A8 | 1200 | 1200 | | | 1.0 | |
| | Wall | A9 | 1500 | 600 | | | 2.5 | |
| | | | | | | | | |
| 3 | Wall | A1 | 40 | 8 | Detergent 5% | Mechanical | 5.0 | 2nd decontamination (absorbent paper) |
| | Wall | A6 | 900 | 450 | | | 2.0 | |
| | Wall | A7 | 800 | 350 | | | 2.3 | |
| | Wall | A8 | 1200 | 900 | | | 1.3 | |
| | Wall | A9 | 600 | 600 | | | 1.0 | |
| | | | | | | | | |
| 3 | Wall | A1 | 8 | 5 | HCl 1% | Mechanical | 1.6 | 3rd decontamination (absorbent paper) |
| | Wall | A6 | 450 | 200 | | | 2.3 | |
| | Wall | A7 | 350 | 300 | | | 1.2 | |
| | Wall | A8 | 900 | 750 | | | 1.2 | |
| | Wall | A9 | 600 | 600 | | | 1.0 | |
| | | | | | | | | |
| 3 | Wall | A1 | 5 | --- | --- | --- | --- | --- |
| | Wall | A6 | 200 | 200 | HCl 1% | Mechanical | 1.0 | 4th decontamination (Brush + Absorbent paper) |
| | Wall | A7 | 300 | 150 | | | 2.0 | |
| | Wall | A8 | 750 | 550 | | | 1.4 | |
| | Wall | A9 | 600 | 400 | | | 1.5 | |
| | | | | | | | | |
| 3 | Wall | A6 | 200 | 100 | Progressive demolition by layers | | 2.0 | Elimination of the tiles |
| | Wall | A7 | 150 | 100 | | | 1.5 | |
| | Wall | A8 | 550 | 30 | | | 18.3 | |
| | Wall | A9 | 400 | 150 | | | 2.7 | |
| | | | | | | | | |
| 3 | Wall | A6 | 100 | 80 | Progressive demolition by layers | | 1.3 | Removing of internal layers |
| | Wall | A7 | 100 | 40 | | | 2.5 | |
| | Wall | A8 | 30 | 5 | | | 6.0 | |
| | Wall | A9 | 150 | 5 | | | 30.0 | |
| | | | | | | | | |
| 3 | Wall | A6 | 80 | 5 | Progressive demolition by layers | | 16.0 | Removing of internal layers |
| | Wall | A7 | 40 | 5 | | | 8.0 | |
| | Wall | A8 | 5 | --- | --- | --- | --- | --- |
| | Wall | A9 | 5 | --- | --- | --- | --- | --- |

*FIG. I.C–3. Example of the standard survey report form (cps = counts per second).*

| | |
|---|---|
| | Date: |
| Location and sub-location: | |
| Type of surface for indirect measurements: | |
| Smear material: | wetting agent: |
| | |
| Removal factor for indirect measurement (measured or assumed): | |
| Instrument used (type, serial number, etc.): | Instrument efficiency and calibration date: |
| Instrument reading of the contamination (surface or smear): | |
| Background reading: | Activity per unit area: |
| Notes on the extent of the contamination: | Other observations: |
| | Operator's name: |

*FIG. I.C–4. Report for surface contamination measurements [I.C–2].*

The progress of decommissioning was documented in detail. All radiological measurements were reported in a register. Containers with radium sources and radioactive waste were properly identified.

The D&D team collected all the information concerning the progress of the work, according to established work procedures. A traceable report of the decommissioning activities is available. These data are included in the final decommissioning report. An example of the data collected during day to day decontamination works is shown in Fig. I.C–5.

The documents involved at this stage were:

— A technical report on D&D activities, including (1) records of more than 70 photographs taken in the facility before, during and after the decommissioning, (2) a report of surface contamination measurements and (3) records on the progress of the D&D project.

## I.C–10. WASTE MANAGEMENT RECORDS

The generation of radioactive waste from the decommissioning process was kept to the minimum practicable; the waste was adequately segregated and characterized

| Crew Member | Working on | | Main Results | |
|---|---|---|---|---|
| | **D&D Day** | 1st | **Date** | 10/06 |
| A, B, C, D | Technical Seminars with all the personnel involved in D&D activities | | Technical Seminars with the personnel from the facility to be decommissioned. Discussion of all aspects related with the D&D activities. | |
| | | | | |
| | **D&D Day** | 2nd | **Date** | 14/06 |
| A, B | Transfer all equipment and materials to INOR | | Preparation of the initial conditions for the D&D activities | |
| | | | | |
| | **D&D Day** | 3rd | **Date** | 15/06 |
| A, B | Defining working zones<br>Covering the floor of the control zone with plastic sheets | | Preparation of the control zone and area for cloth changing | |
| A, B | Covering the floor in from of the PVC-pipes area | | Preparation the control zone for overshoes and hot area | |
| D | Radiological Survey. Control of contamination on the first pipes and sand around the pipes | | No radioactive contamination on this area | |
| A, D | Control of possible internal contamination in pipes and possible presence of water, by drilling the PVC pipes A8, A9, A10 and A11. | | No radioactive contamination<br>No water | |
| A, D | Cutting of PVC pipes A8, A9, A10 and A11. | | Finding of a small container in A8 with 12 radiation sources. The dose rate at 1 m of the container was 307 μSv/h<br>A small container with one source (needle) found in A10.<br>A radiation source without container found in A11, just at the end of the pipe. | |
| B | Transferring the sources to the place of conditioning | | | |
| C, D | Measuring the dose rate of each radiation source at 1m.<br>Placing the radiation sources into a stainless steel capsule XX1. | | Conditioning of spent $^{226}Ra$ sources for long term storage. | |
| A, D | Control of possible internal contamination in pipes, possible presence of water, and cutting of PVC pipes B8, B9 and B10. | | A contaminated lead lid was found in B8.<br>Pipe B9 empty.<br>A small container with 2 radiation sources found in B10. | |
| A, D | Control of possible internal contamination in pipes, possible presence of water, and cutting of PVC pipes C8 and C9. | | Two containers found in C8, one within the other. Water and a radiation source found in the inner container. Water no contaminated.<br>Pipe C9 empty. | |
| B | Responsible for radiological measurements | | | |
| C | Responsible for Record Keeping | | | |
| --- | Waste generated during the day | | 0.5 $m^3$ of non-radioactive wastes<br>0.03 $m^3$ of radioactive non-compactable waste | |
| --- | Radiation Sources Recovered | | 17 spent $^{226}Ra$ sources | |

*FIG. I.C–5. Example record of day to day activities during decommissioning.*

to facilitate the overall safe management of conditioning and long term storage, according to national capabilities. Before decommissioning, consideration was given to the various categories of waste to be generated and their safe management. An inventory of all the kinds of waste generated was included in the decommissioning project documentation.

Radioactive waste arising from decommissioning was not treated or conditioned during the D&D project but was instead transported to the Centralized Treatment and Conditioning Facility for long term storage and included in the National Waste Management Database.

The documents involved at this stage were:

— An inventory of the radioactive waste generated during the D&D, including records of the recovered and conditioned disused radiation sources.

## I.C–11. FINAL RADIOLOGICAL SURVEY AND STATUS REPORT

A final facility radiological survey provides a complete and definitive record of the radiological status of the facility at the completion of its decommissioning. This demonstrates that the requirements established by the regulatory authority were achieved and that therefore the facility can be released from regulatory control.

The final radiological status report survey was performed by the CPHR and verified by the licensee, and a report was prepared that contained that recommended in annex III of Ref. [I.C–3]. This was then submitted to the CNSN, which reviewed the report and inspected the facility. The CNSN did not identify a need for further decontamination or surveys.

## I.C–12. FINAL PROJECT REPORT

Once the D&D project was completed the decommissioning staff prepared the final decommissioning project report, including supporting records.

The final decommissioning records and information package currently contains several different forms of records: hardcopy records and reports, computer files, figures and photographs.

Four complete sets of this information package were prepared and distributed to:

— The regulatory body (the CNSN);
— The hospital (i.e. at the decommissioning facility site, INOR);
— The CPHR central information system;
— The D&D team.

The documents involved at this stage were:

- — The final decommissioning project report, including the final radiological evaluation report.

The decommissioning project was successfully completed. Project management ensured that a sufficient programme was implemented for safety assurance, radiation protection, waste management and record keeping. The requirements established by the regulatory body to release the facility from regulatory control were achieved. Upon the successful completion of decommissioning, INOR received authorization from the regulatory body for an unrestricted use of the facility.

The documents involved at this stage were:

- — An application for a licence termination;
- — The licence termination.

## I.C–13. CONCLUDING REMARKS AND LESSONS LEARNED

The lack of record keeping during the operational life of the medical facility resulted in a scheduled delay of at least two weeks and in more costly operations from an economic and a safety point of view. The decommissioning staff needed to spend additional time searching for data that should have been readily available from operational records, such as the inventory of radiation sources and materials, radiological survey data and the construction and radiological characteristics of the contaminated rooms.

During the D&D project a complete set of records was compiled that contained the relevant information about the decommissioning activity. In the future this record keeping process could be an important element in facilitating the timely and efficient D&D of similar types of facility.

## REFERENCES TO ANNEX I.C


[I.C–1] MINISTERIO DE CIENCIA, TECHNOLOGIA Y MEDIO AMBIENTE, Reglamento de Autorizacion de Practicas Asociadas al Uso de las Radiaciones Ionizantes, Resolucion No. 25/98, CITMA, Havana (1998).

[I.C–2] INTERNATIONAL ORGANIZATION FOR STANDARDIZATION, Evaluation of Surface Contamination, ISO 7503-1, first edition, ISO, Geneva (1988).

[I.C–3] INTERNATIONAL ATOMIC ENERGY AGENCY, Decommissioning of Medical, Industrial and Research Facilities, Safety Standards Series No. WS-G-2.2, IAEA, Vienna (1999).

## Annex I.D

## DENMARK: RECORD KEEPING FOR THE DECOMMISSIONING OF THE DR 2 REACTOR

### I.D–1. INTRODUCTION

To allow for timely decommissioning it is important that all the relevant information on a nuclear plant about to be decommissioned is readily available. This applies to research reactors as well as to other facilities.

The amount of information available for any type of shutdown nuclear facility will decrease with time. People who worked at the plant will be transferred to other jobs or retire and their personal knowledge of the plant will gradually disappear. Further, the operational skills of the staff will deteriorate if no longer used. The printed information contained in drawings, reports, minutes of meetings and manuals, as well as reactor models and other durable forms of information, may disappear if no conscious effort is made for its preservation.

### I.D–2. INFORMATION STRATEGIES

It is clear that if the dismantling of a research reactor occurs shortly after the reactor shuts down (i.e. immediate dismantling) the risk that available and relevant information will be lost decreases dramatically. Under the circumstances of an immediate dismantling a significant part of the former operational staff will or may be part of the decommissioning team. If, however, the dismantling of the reactor is postponed for some years (i.e. deferred dismantling) the risk of information loss is considerably higher. However, even for immediate dismantling the process will still take some years and the loss of relevant information may increase during this period.

Various measures may be adopted to preserve the information about a facility. One approach is to store as much information as possible, as it is difficult to foresee which information will be the most critical for the decommissioning process. Another approach is to preserve only what is believed to be the most relevant information in order to make it easier to retrieve that information later for the eventual dismantling. A third approach is to have just one archive containing the information and keep it under very controlled and safe conditions, while a fourth is to have duplicate archives so that if one of the archives is destroyed, for example by a fire or flood, the information will still be available.

For reactors to be decommissioned in the near term most of the information will be available on paper; that is, in the form of drawings, reports, photographs, etc. It may be argued that in the age of information technology it would be wise to transfer the information to compact disks or some other computer storage units that are usable with scanners. If properly indexed such transfers would make it easier to find the needed information, and it would also make it easier to produce several archives. It would, however, take a major effort to scan all the paper information available, even if only the relevant parts of the existing information were to be scanned.

## I.D–3. RELEVANT INFORMATION

The information needed when operating a research reactor covers many areas, not only technical areas but also, among others, administrative and personnel matters. However, when it comes to decommissioning it is primarily the technical information that is relevant and that needs to be preserved. Further, not all the technical information on the reactor is equally important.

Of prime importance is the information on the design and construction of the reactor, the surrounding shielding, the primary cooling circuit and the auxiliary systems connected to the primary circuit. This part of the reactor plant includes all the components that may have been activated or contaminated during the operation of the reactor and that, therefore, may have to be treated as radioactive waste. The majority of this information is usually available in the form of drawings.

Information on the secondary circuit, including any cooling tower, is of interest since it has also to be dismantled. However, if this part of the plant is not radioactive it can be dismantled immediately; that is, at a time when the reactor personnel with knowledge of the plant are still available. Here too the major part of the interesting information is available in the form of drawings.

Once the reactor is shut down and the fuel has been removed from the reactor, criticality is no longer possible and the electronic equipment associated with the control rod system is no longer needed. This equipment can therefore be removed; if this is done there is no need to keep information on the control rod system. Since radioactive components are likely to be moved around in the reactor hall and in the basement, the radiation monitors in these rooms should not be removed, and consequently information and records on these monitors should remain available. If the monitors have already been removed, new radiation detectors may have to be installed before the actual decommissioning work is started.

The use of a crane in the reactor hall is essential during the decommissioning process. The crane has therefore to be maintained, as does the information on its operation. Some of the service systems may be closed and removed, but the power supply, water supply and ventilation, illumination and drainage systems have to be maintained, as does the information on these systems.

When the reactor is shut down and its fuel removed, measurements of the radiation field in the reactor should be made to permit an assessment of the remaining activity of the reactor. This will allow the mapping of what and how much activity from which radionuclides remains in the reactor system. It is desirable to remove all movable, strongly radioactive parts from the reactor before the radiation field is measured and to perform separate measurements on the removed parts, although they may later be returned to the reactor. Another possibility is to take samples from various parts of the reactor and to perform activity measurements on these samples. These measurements may have to be supplemented by calculations, since not all parts of the reactor plant are equally accessible. Measurements of activities in the primary cooling system will also be made, with all such information being kept in the records of the facility.

In order to perform activation calculations it is important to have a full knowledge of the geometry of the reactor (including the fuel elements) and the composition of the materials used to construct these items. The necessary nuclear data for such calculations are readily available; unfortunately, however, detailed information on impurities in the materials used, which may dominate the activity, will often not be available. Any available information on the material composition should be kept. Information on the operational history is also of importance for activation calculations. Since the dismantling of the reactor will at the earliest take place a couple of years after shutdown and the short lived radionuclides will have therefore decayed, not all detailed information on the reactor operation history is needed, but the general operational pattern has to be known (i.e. the periods of different power levels, the weekly operational hours and the total integrated power of these periods). In addition, information on flux measurements of various parts of the core and the reflector and at various power levels is also relevant.

If the decommissioning is to be deferred it is normal accepted practice to perform a routine (e.g. once a year) monitoring of the activity of the system. The results of these measurements must be kept in the records. These data will provide information on the decay of the activity. It may be argued that the decay of the radionuclide inventory could be calculated; this, however, is often not the case. Initially (i.e. after the removal of the fuel) the dominating radionuclide in most research reactors is $^{60}Co$, which can be easily identified. However, later, when the cobalt activity has been significantly reduced, other radionuclides with longer half-lives, which are more difficult to identify directly, may become important.

For deferred dismantling a number of measures will be carried out on the reactor systems to ensure that no undesirable changes occur during the storage period. These measures may include the use of the reactor tank or other reactor areas for the storage of the active components, setting up additional shielding material and sealing openings to the reactor. Information on such measures, including minutes of meetings in which such measures are discussed, should be included in the archives.

Other information, such as design reports, core and shielding calculations, the safety report and the requirements of the regulatory authorities with respect to the reactor plant, should also be archived.

## I.D–4. RECORD KEEPING

As mentioned in Section I.D–2, the information available on research reactors is likely to exist on paper, as drawings, reports, etc. However, with the use of scanners much of the information can be transferred to compact disks or other computer storage media. Such transfers allow the economical establishment of several archives and thereby reduce the risk that the information will be lost. A disadvantage of this approach is that the operating systems of computers and computer formats change often, at least once every five years; claims that the new operating system or formats are compatible with the old are usually not as accurate as may be hoped. Unless efforts are made to ensure that the new system can read all the stored information correctly, some or in the worst case all the stored information may be lost. If deferred dismantling is selected, and the information is stored for 25 years, for example, the probability of some loss of important information is high.

Another possibility for information storage is the use of microfilms. By the use of the microphotography of drawings and documents large amounts of information can be stored in a very limited space. In this way several archives can easily be established, but this type of information is not readily accessible.

Questions were raised in Section I.D–2 of whether all the information or only relevant parts of it should be stored and whether there should be one or more archives. A possible solution is to have one archive containing all the available information, which means in practice the archive of the research reactor that exists when the reactor is shut down, and, in addition, a second archive containing only the part of the full archive that is believed will eventually be of interest to the decommissioning project staff.

During the lifetime of a research reactor a number of projects for its modification and improvement might have existed, only some of which would have been carried out. If information on the projects that were not carried out is left in the archives it may mislead the personnel who are to perform the dismantling, and therefore this type of information should be removed.

The decommissioning archives should be established on the basis of the information available in the archive of the reactor at the time of its shutdown. It is of the greatest importance that the archives be kept up to date. If a conscious effort is not made to include new, relevant material there exists the risk that new, relevant information that becomes available during the decommissioning process is not included in the archives. This risk is significant if deferred dismantling is the selected decommissioning strategy. For deferred dismantling there will be a long period between shutdown and dismantling, and little thought may be given to the archives during this period. One possibility to overcome this problem is to appoint one person to be responsible for the archives and to ensure that this person receives all the relevant information. This person should also visit the archives at regular intervals to ensure that their physical conditions are acceptable. Since for deferred dismantling the time between shutdown and dismantling may be many years, different people may successively be made responsible for the archives. This involves a risk of information loss, but cannot be avoided.

## I.D–5. DR 2 CASE HISTORY

It was decided to establish two identical archives for the DR 2 research reactor after it was shut down. These archives contain copies of the relevant drawings and documents. The establishment of the two archives was carried out in accordance with the conditions of operation for the DR 2 after shutdown, which were issued by the Danish regulatory authorities. In addition, all the files available for DR 2 at the time of the shutdown have been kept together in one of the archives for use in the unlikely event that there will be a need for them.

All material is kept in steel file cabinets for its protection, and the two archives are kept in separate buildings. The archives are kept in locked rooms or in locked cabinets. Initially one of the archives, together with the remaining DR 2 material, was kept in the basement of DR 2. It was later moved to the DR 2 office building and later again, owing to building renovation, to a temporary office building. The other archives have remained in storage within the main administration building.

Some problems have been experienced with the archive at DR 2. After the shutdown of the reactor the reactor hall was used for chemical engineering experiments. In one of these experiments a major spill of liquid chemicals occurred; the liquid poured into the basement and showered the cabinets in which the files were stored. Some of the drawings were hanging in the cabinets, fixed to cardboard strips by the use of a tape that was unfortunately not strong enough to hold them up, which resulted in them falling down. When the liquid entered some of the cabinets it damaged the drawings that had fallen, but fortunately the damage was of limited consequence. After this accident the complete archive was moved up to a locked room in the DR 2 office building, and the suspension of the drawings was improved, but it is obviously necessary to check at regular intervals, for example once a year, that the drawings are still hanging correctly.

For a number of years little was done to keep the two sets of archived files current on activities performed at the DR 2 after its shutdown. However, information on these activities existed at the DR 3 research reactor, which is responsible for DR 2.

In connection with the present decommissioning project for DR 2 the archives are being brought up to date.

When DR 2 was built a transparent plastic model of the reactor, showing all its tubing, was made. This model would have been useful when the reactor concrete shielding is dismantled. However, this model was used at exhibitions and at one of these it got damaged. The person in charge of the exhibition stand decided that the model was damaged beyond repair and no longer of interest, so it was abandoned.

DR 2 was shut down because it appeared that the DR 3 research reactor could handle all Danish needs for beam experiments, irradiation facilities, etc. There was some doubt, however, as to whether this was correct and consequently DR 2 was initially shut down on the condition that it should be easy to restart it. A couple of years later it was established that there was indeed no further use for DR 2 and the shutdown was made permanent. Since the initial shutdown was not seen as necessarily permanent, no detailed assessment was made of the activities in the reactor and its components. Also, no detailed record was made of which reactor components were stored where. Components are stored in three locations. In the reactor tank are stored core components, for example the beryllium reflector elements, control rods, guide tubes and magnets. In the concrete cave around the thermal column are stored old beam plugs. In the hold-up tank room in the basement under the reactor are stored various other radioactive components. It is one of the goals of the present DR 2 project to obtain a complete record of these components and their activities and of the activities of the various fixed parts of the reactor and of the surrounding concrete shielding.

## I.D–6. CONCLUSIONS

When a research reactor is shut down it is of great importance to establish a complete set of records of all the information that will be of interest for its full decommissioning. These records include information on the reactor design and on the remaining radioactivity.

This information must be kept, preferably, in two archives, which may contain the information on paper, in an electronic form or as microfilms. It must be ensured that the information in the archives remains readily available and in good physical condition until greenfield conditions (or final dismantling) have been achieved. It must also be ensured that new, relevant information is continually included in the archives.

## Annex I.E

## FRANCE: RECORD KEEPING FOR COMMISSARIAT À L'ÉNERGIE ATOMIQUE'S DECOMMISSIONING PROJECTS

The French government authorities approve specific constraints and exercise surveillance on installations in which radioactive substances are processed.

The regulatory concerns of these authorities in the area of nuclear safety are for:

- The establishment and application of general safety rules;
- The issuing of licences to each installation after an in-depth technical appraisal of the safety case;
- Scrutiny of the application of the requirements.

The Direction de la sûreté des installations nucléaires (Nuclear Installations Safety Directorate, DSIN) is the government authority responsible for nuclear safety. It reports both to the Ministry of the Environment and the Ministry of Industry.

The DSIN manages the entire application process for licensing the design, construction, operation and decommissioning of basic nuclear installations.

Licences are granted by ministerial decree signed by the Prime Minister, with the different phases defined per Decree 63-1228 Modified. At all times operators are responsible for the safety of their installations.

According to a typical scheme, the DSIN sets out the general safety objectives. Operators suggest solutions to reach those objectives and, after approval by the DSIN, implement their proposed solutions. This implementation is done under the DSIN's control and oversight.

As a general rule, operators are free to choose their decommissioning strategy and the techniques to be used provided that all safety criteria are respected. These criteria are formulated by the nuclear safety authority through the issuance of technical prescriptions that take into account the specific risks from decommissioning.

Dismantling operations lead to large amounts of material and radioactive waste. According to the French regulations an operator of a nuclear installation undergoing decommissioning works is responsible for:

- Managing its material and waste exhaustively, properly and safely;
- Keeping records of this management in an appropriate way.

It follows that each category of waste should be dealt with from generation to disposal according to a preassessed and controllable scheme. In particular, this approach excludes the practice of having unconditional clearance levels for very low level radioactive waste because, according to the French approach, such a practice might imply the waste producer loosing responsibility.

The DSIN has recently developed an approach that takes into account the above mentioned principles for waste management. This approach has been applied to the decommissioning of the EL4 reactor in Brennilis, Brittany. Before the actual dismantlement, in the authorization decree the DSIN required the operator (Commissariat à l'énergie atomique (CEA)) to submit for approval a detailed waste management plan, called a waste study, that describes and justifies all the steps involved in the management of each category of waste. In addition, the operator proposed to the DSIN the routes to dispose of the waste. The approval procedure of the DSIN includes an impact assessment and a public inquiry.

The CEA has carried out a variety of decommissioning projects for several reactors and nuclear facilities throughout its centres in France. Such projects have included 15 reactors and 11 facilities (research laboratories and nuclear fuel cycle facilities).

All the decommissioning projects have, to some extent, experienced a lack of accurate and reliable records.

A records management programme has been set up for the ELAN IIB decommissioning project at La Hague. ELAN IIB (INB 47) was used for the production of $^{137}$Cs and $^{90}$Sr. This facility is located inside the La Hague reprocessing centre and belongs to the CEA.

ELAN IIB was put into operation in 1970 and was shut down in 1973. The decommissioning works began in 1980 and were given through a turnkey contract to a prime contractor. The contract was terminated in 1991 owing to some difficulties, including the impossibility of fully achieving the project's objectives.

The facility was put into a safe storage condition in 1996 to minimize surveillance and maintenance costs.

As a result of the ageing of the facility and the difficulties in maintaining its appropriate safety and security, it was decided to restart and complete the decommissioning work up to the phase of unrestricted release.

For future safe and efficient work the management of the ELAN IIB project, aware of the regulatory problems, set the adoption of a document listing approach as a project in its own right. This approach led to the creation of a document reference database, which is twice as extensive as was initially estimated.

To meet the needs of those requiring the documents, a documentation office was created under the responsibility of a third party. In an effort to keep the number of advisory teams to a minimum, full advantage is being taken of the feedback of experience.

The work has been carried out in phases since the beginning of 2000. The objective is to find an effective way of collecting, indexing, managing and saving documentation and archiving it in a centralized reference database to enable people to consult documents rapidly. The phases of the document listing project are shown in Table I.E–I.

TABLE I.E–I. PHASES OF THE DOCUMENT LISTING PROJECT

| | |
|---|---|
| Phase 1 | Listing of 8232 documents: completed 24 April 2000 (to meet CEA requirements) |
| Phase 2 | Selection (3000 documents) (meeting between CEA and COGEMA) |
| Phase 3 | Indexing and loading into electronic document management system |

The requirement of the project is to control what is available in the listings, to select those documents that are useful and then to be able to guarantee experience feedback, keep track of events and allow ready access to them.

The documentation process was carried out in steps, which included:

- Centralization.
  - Documents sent for copying.
  - The creation of a classification plan.
  - Documents entered into a computer system.
  - Classification.
- Sorting and selection.
  - Document selection.
  - Shredding.
- Indexing.
  - The allocation of technical descriptors.
  - Document updating.
- Digitalization.
  - The creation of files.
  - Incorporation into a computerized system (CINDOC).
- System put into operation.

CINDOC will be easy to implement and use and will perform the following functions through a simple, user friendly interface:

- The acquisition and indexing of information and documents;
- Saving and archiving;
- Searches;
- The display and retrieval of documents;
- The circulation of information.

ELAN IIB's documentation will by the end of 2001 be available locally and, for authorized personnel, through a web site.

## Annex I.F

## GERMANY: DECOMMISSIONING RECORD KEEPING CRITERIA AND EXPERIENCE IN ENERGIEWERKE NORD

### I.F–1. INTRODUCTION

The requirements for record keeping for D&D in Germany are regulated by the guidelines of the Federal Ministry of the Interior (BMI) [I.F–1, I.F–2] and by Nuclear Technology Committee (KTA) Rule 1404 [I.F–3]. These documents specify the basic requirements for record keeping concerning the scope, objectives, terms and management of documentation.

Documentation is defined in Ref. [I.F–1] as the systematic composition of all the documents needed for the proof of work and certification of the state of a plant. The measures performed during decommissioning should be documented in accordance with the regulations for licensing. The state of the plant must be clear and available for review by the authority with regard to:

— The radioactivity inventory and its distribution;
— The condition of the buildings, systems and components.

Furthermore, instructions on the protection of personnel against radiation and the release of radioactive and non-radioactive material, including the procedures for measurements and the measurements themselves for decisions on releases, have to be documented.

The creation of a second set of documentation for D&D is required only if the nuclear fuel is removed. The use of documentation as a support for the actions to be taken for emergency response is important, as stated in Article 38, para. 1, of Ref. [I.F–4].

For the operation of a (long term) safe enclosure the documentation has to be compiled in such a way that all the required information important for safety is available during the decommissioning process (i.e. it should be able to accommodate the deferred dismantling of a plant and should take into account the possibility of a change in ownership).

According to the licence regulations, for exemption from the basic nuclear law, after the completion of a licensed dismantling of a plant, documentation has to be submitted to the supervisory authority; this documentation should include:

— A description of the state of the site after the completion of all decommissioning measures;

— The applied release criteria, measurement methods and measurement results for all the structures remaining on the site and for the site area itself.

In this annex the main aspects of record keeping for decommissioning in Germany, and a few examples from the Greifswald NPP (Energiewerke Nord) decommissioning project related to the requirements for documentation, are presented.

## I.F–2. GENERAL REQUIREMENTS

All the information included in the documentation for decommissioning must be available directly at the site of the nuclear power plant. The documentation should be protected against fire, flood, extreme temperatures and humidity, as well as against unauthorized access. For the important documents specified in Ref. [I.F–3] a second duplicate copy should be stored in another location until the fuel is removed from the reactor.

The documentation and duplicate copies should be continuously updated and modified during the construction of new plant parts or during changes to the plant.

The conditions for storage and administration should be such that they can guarantee access for inspection by the authorities and authorized experts at any time.

The provision of a documentation centre complies with the above requirements.

The documentation should be stored as follows:

— The management of the documentation should be by the means of a transparent file system with a detailed key for the purposes of its easy assignment and classification.
— There should be facilities for a quick, easy search, preferably by means of a computer aided search system.
— It should be possible to make controlled additions.
— It should be forgery proof and secure against unauthorized use. If a computer aided system is used the nature of any secrecy (e.g. whether the material is classified, a business secret or a trade secret) should be included as a feature of the search system.
— The documents should be easy to read.
— The shelf life of the documents should be commensurate with the required time of safe keeping; this can be achieved by a suitable selection of the data medium or storage techniques or by a suitable transfer of the data on to a new data medium at the right time.

Energiewerke Nord's important records are primarily kept on paper; all other forms of records are used only as support documentation. Some reasons for this are that:

— Only original documents, signed and stamped by independent experts on behalf of the authority, are legally binding for use in the event of a dispute and are forgery proof;
— A second set of documentation has to be stored on paper for its immediate access in the event of an emergency and for when rapid action may be necessary;
— The long term storage of electronic files (for up to 30 years or more) may cause problems in the future, owing to software and hardware developments;
— Any application document sent to the authority has to be submitted on paper.

## I.F–3. REQUIREMENTS FOR THE LICENSING PROCESS

In the framework of the whole licensing process according to Articles 7 and 19 of the basic nuclear law, there is a requirement to establish safety and licensing documentation. Table I.F–I presents the main requirements for the records and the time period for record keeping for the Energiewerke Nord decommissioning project (the complete list comprises more than 40 pages of the Energiewerke Nord documentation manual) [I.F–5].

The licensing application contains the following documents:

— The application documents: the safety report, waste concept, radiation protection concept, radiological assessment of the controlled and monitored areas, qualification requirements and certification programme of the shift personnel during the post-operation and decommissioning periods.
— The site construction documents, for example the site plan, specification for cranes, room list, details of the construction of the buildings and electrical cable plans.
— The analysis documents for the nuclear power plant during the post-operation period and the incident analysis.
— Manuals: the operational manual (parts 1–4) based on Ref. [I.F–5], the emergency handbook, the QA handbook, the documentation manual and the material test handbook.
— Others: the fire protection concept, the physical protection assessments, environmental monitoring and meteorology reports, the radiological measurement programme, the remote dismantling concept, the waste management concept, the decontamination concept, the systems update and adaptation for decommissioning purposes documents and the dismantling plan for different areas, including remote operations, etc.

TABLE I.F–I. EXAMPLES OF TIMES FOR RECORD KEEPING

| Document | Time |
|---|---|
| Licensing applications | FFL[a] |
| Certificates | FFL |
| Licences | FFL |
| Additional requirements from authorized experts and instructions | FFL |
| Notifications of changes | FFL |
| Announcements of changes in the operational manual | 10 a |
| Storage of radioactive waste | 30 a |
| Documentation on radioactive site releases (in air and water) | 30 a |
| Radiochemical analyses | 1 a |

[a] FFL = final file library. These documents must be stored over the whole plant lifetime. They include licensing, QA and operational documentation [I.F–3].

Furthermore, it is required that the application and licensing documents be specifically marked. Safety copies must be issued and stored in a separate place. Some of the licensing documents should be integrated in a second documentation set.

## I.F–4. QA REQUIREMENTS

The QA system for the Greifswald NPP was implemented based on regulation DIN EN ISO 9001 and the requirements of Ref. [I.F–6]. The QA programme and the internal QA orders are provided in the QA management manual.

## I.F–5. REQUIREMENTS FOR DECOMMISSIONING OPERATIONS

The requirements for the records for when a nuclear power plant is finally shut down continue to the point at which the reactor is defuelled. For this phase the normal operational instructions for the plant will remain in force and the appropriate records should be maintained. An aspect of these documents will be a comprehensive record of the defuelling processes and the necessary evidence to demonstrate to regulators and others that the plant has been totally defuelled. Such a defuelling exercise could take three to five years. Once the plant has been totally defuelled, the normal operational instructions need to be revised to match the decommissioning status of the plant. As such, the systems of the plant will need to be reclassified, noting the now significantly reduced hazard from the plant. This revision will become a documented record. It will be updated and maintained as the decommissioning proceeds. Further requirements for record keeping for decommissioning activities are relevant to the overall waste handling scheme. To manage the mass flow of material a special waste flow tracking and QA system is required.

## I.F–6. CONCLUSIONS

The requirements of the relevant ministries (the BMI and Federal Ministry for Environmental Protection and Reactor Safety) and the KTA rules need to be checked for their applicability to decommissioning. These rules and requirements can be divided into three categories:

- The rule is of a general nature and is considered relevant to decommissioning;
- The rule is not relevant to decommissioning;
- The rule is applicable to decommissioning but, because of the reduced hazard potential in comparison with the construction and operation of nuclear power plants, the hazard should be graded accordingly.

If decommissioning work involves no nuclear safety or radiation protection issues, technical regulations of a generic (i.e. non-nuclear) nature apply. If there are nuclear safety or radiation protection issues, the rules of the KTA apply.

## REFERENCES TO ANNEX I.F


[I.F–1] BUNDESMINISTERIUM DES INNERES, Grundsätze zur Dokumentation technischer Unterlagen durch Antragsteller/Genehmigungsinhaber bei Errichtung, Betrieb und Stillegung von Kernkraftwerken, BMI, Bonn (1987).

[I.F–2] BUNDESMINISTERIUM DES INNERES, Anforderungen an die Dokumentation bei Kernkraftwerken, GMB1 (1982) 546.

[I.F–3] KERNTECHNISCHER AUSSCHUSS, Documentation During the Construction and Operation of Nuclear Power Plants, KTA 1404, KTA, Salzgitter (1989).

[I.F–4] BUNDESAMT FÜR STRAHLENSCHUTZ, Vierte Verordnung zur Änderung der Strahlenschutzverordnung, Bundesgesetzblatt BGBl.I (1997) 2113.

[I.F–5] KERNTECHNISCHER AUSSCHUSS, Requirements for the Operating Manual, KTA 1201, KTA, Salzgitter (1998).

[I.F–6] KERNTECHNISCHER AUSSCHUSS, General Requirements Regarding Quality Assurance, KTA 1401, KTA, Salzgitter (1987).

## Annex I.G

## INDIA: DOCUMENTATION AND RECORD MANAGEMENT FOR DECOMMISSIONING

### I.G–1. INTRODUCTION

Careful and detailed planning is required for the safe and successful decommissioning of any nuclear installation. The decommissioning planning process optimizes the preparations for decommissioning. From the design stage through to the final shutdown of a nuclear facility (i.e. through the construction, commissioning and operational phases) large amounts of information and data are normally generated and documented. Some of this will be essential for properly planning and performing the decommissioning programme.

### I.G–2. DOCUMENTATION AND RECORD KEEPING FOR DECOMMISSIONING

The preparation of an initial or preliminary decommissioning plan should be initiated at an early and suitable stage during the operational phase. This plan should be periodically updated until the preparation of a final decommissioning plan is appropriate. This ongoing process of updating the initial decommissioning plan during the operational phase will help in identifying the further information and data required to be documented for the decommissioning.

#### I.G–2.1. Basis for the generation of decommissioning related records

Since not all the records and data generated over the operational phase of a facility are relevant to decommissioning, it is necessary to select and collect that information and data that is relevant and to preserve these in an easily retrievable form in a cost effective manner. This task should be performed as an ongoing process within an overall RMS. The basis for the records to be generated during the operational phase of the installation should be established and, accordingly, temporary and permanent records should be identified and maintained. Similarly, some basis for generating and maintaining a set of decommissioning related records should be established.

Since the strategy for decommissioning for an operating nuclear installation is not decided upon during the early phase of its operation, the decommissioning related records that are generated and maintained should, until a final decommissioning strategy is selected, meet the needs of all the possible decommissioning strategies.

### I.G–2.2. Specifics of documentation and record keeping for decommissioning

*I.G–2.2.1. As built construction drawings*

As built drawings are a basic requirement for the planning of a decommissioning. The literature shows a number of examples in which the decommissioning of nuclear installations has been affected and the methods and sequences of dismantling had to be altered owing to differences in the details of the available and as built construction drawings.

Based on experience of the operational phase and the difficulties faced during refurbishment, the as built drawings should be confirmed to be as per the site details. For example, during the decommissioning of the ZERLINA research reactor, after the complete dismantling of the graphite reflector, when the reactor vessel was to be removed it was discovered to have been tack welded to the bottom grid support structure at five locations on its periphery. This was not indicated on the relevant drawings or in other documents. The reactor vessel was subsequently separated from the grid support structure by cutting the welds with a hand operated mechanical saw.

Another example of documentation not being available and having an impact on an activity is that which occurred during the planning stage of the project for the core conversion and refurbishment of the APSARA research reactor. In this project there was a need to increase the width and depth of the pipe trenches in the coolant system equipment room to accommodate larger pipelines. Details of the size and depth of the footings for the columns in the room were not available, and hence the piping layout in the room and the trench routing had to be altered. As another example, in the same project there was a need to convert a small room housing an electronics laboratory into a shielded room to house new equipment and piping for a heavy water reflector cooling system. Owing to the non-availability of the structural details and the strength of the plinth beams, it was difficult to assess whether the beams could take the higher loads of the new concrete walls to be put in place of the existing brick walls. This led to a decision to build using an unconventional design.

*I.G–2.2.2. Photographs and video recordings*

Photographs and video recordings taken during construction and installation could be additional tools for use by a decommissioning project manager and contractors. These may assist in the selection and detailed planning of the sequence of the decommissioning activities.

*I.G–2.2.3. Constructional sequences and methods*

Documentation on the sequences and methods used during the construction of a nuclear installation can assist in deciding upon the appropriate methods for and sequence of its dismantling. The identification of construction joints and details of the metal linings of structures can aid in planning the correct sequence of their dismantling.

Details of the material handling methods and equipment used during the fitting out of the facility may also assist in making preparations for various dismantling activities. The documentation of experience gained during major maintenance activities on large equipment during refurbishments is also useful, as it gives additional input on the radiological aspects of the handling and dismantling of large equipment.

*I.G–2.2.4. Scale model of the nuclear installation*

A scale model of the nuclear installation, if made the during the construction stage, could be an additional aid to the decommissioning project manager and contractors for planning the decommissioning activities to be taken and for training the decommissioning staff.

*I.G–2.2.5. Surveillance and conditioning monitoring of systems, structures and components*

Operating plants are required to monitor and perform surveillance on structures, systems and components (SSC) to assess the effects of their ageing and their residual life. Based on such studies, for plant life extensions the refurbishment of various SSCs is performed. The data and documents generated during these ageing studies and the subsequent refurbishment activities will become an additional input for the planning of decommissioning.

For example, ageing studies and any subsequent refurbishments may indicate whether the material handling systems in an installation would be able to support the required loads expected during the decommissioning. Containment systems for the nuclear facility are required for the confinement of the radioactivity arising during the decommissioning activities. The surveillance and maintenance performed during the service period and ageing studies could aid in predicting the condition of the containment system. Based on the condition of the containment system, a decision on decommissioning, immediate or deferred, could be taken.

*I.G–2.2.6. Relevant details of the design basis, calculations and material test certificates*

The design basis, calculations and data on material properties, based on material test certificates of various SSCs (particularly the thermal and biological shields of the reactor structure), can assist in performing an assessment of the activated radionuclides generated during the life of the reactor installation.

*I.G–2.2.7. Unusual occurrences during operation*

The documentation on any unusual occurrences in a facility through to its final shutdown may give all the required information necessary for assessing the detailed and correct radiological status of the SSCs, the residual fissile material in the SSCs, alterations or modifications to the SSCs and changes in operational practices.

Unusual occurrences during operations may have changed the radiological conditions in parts of the installation. Details of these are required for planning decommissioning activities; for example:

— Radioactive spillages owing to the breakage of piping or tanks holding radioactive liquid could cause localized permanent contamination spots;
— Excessive fuel clad failures could highly contaminate piping and the equipment of the primary coolant circuit, requiring a full scale decontamination;
— Inadequate shielding in certain areas may generate higher levels of material activation than anticipated in the design;
— Failures in the metal lining of the structures (such as sumps or spent fuel storage ponds) holding radioactive material may have contaminated substantial portions of these structures.

*I.G–2.2.8. Radiation and contamination level mapping as per the periodic radiation survey*

During the service period of an installation radiation and contamination level mapping is performed in various areas or locations. This documentation designates those areas that require special attention because of their radiological situation and that should be taken into consideration in the planning of the decommissioning.

*I.G–2.2.9. Accounting for spent and fresh fuel until the dispatch of all fuel to the off-site location*

For any nuclear installation there will be detailed documentation of fuel inventories (both fresh and spent) and of their movements for the entire operational phase.

This documentation may aid in ensuring the removal of all remaining spent and fresh fuel inventories from the facility during the initial phase of its decommissioning.

*I.G–2.2.10. Material handling systems*

Documents and test reports are required to be maintained on the operating condition of material handling systems and equipment (for example cranes, crawlers and other lifting tackles) in order to comply with the relevant provisions of regulatory practices. This documentation is necessary to confirm their readiness for decommissioning activities.

*I.G–2.2.11. Decontamination and dismantling experience during the operation and refurbishment operational phases*

Over the period of the operating phase the accumulation of radioactivity in some systems (e.g. the primary coolant) necessitates a full scale decontamination of such systems to reduce the radiological exposures during facility maintenance outages. The documentation generated from experience gained in decontamination, dismantling work and from various processes, facilities or mechanisms developed during these phases may be used during the decommissioning.

*I.G–2.2.12. Environmental monitoring*

The records generated from the monitoring of bore wells around the facility should comprise the radioactivity levels of the various radionuclides in the bore wells, water sediment samples and the water levels in the bore wells. These data, generated through to the final shutdown of the facility, are a reference and will indicate the migration, if any, of radioactivity from the facility to the surrounding environment during the long duration of the decommissioning phase. Changes in the water table, if any, due to any site specific events such as an earthquake, sea shoreline change or flooding, are useful for safety analyses of the confinement of radioactivity.

*I.G–2.2.13. Additional reports to be maintained*

Additional reports on the following topics should be maintained:

— The satisfactory functioning of radiological monitoring instruments, their calibration and frequency of testing;
— Up to date records of exposure of the personnel (both individual and collective) and records of radioactive waste under temporary storage, radioactive effluents released and waste finally disposed of;

— The results of environmental monitoring and the frequency of the monitoring;
— Demonstrations of compliance with national and local government legislation on environmental control;
— Fire detection and fire fighting provisions in the facility and records of their testing;
— System and equipment performance, including surveillance testing and in-service inspections of all utilities, for example ventilation systems, including containment, and compressed air and waste handling systems.

## I.G–3. ORGANIZATION

The organization of a nuclear installation should include a records management unit or documentation department, depending on the size of the installation. The records manager should have experience in plant operations and maintenance and of computerized record systems. Since records could be in the form of a hard (paper) or soft copy (computer files), or in both forms, periodic training for the access, proper understanding, modification, security and safety of records is required based on the latest developments in computer systems. Upon the final shutdown of the nuclear facility this records management unit could become part of the decommissioning organization.

## BIBLIOGRAPHY TO ANNEX I.G

ATOMIC ENERGY REGULATION BOARD, Safety Manual for Decommissioning of Nuclear Facilities, Rep. AERB/SM/DECOM-1, AERB, Mumbai (1998).

INTERNATIONAL ATOMIC ENERGY AGENCY, Maintenance of Records for Radioactive Waste Disposal, IAEA-TECDOC-1097, IAEA, Vienna (1999).

## Annex I.H

## ITALY: RECORD KEEPING CRITERIA AND EXPERIENCE

### I.H–1. REGULATORY AUTHORITY REQUIREMENTS AND EXPERIENCE

#### I.H–1.1. Introduction

The decommissioning of nuclear facilities in Italy reflects the peculiar conditions there after all nuclear programmes were terminated as a consequence of the result of a referendum held in 1987. Nuclear fuel cycle facilities, research reactors and nuclear power plants built and operated from the end of the 1950s now have to be dismantled.

A deferred dismantling strategy was in place for the decommissioning of nuclear power plants through to 1999, at which time the immediate dismantling option was agreed upon by the State government, the regional authorities, the regulatory body and the operators involved.

Most research reactors have now been shut down for a long time. Only a few research facilities, operated by the Energy Department of ENEA (Ente per le Nuove Tecnologie, l'Energia e l'Ambiente) or by universities, are still in operation for research purposes.

Some older research facilities, which were all smaller reactors that were periodically operated for specific research programmes, have already been decommissioned. Safety relevant problems were not reported during the operation of these plants or during their decommissioning, and there were only some minor events of interest for future decommissioning activities.

Safety issues for the decommissioning of the Caorso, Trino, Garigliano and Latina NPPs and for the licensing of the national low and intermediate level waste repository will be the most important tasks for the Italian Nuclear Regulatory Body (the nuclear department of the Agenzia Nazionale per la Protezione dell'Ambiente (ANPA), the National Environmental Protection Agency) in the future.

A definition of the technical documentation needed for the safe execution of activities is therefore of basic importance for ANPA.

A summary of the Italian regulations and of the ANPA technical guides is given below.

#### I.H–1.2. State law requirements

The fundamental Italian nuclear law is D.L. 17/03/1995, No. 230, issued to update the previous rules according to Euratom directives.

This law states requirements on the documentation that must accompany the design, construction and operation of a nuclear power plant from the point of view of nuclear safety and radiation protection.

This minimum set of documentation that must be submitted to ANPA includes:

- The general plant design;
- The preliminary safety analysis report;
- The design of the safety relevant systems;
- The final safety analysis report;
- The operations manual.

The documentation that the applicant must provide to ANPA for the licensing of a nuclear plant includes information on the safety relevant parts of the plant, but does not cover in detail all the parts needing attention for decommissioning, nor is it a sufficient base for designing the structural interventions required for component movement purposes. This means that the archive of the licensee has a basic importance for plant interventions after its construction.

### I.H–1.3. Regulatory body’s technical guides

Technical guides are regulatory documents issued by the regulatory body to provide guidance for fulfilling State law requirements.

ANPA technical guide No. 8 (issued in February 1977) concerns nuclear power plants’ QA general criteria and states that an updated copy of the documentation covered by subsection II.1.4 (b) must be available at the installation and filed in compliance with the criteria reported in that subsection.

This documentation must include at least:

- The basis, criteria, standards and regulations adopted for the design;
- The calculations, technical analyses and design verifications;
- The drawings and design specifications governing supplies, building works and installations and subsequent amendments thereto;
- The procedures for special processes involving, for example, welding, heat treatments, chemical treatments, surface treatments, platings and claddings;
- The certification and materials test data;
- The procedures and reports of examinations, tests and trials relating to conformity verifications;
- The documentation relating to non-conformities and the actions taken to correct them;
- The drawings and recorded data that reflect the as built arrangement of the installation and parts thereof, as described in the final safety report, together

with any amendments to such documents that may be due to subsequent modifications of the installation;
- The records as prescribed by the operating licence;
- The data, results of analyses, results of tests and inspections, reports of accidents and details of significant malfunctions, as well as of any incidents relating to the period of operation, and the results of audits.

The documentation must be legible, identifiable and easily retrievable.

It is necessary, among other things, that documented measures be adopted for developing, implementing and maintaining an efficient system for the identification of the plant, components and apparatus in the installation and for the systematic acquisition of the relevant data. Such a system must:

- Provide identification to which documents and design, supply, fabrication, installation, construction, inspection, testing, operating, repair and modification data can refer.
- Provide the means for ascertaining the location of such parts of the installation.
- Ensure that a correlation is maintained between the design documents (drawings, specifications and relevant technical documents) and what is produced.
- Form a basis for the adoption of measures capable of precluding the use of incorrect or defective materials, components or assemblies. The system must be correlated with systems for controlling the issuance of and circulation of technical documentation and for acquiring and filing the QA documentation that must satisfy the criteria specified in ANPA technical guide No. 8.

Documentation must be filed in a manner such that it is protected from deterioration, damage or loss. The applicant and/or licensee must specify requirements such as the location of the archives and the minimum times for the storage of the various types of document and define the relevant organizational responsibilities.

The amount and type of documentation required to be stored during the construction and operation of a nuclear power plant should be sufficient to cover decommissioning. However, a noticeable effort is required to design a record storage system that satisfies the requirements listed above.

The first application of this procedure took place in the construction of the Alto Lazio NPP, but did not finish owing to the decision to stop the use of nuclear power for the generation of electricity and therefore stop all nuclear power plant construction.

The experience gained during the four years of construction of the Alto Lazio NPP shows that the collection of all the required documentation at the installation is almost impossible, at least for its construction, and that the co-operation of the architect–engineer and the other main suppliers is required to provide a qualified storage system.

If its construction had been completed, the archive at the installation would have included all the drawings of the construction of the civil structures, the installation of the systems equipment and the documentation relating to non-conformities and the actions taken to correct them.

Other documentation, such as analysis reports, the verification of the design and the manufacturing reports, would have been stored at the offices of the architect–engineer and the main suppliers. This storage system satisfies the requirements established in ANPA technical guide No. 8 on the conservation and retrieval of documents.

The situation is similar to that at the shut down nuclear power plants, although it should be born in mind that strict QA requirements were not implemented at that time.

When considering the drawbacks and benefits concerning the above described approach, points such as the following arise:

- Increasing numbers of storage locations for records means a larger number of organizations becoming responsible through long term contracts for their storage and preservation; in the event of a change of ownership the new proprietors must be committed to the maintenance of the storage and retrieval system.
- The relationship between the plant licensee and the other organizations involved in the storage of the documentation must include good lines of communication and provide for the easy transmission of the documents; expenses related to this service must be envisaged in the contracts for the construction of the nuclear power plant.
- The regulatory body should take the responsibility for performing audits for verifying the efficiency of the storage system and the reliability of the operating organizations; in the event of the audits showing unsatisfactory practices, the plant licensee should be compelled to assume the responsibility for the storage system.
- The subdivision of the total archive into smaller specialized archives (for analysis reports, fabrication reports, data sheets, construction drawings, installation drawings, non-conformity reports, operational events reports, modification and repair reports), managed by the organizations that used them, could be a simpler storage system.
- The reduction of the amount of documentation to store for the decommissioning of the plant, together with its collection in a single storage place, could be achieved by selecting documents during the design, construction and operating phases; this procedure, however, requires duplication of the documentation, a new archive and more resources to manage the storage system, which could constitute a further burdening of an already complicated and heavy process of documentation management.
- At the end of the life of the plant, if the deferred dismantling strategy is adopted, the archived documentation could be reduced by the selection of

those documents necessary for the future dismantling activities. A rational approach to this solution would require the preparation at this stage of a planning for preliminary activities report in order to identify the documents that must be preserved. Owing to the safety issues involved, the nuclear regulatory body should state the requirements and monitor such a procedure.

— The system currently used for storage is that of storing the hardcopy, paper documents. This enables, if required, the legal validity of the document to be officially proved and provides for a long conservation period. Using electronic media could improve the storage system but the problems of physical durability, changes in software and the legal validity of this form of document need to be addressed.

### I.H–1.4. A work in progress: the decommissioning of Caorso NPP

Caorso NPP was shut down for refuelling in November 1986 and, by a governmental decision, never restarted. In July 1990 the government decided to close the plant. Actions were undertaken to move the fuel elements from the reactor pressure vessel to the spent fuel pool, which is located inside the reactor building. The spent fuel will not be reprocessed but temporarily stored in dual purpose casks on the site of the plant.

In 1999 the consensus on the immediate dismantling strategy was reached by the main organizations and institutions involved. The adoption of this decommissioning strategy takes into account the plan for the construction of a final medium and low level radioactive waste repository. Completion is envisaged within 10 years.

The licensing procedure established by the Italian nuclear law in order to consider the issues of safety is that:

— Each application for the decommissioning of a nuclear facility should include a global dismantling plan and must be presented by the licensee to the Minister of Industry; this plan can consider the intermediate phases.
— Each intermediate phase must be authorized by the Minister of Industry after a safety evaluation by ANPA that takes into account observations from other State and local administrations.
— The Minister of Industry grants the authorization, which requires that the conditions stated by ANPA be observed.
— The dismantling activities are carried out under ANPA surveillance.
— At the end of the dismantling activities the licensee issues reports that document the works performed and the actual status of the plant or site, which must be transmitted to ANPA.

— Finally, the Minister of Industry, after consultations with ANPA and the other State and local administrations involved, issues possible specifications concerning the status of the plant or site.

The technical documentation that must be presented to ANPA for each intermediate phase includes:

— A plan of the activities to be carried out;
— A description of the status of the plant and the inventory of the radioactive products;
— Information on the status of the plant at the end of the phase concerned;
— A safety analysis concerning the planned activities and the status of the plant at the end of the phase concerned;
— Information on the final destination of the waste produced;
— An environment impact evaluation;
— A radiation protection plan that covers normal and emergency events.

The information described above identifies the type of documentation required:

— The planning of activities must be supported by structural drawings, drawings of equipment and components, information on changes to the original construction and possible designs of structural interventions needed for the transport of large objects;
— A determination of the inventory must be performed through an analysis of the documentation for the operational life of the plant;
— The safety analysis must consider potential accidents and contain an evaluation of their consequences (e.g. fuel element drops, fuel cask drops, the structural collapse of civil structures or mechanical systems that result in a possible loss of radioactive or contaminated material, a change to the structural system in the course of dismantling or the consequences of a design basis event, for example an earthquake, occurring).

## I.H–2. WORK IN PROGRESS FOR THE DECOMMISSIONING OF NUCLEAR POWER PLANTS BY SOGIN

### I.H–2.1. Background

In November 1999, after enforcement of Decree No. 79 of 16 March 1999, Application of the Guideline 96/92/EU Containing Common Laws for the Internal

Market of Electricity, Enel (Ente Nazionale Energia Elettrica, Italy's electricity utility company) constituted Sogin, a nuclear power plant company, to which was passed all the assets and the legal responsibilities for the decommissioning of the four shut down nuclear power plants, fuel storage and related activities.

After the 1987 referendum Enel started the safe enclosure preparation phase (SEPP) of the plants. The activities are in the initial phase for the nuclear power plants Trino and Caorso, while for Latina and Garigliano NPPs they are almost complete.

With the establishment of Sogin the government has set new strategic goals that provide for the decommissioning of the nuclear power plants in one step, bypassing the SEPP and aiming at the unconditioned release of the sites by 2020. Sogin is currently planning decommissioning activities according to this new scheme.

Within the framework of the decommissioning programme one of the first activities is the organization of the nuclear power plant archives.

### I.H–2.2. Status of the nuclear power plant archives

The organization of the nuclear power plant archives is underway and is almost complete. The present situation of the archives for the four nuclear power plants can be summarized as follows:

- The four paper archives are almost complete;
- The archives of older drawings of the plants as built are not yet complete;
- There is the problem for all the archives of the preservation of paper (particularly tracing paper).

### I.H–2.3. Activity plan

The activity plan provided by Sogin is:

- Determination of the necessary documents for the dismantling.
- The state of preservation of the documents should be checked.
- The transfer of information on to other media (depending on the type of paper used). Media have been evaluated that should be more reliable as far as their perishability and management are concerned.
- The collection in a suitable location of all the papers related to dismantling (at present it is not expected that the remaining papers will be destroyed).

Sogin decided to adopt as an experiment a three dimensional modelling system for the dismantling of Caorso NPP's turbine building. This system permitted the dismantling activities to be optimized by enabling:

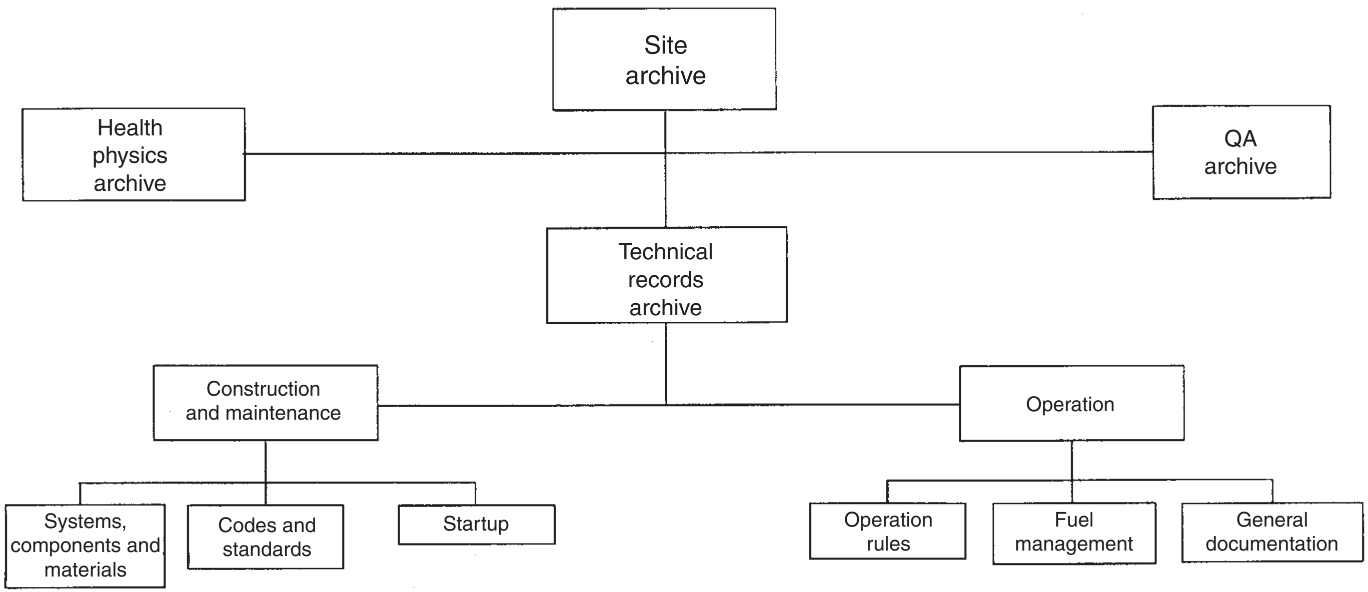


*FIG. I.H–1. Organization of the archive for the operational phase.*

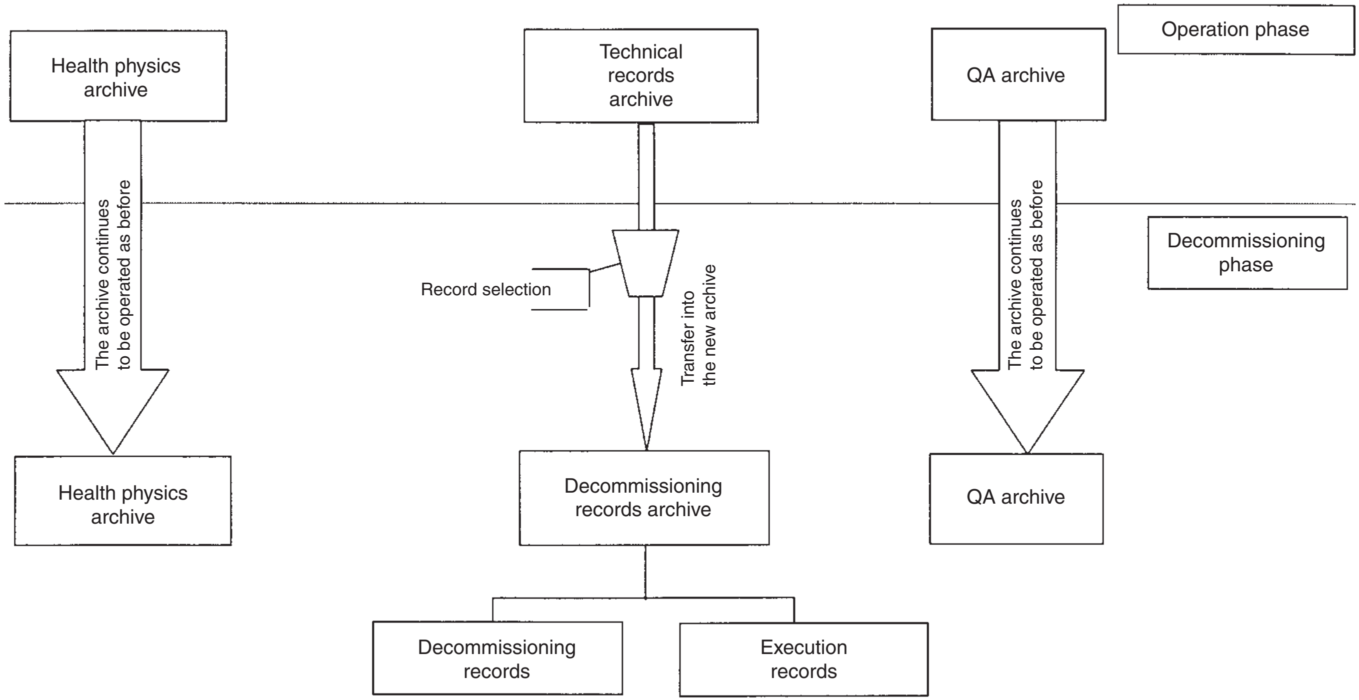


*FIG. I.H–2. Organization of the archive for the decommissioning phase.*

— The possibility of studying the disassembly phases and hence minimizing in situ surveys, which eliminates doses to personnel in areas of high contamination or areas that are particularly complex to decommission;
— The availability of a database that can give in real time the location of the components that have already been dismantled;
— The possibility of controlling the progress of the dismantling activities;
— The possibility of adjusting the management of the activities and the planning programs (i.e. Microsoft Project, which is supplied in the integrated project software package) to optimize the use of both internal and external resources.

The dismantling of the turbine building would normally not justify a complex three dimensional design and management system. However, it was used as it gave an opportunity to test and optimize the system, which was invaluable for its adoption to more complex decommissioning projects, such as for the reactor building. The turbine building exercise also enabled the distribution of the basic concepts of the system through the company.

The planning of the dismantling activities and the definition of the applicable quality plans are underway. These will take into account the experience gained in the SEPP activities at Latina and Garigliano NPPs.

Figures I.H–1 and I.H–2 show how the Caorso NPP QA programmes evolved from operation to decommissioning.

## Annex I.I

## REPUBLIC OF KOREA: RECORD KEEPING PLAN FOR THE KRR 1 AND 2 D&D PROJECT

### I.I–1. INTRODUCTION

Korea Research Reactor 1 (KRR 1), the first research reactor in the Republic of Korea, went critical in 1962, and Korea Research Reactor 2 (KRR 2) went critical in 1972. Operations were phased out in 1995 owing to their age and the start of operations at the new and more powerful research reactor HANARO (the High-flux Advanced Neutron Application Reactor) at the site of the Korea Atomic Energy Research Institute (KAERI) in Taejon.

Both KRR 1 and 2 are TRIGA pool type reactors in which the cores are small, self-contained units sitting in tanks filled with water. KRR 1 is a TRIGA Mark II, and could operate at levels of up to 250 kW, and KRR 2 is a TRIGA Mark III, which could operate at levels of up to 2000 kW.

The D&D of KRR 1 and 2 started in January 1997 and is scheduled to be completed by no later than December 2007. From 1997 to 2000 the decommissioning project work focused on the preparation of a decommissioning plan and an environmental impact assessment. In addition, efforts were underway to receive from the government a licence for decommissioning. In June 1998 all spent fuel from the two research reactors was safely transported to the USA in accordance with its spent fuel take back policy. The scope of this project therefore did not include the management or handling of spent fuel or any potential criticality hazards. The phase II operational decommissioning activities started in 2001.

### I.I–2. DECOMMISSIONING STRATEGY

The objective of the phase II decommissioning activities is to begin decommissioning operations on the KRR 1 and 2 reactors and to decontaminate the residual structures to free release levels. The decommissioning plan assessed the proposed methodology for the safe, practical and economical decommissioning of the reactors and their associated facilities.

The decommissioning operations should comply with regulatory and legislative requirements and the proposed methods must consider the safety of both workers and the public in accordance with the as low as reasonably achievable concept.

The methods and order for decommissioning have been chosen taking into consideration both the physical structure and radiological conditions of the reactor components and the safety of all operations, all of which were considered during the hazard and operability (HAZOP) studies for this project. The HAZOP studies allowed the project to design safeguards into the system and the flow of operations where necessary to reduce the potential for incidents to occur; in the event that an accident does occur, the consequences are minimized due to operational limits established for the decommissioning activities.

## I.I–3. GENERAL CONCEPT OF RECORD KEEPING

The systematic arrangement and maintenance of record keeping should be considered well in advance of commencing planning for D&D. However, the lack of a systematic management approach for the retention and management of those records largely causes great difficulty for efficient shutdown and eventual decommissioning. Legally, according to the Atomic Energy Act of the Republic of Korea, the constructor and operator of nuclear and related facilities must retain all the records relating to their construction and operation.

Record keeping should be performed not only during construction and operation but also during the entire decommissioning period for all the relevant information generated from those activities. Record keeping provides for improvements in the design, construction and operation of future nuclear facilities. Furthermore, it has an important influence on facilitating the efficient D&D of all nuclear facilities.

## I.I–4. CRITERIA FOR THE SELECTION OF RECORDS AND CATEGORIES OF DECOMMISSIONING RECORDS

Decommissioning record keeping requires a careful review and selection of all the relevant and available information to facilitate the cost effective planning and implementation of decommissioning. This selection process should result in a considerable reduction in the number of documents. Generally, the records to be selected are to satisfy the:

- Statutory and regulatory requirements;
- Responsiveness to requests by the users, including for the operator’s legal defence against litigation;
- Historical value, legacy or cultural interest of the records;
- Usefulness for the support of the engineering and nuclear safety aspects of immediate and future decommissioning activities.

The records satisfying the above criteria can be placed in logical categories according to their perceived future use, retention period and relative importance.

The types of record that can be identified from any particular facility are very diverse and, for each facility, the records have to be appropriately classified. The classification scheme can be largely divided into two categories: (a) those needed for predecommissioning activities and (b) those generated during decommissioning. The former includes records on design, construction and operation, and the latter records on decommissioning planning, practical activities and lessons learned.

Predecommissioning records include:

- Records of the design and construction phase.
  - Complete drawings and construction photographs of the facility as built.
  - Procurement records that include the types and quantities of the materials used during construction.
  - The statements and specifications for equipment and components, including details of the suppliers, their weight and size, and the materials of construction.
  - Experimental data for any special material used in the construction.
- Records of the operation phase.
  - Safety analysis reports.
  - Technical specifications and operating manuals for key installation operating equipment.
  - Environmental assessments.
  - Power history and operating logs.
  - Radiological surveys and workers' radiation exposure records.
  - Operating and maintenance procedures.
  - Abnormal occurrence reports.
  - Design changes and updated (as built) drawings.
  - Reports, papers and memoranda generated during operation that may assist in decommissioning.

Decommissioning records include:

- Records of the planning phase.
  - The decommissioning plan.
  - The environmental impact assessment.
  - The project management plan.
  - The funding source and spending plan.
  - The estimated cost and work schedule.
  - The future plan for the site and facility.
  - The radiological survey.
  - The QA programme.
  - The dismantling technology assessment.

— Records of the dismantling and restoration phase.
  - The detailed work procedure and status.
  - The safety analysis report.
  - The periodic status reports — actual performance measured against planned performance.
  - The final radiological survey for the site and facilities.
  - The final project report.
  - The licence modification and termination.
  - Lessons learned.

## I.I–5. SPECIFIC RECORD RETENTION STATUS FOR KRR 1 AND 2

KRR 1 and 2 operated for about 30 years. All the retained records have been divided into two classes: the documents concerning design and construction and the records generated during the operation of the reactors. The documents related to the design, construction and operation of KRR 1 and 2 consist of 46 volumes with 16 categories for unit 1 and 1661 volumes with 408 categories for unit 2. These records are currently kept at KAERI's facilities in Seoul. The documents concerning design and construction include the:

— Design drawings;
— Specifications;
— Safety analysis reports;
— Operation and management statements;
— QA plans;
— Documents related to purchasing for auxiliary installations;
— Material test results.

Records related to the operation are:

— The daily operation records;
— The radiation safety management reports;
— The environmental inspections;
— Various reports and papers;
— The nuclear fuel treatment reports;
— The regular inspection results;
— The reports of accidents during operation;
— The reports on the treatment of the radioactive waste generated during operation.

Most of these records are kept in the form of paper copies without details of classifications or criteria. Decommissioning records will, however, be produced as the dismantling progresses, at which point all these records will be subject to the appropriate classification, selection and storage processes.

## I.I–6. PLANNING FOR RECORD KEEPING FOR THE KRR 1 AND 2 D&D PROJECT

The planning for record keeping, including the storage, reading, retrieval, modification and output of information from the KRR 1 and 2 projects, is currently being developed. All information will be put into the KRR Decommissioning Information Database System (KRRDIDS). The predecommissioning records include the documents on the design, construction and operation of KRR 1 and 2, records of incidents, the decommissioning plan and the radiological archives. The decommissioning records include the data and documents for all activities concerning the dismantling, from the preparation of the work to the treatment of the radioactive waste, such as experimental data and records of the exposure of workers, human resources and costs.

All information related to KRR 1 and 2 is classified and screened using record selection criteria, examples of which are the Document Identification Coding System or the Document Control Master Index. The screened information is stored on digital media in the form of computer files to enable their future easy access.

The stored digital files are then put into the database. Each electronic file in the database consists of a classification number, its title, its body, a reference, a date, details of its location, etc., which can be directly accessed and displayed. For some hardcopy records generated before the dismantling work, however, only the classification number and storage locations are input; for these the Basic Subject Index is used. An example of the Document Identification Coding System is shown in Fig. I.I–1; Section I.I–6.1 gives an example of the Basic Subject Index.

Paper records are transferred into the KRRDIDS by scanning, while digital files are directly stored with keywords in that system. A transmittal index is given for the information to be screened. Information satisfying the record keeping criteria receives a classification index and is stored. Information of no value is removed. Stored files can be read through a retrieval function either on the KRRDIDS screen or on corresponding software.

The database system is designed so that retrieved results can be modified, updated and again input or removed taking into consideration the record keeping criteria. The decommissioning database established will also graphically depict, store, read and retrieve output and update the decommissioning information.

| R | 2 | R | - | II | 1 | 2 | 1 | - | 0 | 6 | - | N | - | 0 | 0 | 0 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Prefix | | | | Main Classification | | | | | Suffix | | | | | | | | |

| Category Block No. | | General Doc. | Related Com pany | Recording Doc. |
|---|---|---|---|---|
| Prefix | 1 | Category (G, C, R) | | |
| | 2 | Unit (KRR-1, KRR-2) | | |
| | 3 | Data Property (W, C, H, R…) | | |
| Main Classification | 4 | Document Identification | Classification No. of the related company | Phase (I ~ IV) |
| | 5 | | | System / Facility |
| | 6 | | | |
| | 7 | | | Location |
| Suffix | 8 | Company Code (Owner / Contractor) | | Work Code |
| | 9 | | | |
| | 10 | Quality Class (Q, T, S, N) | | |
| | 11 - 14 | Serial Number | | |

*FIG. I.I–1. Data identification using the Document Identification Coding System for the KRR 1 and 2 D&D project. This is for a recording document (R) with serial number 0001 for a decontamination (=06) of the 12th pipe (=12) in the reactor (=1) KRR 2 (=2) during phase II (=II) for radiological data (=R).*

### I.I–6.1. Example of the Basic Subject Index code

**67000 Common Process and Service**

67100 Water System
- 67120 Circulating Water System
- 67130 Service Water System
- 67140 Fire Protection System

67800 Radiation Monitoring
- 67830 Dosimetry Lab Instrumentation
- 67870 Health Physics Instrumentation
- 67880 Effluent Radioactivity Instrumentation

67900 Radioactive Waste Management
- 67910 Solid Wastes
- 67920 Liquid Wastes (Including Monitoring)
- 67930 Gaseous Wastes (Including Monitoring)

## Annex I.J

## NETHERLANDS: THE RECORDS OF THE DODEWAARD NUCLEAR POWER STATION

### I.J–1. DODEWAARD NUCLEAR POWER STATION

The Dutch Electricity Generating Board (NV Sep) started constructing the Dodewaard nuclear power station (Kerncentrale Dodewaard or KCD) in early 1965. The objective was to acquire experience in operating a nuclear power plant in order to generate electricity and to create research opportunities in the field of nuclear energy. When the further construction of nuclear power stations stopped in the Netherlands there arose an additional objective of maintaining knowledge in the field of nuclear energy. KCD was a small demonstration power station and was never intended to generate electricity on a commercial basis. In 1996, when it became clear that the construction of new nuclear power stations in the Netherlands was not feasible in the short term, NV Sep announced its intention of shutting down KCD. The production of electricity ceased on 26 March 1997, exactly 28 years after the power station had officially been put into operation. Now that production has stopped, NV Sep and KCD want to place KCD into safe enclosure for a period of 40 years. The safe enclosure includes all the measures to keep radioactivity within a defined and controlled area. Dismantling is expected to start in 2043. An application has been made to the Netherlands authorities for the required licence.

The period between the ending of production and the achievement of safe enclosure is divided into three phases. At the end of each phase there will be reorganization and the number of staff will be further reduced.

### I.J–2. SHUTDOWN AND DISMANTLING

In October 1996 it was decided that KCD would be shut down prematurely. The State Archives of Gelderland (Rijksarchief in Gelderland or RAG) subsequently asked KCD, in view of their significance from a cultural and historical perspective, to transfer the relevant records to it in due course and thus secure these records for future generations. KCD was the first nuclear power station in the Netherlands and during its operation it held the social spotlight on many occasions. After agreement had been reached between KCD and RAG a preliminary study was conducted and the Historical Files project was set up.

RAG is one of the twelve State Archives in the Netherlands. Together with the National Archives in The Hague the State Archives form the State Archive Service, which comes under the management of the Ministry of Education, Culture and Science. RAG manages the records transferred from the province of Gelderland, the records of the national institutions in that province and the records of private individuals.

A preliminary study was performed in order to get a good understanding of the (historical) tasks and record keeping of KCD. This provided the basis for the Historical Records and Dynamic Records projects.

## I.J–3. GENERAL APPROACH TO THE RECORDS

The goal of this project was to perform an appraisal and compose a description of the records according to RAG's standards.

Along with this activity came the realization that accurate records will be needed for the period from the end of power production up to and including the dismantling of the power station after the 40 year safe enclosure period. During this period the number of staff will decrease significantly and the organizational structure will constantly change. Many new staff members unfamiliar with the situation will carry out the work. Adequate central records will therefore be essential for the continuation of safe operations. The Dynamic Records project was started for this purpose.

### I.J–3.1. Preliminary research

The preliminary research, which was performed by employees of RAG, included a detailed sequence of activities: a functional analysis, analyses of the series and the creation of an appraisal schedule. Functional analysis consists of preparing a listing of and classifying the historical and current functions and operating processes of an institution. Environmental factors, the basic policy, the communications structure and the organizational structure are also included in the analysis. The appraisal of the functional analysis is used as a basis for the description of the documents. At the end of the 1980s the American Charles Babbage Institute (CBI) recommended this method for analysing public records for firms with high grade and intensive technology. According to the CBI, functional analysis is an adequate tool for record processing in firms with large amounts of technological research, the large scale production of information and numerous technical documents on various data carriers. KCD is such a business.

Statutes, annual reports, the quality management manual, the 1994 safety report on the Dodewaard nuclear power station and interviews with experts were used as sources for the functional analysis.

Analyses of the series are intended to provide an understanding of the composition and structure of the record system. This understanding is necessary in order to be able to make an accurate assessment of the costs of the operation. In addition, the analyses provide data that are indispensable for selecting records and making them accessible. It promotes efficiency and saves time.

The following elements are among those specified for such an analysis: the name of the series, the creator of the record (e.g. the department, committee or official), details of the manager, its whereabouts, its arrangement, the degree of its accessibility, its size, the available resources and links with other series. Series are subdivisions of the company records, which are created and managed by separate departments, committees and officials or which are distinguished from each other by certain features.

### I.J–3.2. Results of the preliminary research

The KCD records measured about 1400 m in length. The records were created on a decentralized basis by departments, sections and individual employees. There was no central record system nor a record policy or plan. The arrangement of the decentralized records and the degree to which they were made accessible varied greatly, often depending on the individual people who created them. The majority of the files were created at the operational level — so-called routine files. The executive records, managed by the secretariat, had developed into the backbone of the company file. A complicating factor was the fact that for a long time there was association at the corporate management level with NV Tot Keuring Van Elektrotechnische Materialen (KEMA), an allied research institute in the field of energy generation. In particular, the policy and financial elements of the records had become mixed.

The data were recorded on a variety of data carriers, for example paper, X ray films, videos, microfilms, tapes and CD-ROMs.

The appraisal schedule that was compiled for KCD contained an overview of the firm's functions and operating processes for the period 1965 to 1997. A schedule was compiled for transferring the records to RAG. Each operating process was provided with a rating of either 'transfer' or 'do not transfer, destroy in due course'. The appraisal of the files for the Historical Records project was based purely on their historical interest (see Table I.J–I); files that were relevant to plant operation, for accountability or for providing evidence were managed by the Dynamic Records project. The operating processes were examined using a number of appraisal criteria that represent the historical interest of the record. A selection committee assessed the draft appraisal schedule and made minor changes. This committee consisted of experts (KCD management), representatives of the State Archives and an external expert. The latter was a former member of parliament with experience in the energy field.

Two projects, Historical Records and Dynamic Records, were started after the completion of the preliminary research.

The Historical Records project processing stage was estimated to last two years and three months (excluding the material processing), and the Dynamic Records

TABLE I.J–I. SELECTION CRITERIA (SUMMARY) FOR THE TRANSFER OF ELEMENTS OF THE FILES TO RAG

| Operating process | Assessment |
|---|---|
| Formation of the policy | Transfer |
| Procedural and organizational frameworks and conditions for implementing the policy | Transfer |
| Executive and routine character | Do not transfer, destroy in due course |
| Far reaching consequences for the design of the nuclear power station | Transfer |
| Providing information and giving account | Transfer |
| Innovation of nuclear technology and scientific research | Transfer |
| Participation or representation in regional and national concerns or organizations | Do not transfer, destroy in due course |
| Participation or representation in international concerns or organizations | Transfer |
| Preventing emergency situations | Transfer |
| Management of nuclear fuel, radioactive waste and the reactor | Transfer, except for:<br>— Routine measurements and checks<br>— Routine paperwork<br>— Routine repair and maintenance |

**Note:** Records resulting from operating processes rated as ‘do not transfer’ are stored and transferred if, at the time of selection, it appears that the record:

- Is part of a confidential data series or if there has been no check on the operating processes;
- Relates to campaigns against the use of nuclear energy;
- Relates to communications with the press or public organizations;
- Concerns the firm’s own publications;
- Relates to participation or representation in organizations for which the secretariat rests with the KCD or, for the case of regular bilateral consultations, for which there is no clear secretariat.

project one year. RAG is advising KCD on the implementation of the project and is monitoring the progress of the Historical Records project. A project committee is supervising the progress made. The committee consists of two employees of the nuclear power station, a representative of RAG and the two archivists.

## I.J–4. HISTORICAL RECORDS PROJECT

The results of the preliminary research formed the basis for compiling the record processing plan. This plan sets out how the records of KCD should be processed in order to make them suitable for transfer to RAG: this is the core of the Historical Records project. RAG laid down the conditions under which the records should be described and packed. The analyses showed that digital file elements were practically never considered for transfer, so that the processing plan was targeted mainly at the conventional data carriers (i.e. paper, film and photographs). The following points were considered in the processing plan: the desired end situation, the processing method, procedures, planning and the budget.

The records of the period from the start until the end of the operation of the power station (1965–1997) are managed by the Historical Records project. The policy records, created at the strategic company level, were first selected and described, followed by the bulk records created at the operational level, followed by the drawings and details of minor changes. In practice, these phases were to some extent intermingled as a result of the departure of staff in connection with the closure of the power station. The material to be processed was first of all centralized and then described and arranged on the basis of functions and operating processes. Once the inventory is ready, the papers that were made accessible will be packed and labelled.

Before the transfer to the State Archive office can take place, a number of essential matters need to be settled, such as ownership, the public nature of the documents, the method of lending, the locations for the files and additions in the future after the final dismantling of the nuclear power station.

## I.J–5. DYNAMIC RECORDS PROJECT

Owing to the reorganizations, the number of (experienced) employees is decreasing, while the number of hired temporary workers is increasing. This makes it essential that a readily accessible record keeping system be established for their use. With the release of workers a great deal of knowledge disappears as, in the past, there was no record keeping. Efficient record management and a readily accessible central, not personal, record keeping system are an essential part of the safe enclosure. Information must be available and centrally accessible to all parties. In the period of safe enclosure and during the dismantling, external workers must be able to find this information for planning and operational purposes.

It was decided to compile a schedule list of storage periods as the first phase of the Dynamic Records project. This schedule gives general criteria for storage and destruction and storage times for categories of files. At the end of the storage period the relevant documents can be destroyed. There was an urgent need to make space in the various storage rooms. In the past nothing was ever systematically destroyed. This start provided a good overview of the various types of document and the value of various records. The storage periods are based on statutory storage obligations, internal and external accountability, their relevance to the operation of the plant and their historical or scientific importance. These periods are not included in the aforementioned appraisal schedule, which is used to determine which records go to RAG. Like the appraisal schedule, the storage times are based on functions and operating processes (see Table I.J–I). When the schedule of storage periods has been approved by the management of the facility, the records can be selected for destruction, after which the actual destruction process takes place.

At the end of the process there will remain three series of records:

— The historical records to be transferred to RAG;
— The records that are to be stored temporarily and to be destroyed in due course;
— The current central series with usually recent documents and a few older records for use in future planning.

The historical records will in due course be accessible to the general public, with some restrictions laid down in the transfer agreement between the nuclear power plant operator, RAG and the competent nuclear authorities. Requests for consulting the current records will be assessed on a case by case basis by the management of the nuclear power plant operator or its legal successors.

## I.J–6. CONCLUSIONS

Both the Historical Records and Dynamic Records projects are to a large extent complete and both have been a success. Much of the (preliminary) work for the two projects had many similarities and to a large extent could be carried out in parallel. Ultimately, the projects follow on from each other, and dynamic records will with time change into historical records.

Initially the method used for the projects was entirely new to KCD. Support was gained for the projects after a proper introduction. People understood the need for the records to be efficiently stored, which is necessary up to and throughout the dismantling of the plant, as KCD will be shut down and the organization will change rapidly.

The Historical Records project was completed in April 2001; however, the final agreement on the transfer of the records between the nuclear power plant operator, RAG and the competent nuclear authorities is still outstanding as at June 2002.

The Dynamic Records project will be concluded when the record system and the record schedule times have been approved and implemented. At that time the management of the dynamic records will be transferred to the regular company organization. This is planned to occur when all the nuclear fuel in the power station has been removed.

There has been little evidence for the original fear that there would be resistance within the organization to co-operating with the transfer of the documents to RAG and in the setting up of a centralized record keeping system. In fact, a certain pride could be detected in safeguarding one's work for future generations, and the need for a different RMS was recognized for the safe enclosure period, up to and including the demolition of the plant.

## Annex I.K

## ROMANIA: DECOMMISSIONING RECORD KEEPING CRITERIA AND EXPERIENCE AT THE VVR-S RESEARCH REACTOR AT THE IFIN-HH

### I.K–1. INTRODUCTION

The VVR-S research reactor of the Horia Hulubei National Institute of R&D for Physics and Nuclear Engineering (IFIN-HH), located in Bucharest, Romania, was started in July 1957. It has a 2 MW designed nominal power level and was devoted to the production of radioisotopes and to research work. After 41 years of operation the reactor was permanently shut down on 23 December 1997. No major modifications were performed during its operational period. The actual status of the reactor is 'shut down for conservation'; decommissioning activities have not yet been initiated. A decommissioning plan for the reactor has been prepared through a technical assistance project with the IAEA.

Following the strategy proposed for this project, the main activities to be performed are that:

- The equipment of the primary circuit, the hot cells and some technological rooms (the main hall, pump room, radioactive material transfer areas, ventilation building and stack) will be dismantled, size reduced and the waste conditioned and packaged. The waste will be mainly radioactively contaminated waste.
- All activated material will remain in place, except the ionization chambers, control rods and control rod channels, which will be handled as above.

One of the important aspects of preparing a decommissioning plan for the reactor was the provision of a complete database that was able to keep records and allow for the systematic retrieval of the necessary information associated with the decommissioning activities.

Following the requirements of the Romanian regulatory authority, some steps have been taken for this purpose, which include:

- The gathering, systematization and management of all the available information connected with the reactor systems.
- Establishing a relational database and keeping records of all the relevant information using Microsoft Access 2.0 software.
- Establishing a complete Microsoft Access 2.0 database that contains all the relevant spent fuel information on this facility.

— Processing all information related to the IFIN-HH treatment station and the Baita Bihor national repository and the development of a FoxPro archive system for the final waste packages. This work is still in progress.
— Attempts to correlate automatically the reactor database with the waste package archive are underway. Linking between the components of the two archive systems mentioned above is also underway.

The results of this work are important for:

— The decommissioning project;
— The spent fuel storage project;
— The safety analysis of the Baita Bihor low and intermediate level waste (LILW) national repository.

## I.K–2. IDENTIFICATION AND SELECTION OF DECOMMISSIONING ORIENTED RECORDS

### I.K–2.1. Primary data

In the first phase of establishing the Reactor Decommissioning Archive System an inventory was taken of all the available data. The basic structures of the database, as established by this work, are as described below.

#### *I.K–2.1.1. Actual status of the reactor system*

Detailed information on each item of the 18 different reactor systems, as well as of the reactor itself, was assembled. This consisted of collecting data on their locations, sizes, material of construction, masses, etc., from various reference documents [I.K–1–3]. This information was compiled using the drawings of the facility, as well as through discussions with the operating staff or by direct observation.

Information on the hot cells, as well as on some technological areas of the reactor hall, was not available during this compilation process.

#### *I.K–2.1.2. Radiological characterization of the reactor*

The induced activation levels and their corresponding dose rates were calculated for all the components of the reactor that were exposed to neutron fluxes and were activated. A calculation methodology (methods, codes, libraries) was used based upon the computational system available in the IFIN-HH institute. Essentially, this approach consisted of a neutron flux evaluation and the calculation of averaged spectral indexes by means of two dimensional transport (DORT code) calculations used as input data for depletion and decay calculations (ORIGEN code). The irradiation history was taken into account and activation levels calculated at various times after the shutdown. For large items (e.g. reactor vessels, iron and concrete shielding) an ad hoc procedure was used that calculates the radioactivity of each part of the item according to the order of magnitude of the neutron flux. Calculated values of the induced activity of the reactor internals were determined after periods of 100 days and 6, 10, 25 and 50 years after the shutdown of the reactor [I.K–4]. Dose rates from some internal structures that might be extracted from the reactor were calculated using the MERCURE-3 code [I.K–5] and with consideration that some of these items are welded together.

*I.K–2.1.3. Historical waste data*

Radioisotope composition measurements and dose rate measurements were taken for the instruments and other equipment currently stored either inside the intermediate external repository or in the reactor concrete storage tubes [I.K–6]. This equipment (i.e. loops and capsules for irradiation purposes) was used in the reactor between 1970 and 1980 and has been removed and is awaiting decommissioning.

*I.K–2.1.4. Information relevant to decommissioning operations*

An inventory was performed of all the available information relevant to the dismantling activities [I.K–7]. Further work procedures for the decommissioning activities will be based on this information.

*I.K–2.1.5. Waste packages*

The waste package element is a very important part of the database, as it will track the waste generated by the decommissioning activities. Currently it is difficult to quantify the exact amount of waste packages that will be generated by the decommissioning of the VVR-S reactor, as it will be strongly dependent on the segmentation and packaging techniques to be used, which have not yet been selected.

In order to learn how best to handle this database segment, the decision was made to load it with some limited technical information. Information on some historical operational waste sent to the IFIN-HH treatment station as well as other data on waste coming mainly from daily reactor staff activities were recorded in this element. Data (e.g. the type, weights, activities and dose rates) were taken from the radiological analysis records supplied for each intermediate level waste drum filled with waste in the reactor facility group and transported to the treatment station for conditioning.

## I.K–2.2. Organization of the Reactor Decommissioning Archive System

### *I.K–2.2.1. Logical scheme of the Reactor Decommissioning Archive System*

By analysing the primary data, the available calculation tools and the purpose of the task to be achieved a logical scheme for the establishment of a Reactor Decommissioning Archive System was established. The database was structured using the five data categories discussed in Section I.K–2.1. Within the 'Systems of the nuclear reactor' segment the characteristics of every system of the reactor are provided (see Fig. I.K–1). Owing to the complexity of the 'Nuclear reactor' system its inventory was designed in a separate logical scheme. A pattern table containing general information on each of the components of the systems was first created. A category entitled 'Reactor system items' was created to supply information such as the location, material, weight or reference (documentation or drawing) from which the information was extracted. The 'Components' segment contains tables structured on component categories. For each type of component (e.g. pipes, flanges and vanes) there is supplied its size, weight, location, etc. The logical flow chart (see Fig. I.K–1) contains also the connections established between the above mentioned segments. The same structure was used for the logical model of the 'Nuclear reactor' segment (see Fig. I.K–2). The basic matrix identifies the items of the reactor according to their location. For example, all the items inside the central vessel, all items between the central and middle vessel, etc., were gathered together.

All the information entered into the 'Nuclear reactor' segment was extracted from Ref. [I.K–3]. For this reason reference information was not included in the archive. Because the radioactivity calculation estimates both total and partial values for each item of the reactor, all the obtained calculation results were entered into the 'Radiological characterization' segment, which allowed the same logical structure as that of the 'Nuclear reactor' segment to be kept (see Fig. I.K–3). The 50 indication procedures for dismantling, cutting, etc., that focused on the components of the reactor systems (see Fig. I.K–1) were aligned with every component to be dismantled. Neither the 'Historical waste data' nor 'Waste packages' segments of the database (see Fig. I.K–1) are connected with the other categories and were designed as separate parts of the archive, due to the specific data available.

### *I.K–2.2.2. Operation of the Reactor Decommissioning Archive System*

The application was achieved by loading the tables into the archives and various connected segments. It must be emphasized that a significant amount of effort was required to establish and download the large amount of information into the system. This information was extracted from various references and was analysed, compared and verified to ensure that it was accurate.

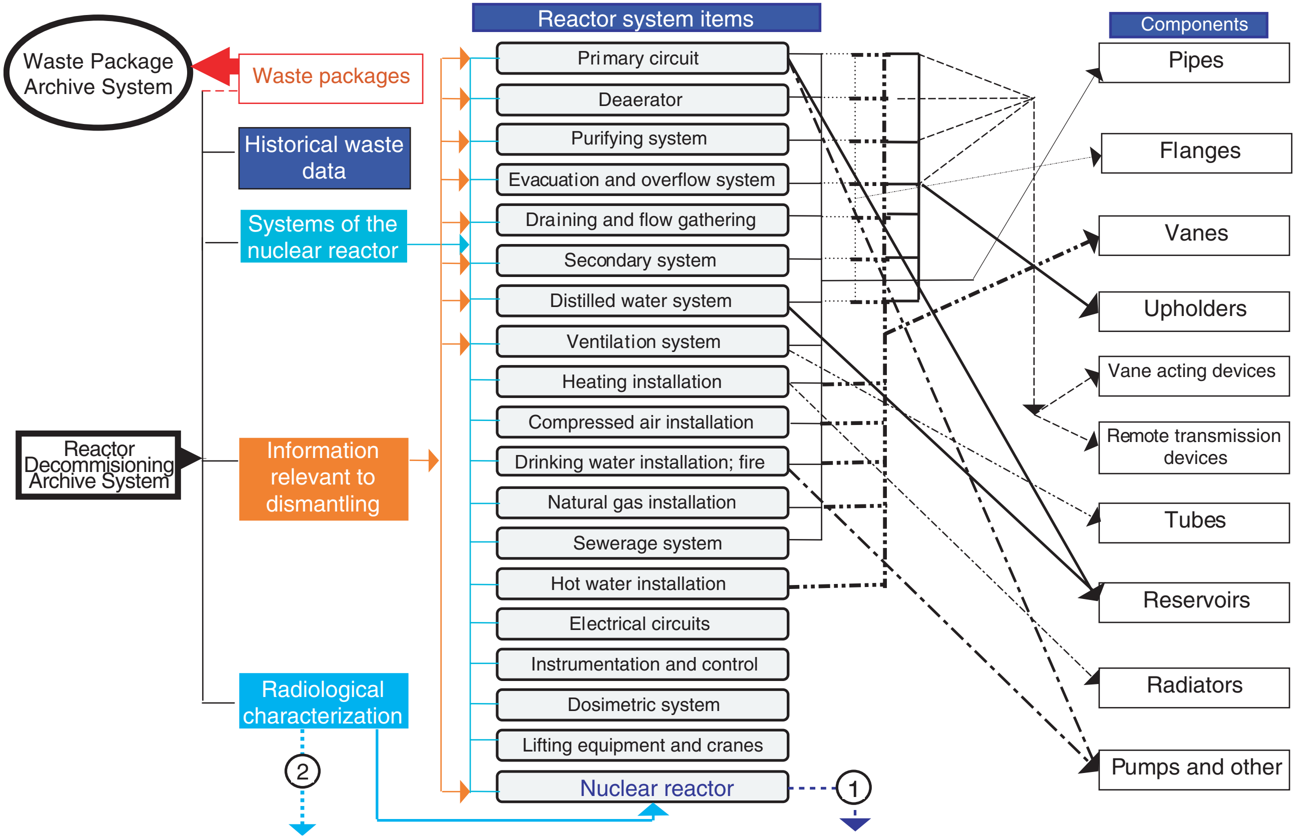


*FIG. I.K–1. Integrated view of the Reactor Decommissioning Archive System for the VVR-S research reactor of the IFIN-HH, Romania.*

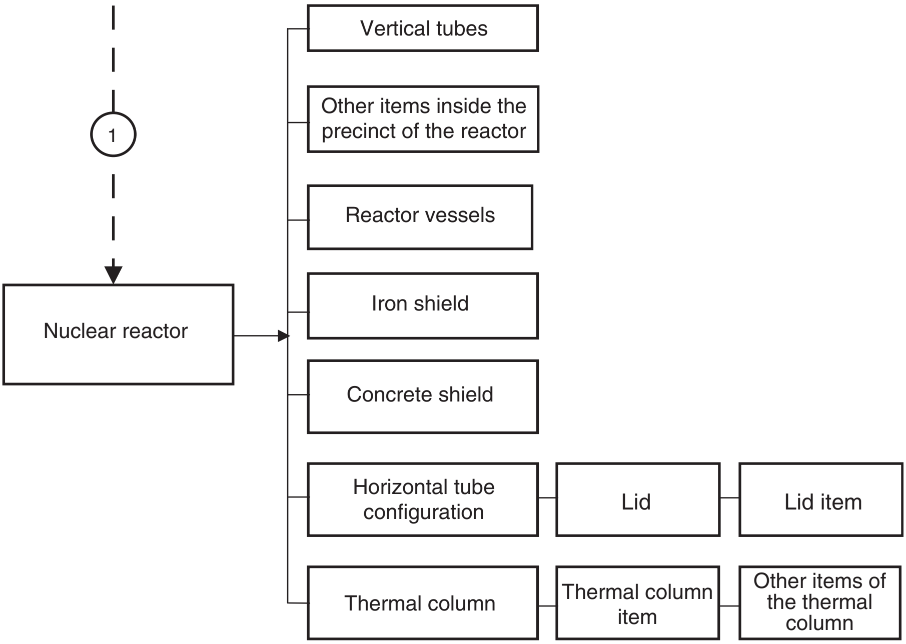


*FIG. I.K–2. The 'Nuclear reactor' segment of the Reactor Decommissioning Archive System for the VVR-S research reactor of the IFIN-HH, Romania (see Fig. I.K–1).*

In order to avoid errors, auxiliary Fortran programs were created to transfer automatically the results of the calculations. Also, Visual Basic programs were created simultaneously to open the database and fill the tables with the calculation results during a run. The database uses Microsoft Access 2.0 software adapted for this purpose.

A complete set of information (i.e. the details of the reactor components selected according to the desired criteria, their radiological characterization, theoretical estimates and the indications for their dismantling) can be extracted from the system and used to support the various decommissioning strategies.

Table I.K–I [I.K–4] presents as an example a list of the items located in the pump room. The quantity of stainless steel components amounts to 47 t, aluminium consists of 0.8 t and all the carbon steel equipment amounted to 3.8 t. These data supply valuable information regarding the possible contaminated waste volumes arising from the dismantling of the pump room equipment.

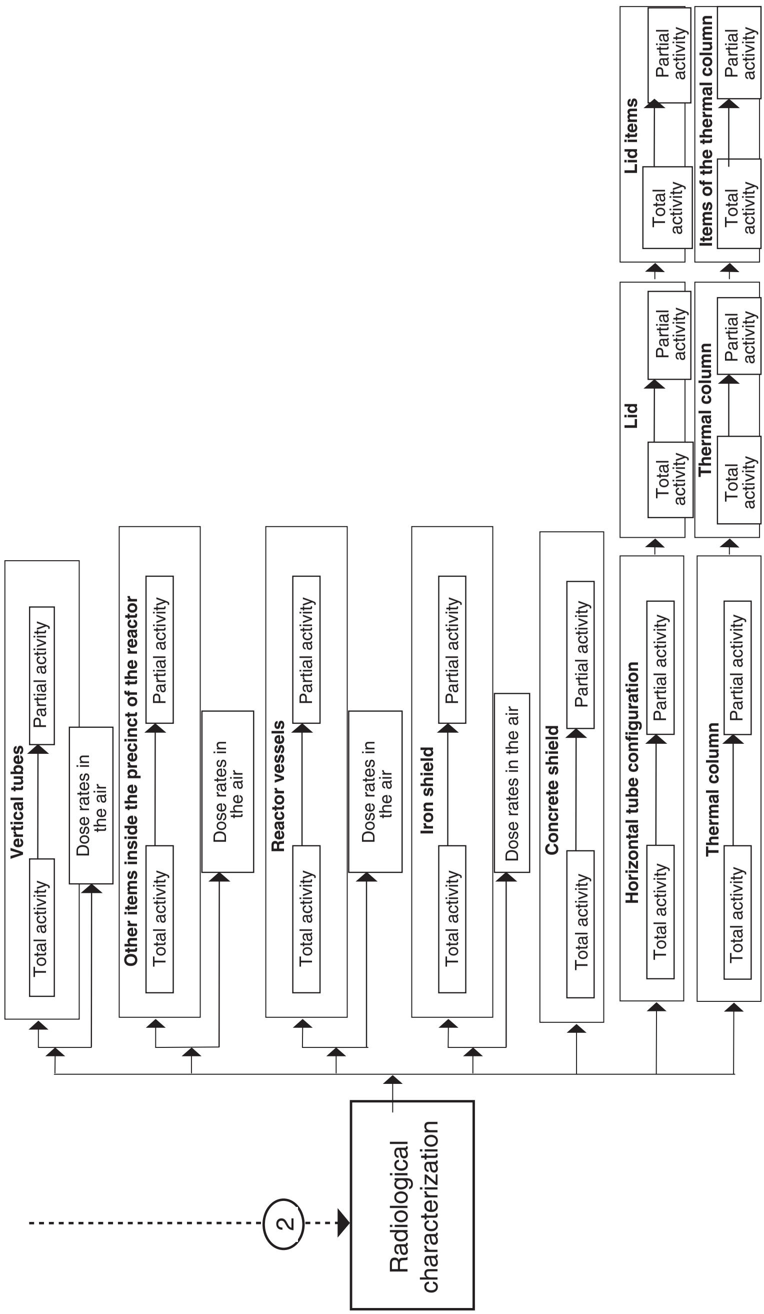


*FIG. I.K–3. The 'Radiological characterization' segment of the Reactor Decommissioning Archive System for the VVR-S research reactor of the IFIN-HH, Romania (see Fig. I.K–1).*

TABLE I.K–I. TOTAL INVENTORY OF THE PUMP ROOM ITEMS

| Item | Material | Total weight (kg) |
|---|---|---|
| Primary circuit pipes (diameter <100 mm) | Stainless steel | 8 635 |
| Primary circuit pipes (diameter >100 mm) | Stainless steel | 1 292 |
| Flanges | Stainless steel | 210 |
| Diaphragms | Stainless steel | 55 |
| Ventilation items | Stainless steel | 8 575 |
| Filter | Stainless steel | 9 100 |
| Heat exchanger (two pieces) | Stainless steel | 10 000 |
| Pumps (five pieces) | Stainless steel | 4 055 |
| Deaerator | Stainless steel | 5 000 |
| *Total stainless steel* | | 46 922 |
| Pipes (diameter >100 mm) | Aluminium | 815 |
| Supports | Carbon steel | 2 285 |
| Crane | Carbon steel | 1 500 |
| *Total carbon steel* | | 3 785 |

### I.K–2.3. Completion of the decommissioning database

Possible next steps in the further development of the Reactor Decommissioning Archive System include the:

- Automatic insertion into the database of updated calculated values of the radioactivity and dose rates;
- Correlation of this system with the Spent Fuel Archive System;
- Inclusion of all information concerning unrestricted release waste;
- Inclusion of all information concerning the characterization of technological areas (maps of dose rates measured as well as the instruments used);
- Inclusion of all information concerning the environment.

The Reactor Decommissioning Archive System will record and track the decommissioning activities, including the disposal scenarios of each item that will be dismantled from the reactor, packaged and transported to the repository.

The data obtained during the inspections and audits based on QA procedures as well as those from environmental surveillance activities will also be included.

In conclusion, the compilation of the Reactor Decommissioning Archive System was a very complex task that will require continuous improvements before, during and after the decommissioning.

#### I.K–2.4. Adaptability to the chosen decommissioning strategy

By means of the correlation between its different components, the decommissioning database supplies information on the actual status of the reactor decommissioning at every desired level of detail. Currently the database supplies information about waste (i.e. its type, volume, weight and radiological characterization) that may arise from the decommissioning activities up to the final dismantling of the reactor. At this stage no records are directed towards a specific decommissioning stage. However, waste generated during the proposed decommissioning activities can be easily selected and removed from the actual database. Further input to the 'Waste package' segment will be associated with additional information on cutting and packaging procedures. In addition, information regarding other technical topics should be entered into the archive. Information and scenarios regarding this necessary information are not yet available.

### I.K–3. UPDATING RECORDS, INCLUDING RADIOLOGICAL CHARACTERIZATION AND THEORETICAL ESTIMATES

Since its compilation in 1997 the Reactor Decommissioning Archive System has been updated once, in 1998, by updating the old radioactive inventory calculations with a new data set. Updated results of the radioactivity of each reactor item, as well as corresponding dose rates, were obtained taking into account the actual shutdown date of the reactor. Owing to the automated procedure already established, the transfer of the data in the archive was a very easy operation.

### I.K–4. ORGANIZATION RESPONSIBLE FOR CREATING AND MAINTAINING A RECORDS DATABASE AND ITS INTERACTIONS WITH OTHERS RESPONSIBLE FOR DECOMMISSIONING

The Reactor Decommissioning Archive System was established by (1) the Nuclear Reactor Department, (2) the Treatment Station Department and (3) the LILW National Repository Department of the IFIN-HH. Being responsible for the three departments mentioned above, the IFIN-HH has the responsibility to create, manage and maintain the Reactor Decommissioning Archive System. Up to now the sharing of information by means of a network connection was done easily with the Waste Package Archive System developed by the same department. Both archive systems are protected by various degrees of security, mainly by passwords and according to the level of access allowed to the user. Automatic connections allow users the ability to access the database directly during the calculation process. Connections with other possible partners may be done easily by means of the network. Reports on the status of the database are periodically sent to the regulators.

## I.K–5. LONG TERM PRESERVATION OF RECORDS AND MEDIA

The Reactor Decommissioning Archive System was conceived and developed using a 486 PC computer and is copied on to 1.4 MB diskettes. It is not yet possible to record on CD-ROMs. The database is also routinely printed out so that it can be saved on paper.

## REFERENCES TO ANNEX I.K


[I.K–1] PAUNESCU, A., et al., Detailed Documentation for the Decommissioning of the IFIN VVR-S Reactor and Enclosed Installations — Technical Details for Dismantling, ST-1821-01, CITON-37/1995, Center of Engineering and Technology for Nuclear Objectives, Bucharest (1995).

[I.K–2] PAUNESCU, A., et al., Cost Estimates of the VVR-S IFIN-HH Decommissioning Activity (Stage 2), ST-1822-01, CITON-37/1995, Center of Engineering and Technology for Nuclear Objectives, Bucharest (1995).

[I.K–3] GARLEA, I., et al., Classification of the Radioactive Wastes after Volume and Composition for Three VVRS-IFIN-HH Reactor Decommissioning Variants, RI A87.4, Horia Hulubei National Institute of R&D for Physics and Nuclear Engineering, Bucharest (1994).

[I.K–4] GARLEA, I., et al., Decommissioning Plan for VVR-S Research Reactor, Appendix 1, Waste Type Volumes and Routes, ROM/9/017, Horia Hulubei National Institute of R&D for Physics and Nuclear Engineering, Bucharest (1995).

[I.K–5] GARLEA, I., et al., Decommissioning Plan for VVR-S Research Reactor, Appendix 2, Dose Estimates, ROM/9/017, Horia Hulubei National Institute of R&D for Physics and Nuclear Engineering, Bucharest (1995).

[I.K–6] GARLEA, I., et al., Methods of Determination of the Spatial Distribution of the Absolute Radioactivity from Materials Obtained from the Decommissioning of the VVR-S reactor, Int. Rep. A83.1, Horia Hulubei National Institute of R&D for Physics and Nuclear Engineering, Bucharest (1998).

[I.K–7] NEICA, N., Horia Hulubei National Institute of R&D for Physics and Nuclear Engineering, Bucharest, personal communication, 1996.

## Annex I.L

## RUSSIAN FEDERATION: RECORD KEEPING FOR DECOMMISSIONING PURPOSES. NEW OFFICIAL REQUIREMENTS AND INSTRUCTIONS

### I.L–1. INTRODUCTION

For the safety and efficiency of a facility a set of as built records that covers the time from the beginning of its operation should be available. This set of records should be constantly updated and augmented during the operation of the facility and should include, for example, details of changes to its construction, its operational history and incidents leading to the contamination of systems, structures and the environment. The procedures of record keeping and configuration management in the former USSR were the subject of regulation through the system of the State Standards.

At the time of the permanent shutdown of an installation a new approach is needed to address the issues relevant to its decommissioning, which are substantially different from those relevant to its operation. It is clear that many operational records are redundant for the purposes of decommissioning. Additional data are needed in a timely manner, however, to provide a reliable basis for safe operations during decommissioning and ultimately to optimize the activities of the project.

To meet these requirements, recently a number of regulatory documents containing recommendations and instructions on record keeping for decommissioning purposes have been issued by Gosatomnadzor, the Federal Nuclear and Radiation Safety Authority of Russia [I.L–1, I.L–2]. Relevant information can also be found in the Gosatomnadzor rules [I.L–3–5] and in Ref. [I.L–6].

The documents quoted above are not oriented specifically to record keeping. They do contain, however, rigid requirements on the content, scope and interpretation of the information to be included in a summary decommissioning report (SDR), which is the essential document for obtaining the licence [I.L–1] and high level approval [I.L–6] for a decommissioning project. Thus the relevant chapters of Refs [I.L–3–5] and Ref. [I.L–6] can be considered, in essence, as official instructions for record keeping for the purposes of decommissioning.

### I.L–2. GENERAL REQUIREMENTS FOR AN SDR

In accordance with Ref. [I.L–1] an SDR must contain specific information and in such a form as to ensure an adequate understanding of the decommissioning project as a whole; that is, the concept, the programme (plan) and the main safety principles of the decommissioning. All design and operational records that are important for the purposes of decommissioning must be included in the SDR or presented in attached files.

The development of an SDR therefore first of all requires a careful identification of all the available documents and data and the selection and validation of these documents and data. This is essential for safe and cost effective planning and the management of decommissioning. The process will in general entail a considerable reduction of the number of documents in comparison with those needed for the operation of a facility.

## I.L–3. REQUIREMENTS FOR THE CONTENT AND FORM OF AN SDR AND FOR RECORD KEEPING PROCEDURES

The following must be included in an SDR:

— The concept of the decommissioning (i.e. the most appropriate variant);
— The characterization of the site and adjoining territory;
— The sources of radiation and radiation protection issues;
— The measures, systems and equipment for decommissioning;
— The decommissioning safety assessment;
— The organization and management of decommissioning activities.

All information should be stated in a clear and concise manner. Declarative statements are not permitted, as all deductions must be supported with documented proof. The duplication of information in various sections should be avoided, and, if necessary, corresponding references must be made.

All computations and analytical estimations must be supported by the initial data, the assumptions used, the results, the interpretations of the results, etc., in order to provide experts with the necessary data for verification (if required). All the software used must be described in enough detail to appraise its acceptability and legitimacy.

Each section of an SDR must contain:

— Information on the design, operational and other materials used for the development of the report;
— The compliance requirements for the statutory and regulatory instruments;
— A bibliography of the literature used.

Requirements for the layout of the report and the records include details such as the format of the list, the size of the font to be used and the procedures for correcting records.

## I.L–4. DECOMMISSIONING RECORDS: HIERARCHY AND CONSISTENCY

### I.L–4.1. Section 1

In the first section of an SDR it is necessary to describe the concept of the decommissioning, the sequence of the actions needed and the radiation protection measures to be taken.

Detailed information is needed on:

- The decommissioning option selected;
- The key stages of the decommissioning and their duration;
- The sequence of the demolition of protective barriers;
- The safety measures for every stage of the decommissioning;
- The state of the facility after the completion of every immediate stage of the decommissioning.

For each stage of the decommissioning the principles and criteria of safety assurance should be presented. The main results of integrated engineering and radiological investigations should also be presented.

It is necessary to show how it is planned to achieve the minimization of radioactive waste arisings, the reduction of the exposure of personnel and the public to radiation and the minimum release of radiocontaminants to the environment.

### I.L–4.2. Section 2

The second section should include information on the geographical, topographical, hydrological, meteorological, geological and engineering–geological conditions of the site to be decommissioned, as well as data on the demography and utilization of the land.

As the basic material for computations of the quantitative or probabilistic characteristics of the site the following files should be included:

- Historical data collected from chronicles, archives, newspapers and photographs;
- Eyewitness accounts;
- Climatic, topographic and engineering–geological maps;
- Data on systematic observations;
- Data on standard hydrometeorological investigations;
- Data on calculated probabilities and parameters of coercions.

All the parameters needed for the assessment of safety for decommissioning activities and to be included in an SDR should be detailed in depth. For example,

TABLE I.L–I. DETAILS REQUIRED FOR ASSESSING THE CHARACTERISTICS OF EXTERNAL EVENTS

| Event | Details required |
|---|---|
| Aircraft crash | The mass of fuel and of other items<br>The velocity of the impact<br>The angle of incidence<br>The vector of the force<br>The area of impact<br>The probability of the event |
| Fire due to external factors | The probable area affected by the fire<br>The heat flow in the source of the fire and changes of the heat flow in the direction of the facility<br>The distance from the facility<br>The velocity and direction of the wind used in the calculation |
| Explosion outside the facility | The surplus pressure in the front of the percussion air waves<br>The equivalent weight of TNT<br>The distance to the facility<br>The calculated concentration of toxic effluents on the facility site |
| Atmospheric releases of explosive, inflammable and toxic vapours, gases and aerosols | The amounts of substances that could potentially be involved in the event<br>The initial concentration at the point of release, the dispersion of releases in the atmosphere, the concentration of hazards caused by the primary sources and secondary effects<br>The velocity and direction of the wind used in the calculation<br>The existence and capacity of the source of kindling<br>The concentration of hazards in a cloud coming towards the facility |
| Breach of a dam | The height of the wave<br>The velocity of the wave<br>The time of flooding |
| Corrosive liquid discharges in surface and groundwaters | The initial concentration<br>The possible concentration of corrosive media near the facility<br>The duration of contact with the water |

**Note:** For other types of external force it is necessary to define the intensity and frequency of the events.

when assessing the characteristics of external events it is necessary to have the details shown in Table I.L–I.

**I.L–4.3. Section 3**

Section 3 is entitled Sources of Radiation and Radiation Protection. It includes:

- The content of radioactive substances in the equipment and technological systems. Data on the composition of the radionuclides, the energy of the radiation, the dimensions of the radioactive sources and the activity should be attached, along with drawings with indications of all the locations of the sources.
- Data on the sources of radioactive waste arisings, both from the operation and decommissioning of the facility. The radionuclide composition of waste and data on the concentrations of radionuclides should be presented.
- The special means for the reduction of dose rates, the minimization of radioactive waste, the simplification of access to equipment as well as the reduction and simplification of other actions in the course of the decommissioning. A detailed plan of the facility must be attached and should include:
  - The borders of the strict regime zone, with indications of which premises are occupied, periodically occupied or empty.
  - The location of medical departments, radiation control points and the special laundry.
  - The flow of the movement of personnel and traffic.
  - The allocation of places for the storage of contaminated equipment, decontamination facilities and sites, and places for the collection of radioactive waste.
  - Details of sensing devices and the control panels of the radiation control system.
  - Details of radiochemical and dosimetric laboratories.
- The organizational structure of the radiation control and medical departments, with an indication of the qualifications, experience, rights and responsibilities of the personnel.

A number of other important files related to radiation safety in the course of decommissioning must also be included in this section of an SDR.

**I.L–4.4. Section 4**

Section 4 is entitled Measures, Systems and Equipment for Decommissioning of Nuclear Facilities. This set of records includes data on the equipment, methods and technologies for dismantling, decontamination, waste management and the remediation of the environment (both those already available and specially developed for decommissioning purposes), as well as the inventory of spent fuel and the management of fissile material.

The requirements for the information needed and for record keeping are detailed and prescriptive. For example, for the management of liquid radioactive waste it is necessary to present:

- The main characteristics of all the systems for the management of radioactive waste for all possible regimes of operation, including accident conditions.
- The description of every individual system, including the technological schemes, equipment, normal directions of the liquid streams and the throughput of the system and reserve equipment. For complex multifunctional systems it is necessary to indicate those subsystems that can be separated into autonomous parts. For every system the maximum and minimum quantities of liquid (in $m^3$/d) must be tabulated or indicated in schemes for all regimes of operation, including accident conditions.
- The measures of and means for reducing equipment stoppages, the minimization of radioactive contamination and improvements in the efficiency of the treatments.

### I.L–4.5. Section 5

Section 5 is on safety analyses for decommissioning. The response of the systems and structures of the facility to possible events must be carefully analysed. These analyses should be for both internal events (e.g. radioactivity releases and the improper operation of the systems) and external events (e.g. seismic events and floods). It is necessary to develop and substantiate using the results obtained from these analyses a strategy for corrective actions aimed at ensuring the safety of decommissioning operations under accident conditions.

### I.L–4.6. Section 6

The organization of decommissioning works is described Section 6. It includes detailed information on the departments or institutions to be involved in the decommissioning, the systems and procedures of control, the means of preventing accidents, programmes of personnel training and other aspects that give an assurance of the successful implementation of a decommissioning project.

## I.L–5. CONCLUSIONS

The Gosatomnadzor rules of Refs [I.L–1–5] determine and formalize the procedures and requirements for record keeping for decommissioning purposes. These relate formally to pre-licensing activities; however, as obtaining a licence is a necessary step to start decommissioning, and since the Gosatomnadzor rules are not at variance with the recommendations of Ref. [I.L–6], there is no reason for operators to use any other approach for decommissioning.

## REFERENCES TO ANNEX I.L


[I.L–1] GOSATOMNADZOR, The rules of safety assurance in the course of industrial reactor decommissioning, NP-007-98, Bull. Gosatomnadzor Russia **2** 4 (1999) 84–112 (in Russian).

[I.L–2] GOSATOMNADZOR, The rules of safety assurance in the course of NPP decommissioning (final draft), Bull. Gosatomnadzor Russia **3** 5 (1999) 41–53 (in Russian).

[I.L–3] GOSATOMNADZOR, The rules of nuclear safety of research reactors, RNS RR-98, Bull. Gosatomnadzor Russia **2** 4 (1999) 7–25 (in Russian).

[I.L–4] GOSATOMNADZOR, The rules of nuclear safety of critical assemblies, RNS CA-98, Bull. Gosatomnadzor Russia **2** 4 (1999) 26–46 (in Russian).

[I.L–5] GOSATOMNADZOR, Requirements to the quality assurance programme when managing radioactive waste, RB-003-98, Bull. Gosatomnadzor Russia **1** 3 (1999) 32–38 (in Russian).

[I.L–6] RUSSIAN FEDERATION MINISTRY OF ATOMIC POWER, Methodical Recommendations on Preparation for the Programme of Decommissioning of Nuclear Installations, Radiation Sources, and Storage Facilities for Nuclear Materials, Radioactive Substances and Radioactive Waste, Minatom, Moscow (1998) (in Russian).

## Annex I.M

## SLOVAKIA: RECORD KEEPING FOR DECOMMISSIONING

### I.M–1. INTRODUCTION

There are three key sets of decommissioning records required in Slovakia:

- Those required during the operation of a nuclear facility and that will be essential for the planning of its decommissioning;
- Those necessary for planning individual works and recording the results of the decommissioning process;
- Those essential for the evaluation of the final status of the site and that are required to facilitate the termination of the nuclear licence.

### I.M–2. REGULATORY RECORD KEEPING REQUIREMENTS

#### I.M–2.1. Regulatory record keeping requirements for decommissioning planning

There is no act or regulation that covers all the regulatory record keeping requirements for the planning of decommissioning or performing decommissioning activities. Different aspects of record keeping are described in different regulations on QA, waste management and radiation protection. These are very briefly defined in the guide Range and Content of Decommissioning Documentation. There is no regulatory requirement for an RMS.

It is the responsibility of a licensee to define the period for which records should be kept. The only exemption is for radioactive waste management facilities, for which the licence holder should keep records of the operational data, the maintenance performed on equipment, any events and the method of eliminating the possible impacts thereof, and should maintain these records until the shutdown of the installation. The regulatory body can at its discretion define other retention periods.

The following types of record are required to initiate planning for decommissioning:

- Up to date drawings of the nuclear facility that include the history of all modifications;

- The level and location of specific radionuclides (contaminated and activated parts of a facility);
- Supporting data on dose rates (e.g. their level and location);
- Radioactive waste management data;
- Waste and material release data;
- The radiological status of the site before the start of the construction of the facility;
- The annual report on discharges and the resulting radiological status of the site and its vicinity.

*I.M–2.1.1. As built drawings*

Original drawings and details of any changes that influence nuclear safety are issued by the operator and evaluated according to legal provisions. The legal requirement is that copies of these records be available at both the operator's site and at the premises of the local building authority. Regulatory bodies usually evaluate only specific parts of documents and do not require the licensee to have a complete set of drawings.

*I.M–2.1.2. Level and location of specific radionuclides (contaminated and activated parts of a facility)*

In general, the legal requirements for record keeping are the same as described in Section I.M–2.1. QA programmes require annual record keeping that includes supporting data on dose rates, both their level and location. Only data relevant to the consequences of any event that results in the contamination of a site and/or equipment are required to be kept for the whole period of operation. The calculated or estimated data on the activated parts of a facility are an important aspect of planning for decommissioning.

*I.M–2.1.3. Radioactive waste management data*

The requirements for this type of data collection are the most comprehensive. A licensee should possess radioactive waste management records and maintain these records until the closure of the repository.

Such records contain:

- Detailed listings of the radioactive waste generated and/or accepted;
- Records of the means and/or method of the handling of the radioactive waste, including the timing of radioactive waste management steps;
- Records of the analytical results of radioactive waste sampling.

*I.M–2.1.4. Waste package checklist*

The following are recorded for all radioactive waste items:

- — The type and origin of the waste;
- — The type and identification data of the packaging, and the date on which it was packed;
- — The type and identification data of the waste package;
- — The total activities of alpha and beta radionuclides;
- — The activities of individual radionuclides for which the contents are restricted and the methods for their determination;
- — The activity of other significant radionuclides exceeding 1% of the total activity;
- — The values of other parameters determined from a safety analysis of the radioactive waste transport and disposal;
- — The dose rate on the surface of the waste package;
- — The total mass of the waste package;
- — The surface contamination data of the waste package;
- — The identification of the person responsible for the checklist, the date of issue and, if transferred, the name of the person who accepts the waste package.

*I.M–2.1.5. Waste and material release data*

Since 2000 there has been a requirement to keep the records of the waste and material release data up until the facility completes its operational life. Regulatory guidance for the release of metal scrap was issued in 1996 and for non-metallic materials in 2000.

*I.M–2.1.6. Data required for the evaluation of the radiological status of the site*

The Health Protection of the Population Act requires that the licensee undertakes a pre-operational environmental monitoring of the site. In addition, annual reports on gaseous and liquid discharges and an annual evaluation of the changes in the radiological conditions in the vicinity of the site are required to be documented and filed. There are no firm requirements regarding the management of these records.

It is the responsibility of the operator to evaluate an event that has radiological consequences and to issue a report to the regulatory body.

### I.M–2.2. Regulatory record keeping requirements for decommissioning activities

The basic data required for decommissioning activities are similar to those for decommissioning planning (see Section I.M–2.1.). The data should be routinely updated and otherwise properly maintained.

The data specific for this period are mostly documents (i.e. the licensing documentation):

- Environmental assessment reports, including environmental impact statements and environmental impact assessments;
- Decommissioning plans and subsequent amendments;
- Safety assessments and reports for each decommissioning phase;
- Environmental monitoring programmes undertaken during decommissioning;
- Decommissioning project QA programme descriptions.

The content of these documents is in accordance with IAEA and European Commission recommendations.

In addition, the following documents are also required:

- Work packages, including the associated records;
- Decommissioning team personnel radiological dose records;
- Radiological survey records;
- Details of significant abnormal events, their consequences and the measures taken;
- Progress and status reports.

### I.M–2.3. Regulatory record keeping requirements for a licence termination

The Atomic Energy Act, including related regulations, requires that the final documentation for a decommissioning site includes:

- A final description of the site;
- A summary overview of all decommissioning work done;
- Data on individual and collective doses for the decommissioning staff and the public and its evaluation;
- A summary of the quantities of the radioactive waste and released material and waste;
- The requirements for subsequent record keeping, including timing;
- The final radiological survey, to be confirmed by an independent organization.

## I.M–3. RECORD KEEPING STATUS: EXPERIENCE

Recent requirements for record keeping are described in Section I.M–2. Some facilities in Slovakia were constructed, operated and even under decommissioning before the requirements for record keeping were issued by the regulator. The status of record keeping for decommissioning purposes therefore varies from one facility to another.

Radiological data collected during pre-operational assessments, annual assessments of normal operational radioactive discharges and the radiological consequences of events, both at the facility and local to it, are available for all nuclear facilities. Changes over time to the methods of measurement make it difficult to compare some original data (which were based on the total alpha, beta activity) with more recent detailed data (which are based on measurements of individual nuclides).

The A1 nuclear power plant reactor was constructed and operated before the requirements for safety documentation were issued. The start of decommissioning was strongly affected by the lack of data. Some data on the materials of construction and radiological data were available from drawings, and this was supplemented by personnel checks by means of remote video recording and remote measurements; the process continues. A record keeping system has been established and data is now routinely added to it.

The data for decommissioning purposes were originally collected using the same system as for the operational data; they are now, however, kept separately in a dedicated decommissioning database. The information in this system includes:

— A description of the technological parts;
— A description of the construction of the buildings;
— Details of the electrical connections, measurements and controls, including all the procurement construction records, the types and quantities of the materials used in construction and the specifications of the components (e.g. the suppliers, weights, sizes and materials used);
— A list of the technical and safety documentation for preparing for decommissioning (i.e. safety reports, technical manuals, environmental assessments, radiological survey reports, decontamination procedures and reports, and technical specifications);
— The radiological characteristics and dose rates;
— Abnormal occurrence reports and surface and volume activity levels (i.e. contamination);
— The documentation and procedures for work breakdown structures.

The V1/V2 nuclear power plant reactors were constructed and operated after the requirements for safety documentation were issued but before the requirements for data management were instituted. For these nuclear power plants there is probably a good complete data set, but there is an insufficient record keeping system. It is difficult to find data to support its decommissioning as they are kept in a paper form together with a great amount of other data. During the preparation of the conceptual decommissioning plan some data were evaluated and simple databases were created, but these are available only at supporting organizations.

## I.M–4. MEASURES FOR THE IMPROVEMENT OF THE RECORD KEEPING STATUS

Although operational record keeping and information systems exist for each nuclear power plant and nuclear installation in Slovakia, these systems are not fully suitable for decommissioning purposes. The requirements for the management of independent record keeping for decommissioning from the start of operations were issued only recently and are very general. These new requirements have not yet been fully implemented and no central decommissioning records file is available.

Some records that may be important for decommissioning are, for a number of reasons, stored in various locations (e.g. the radiological survey is stored by the regulatory body and the component material size and weight evaluations are stored by the contractors), while some will be archived in a central location. For those documents stored away from the central archive there should be a reference in the central archive to this fact and details of where they can be found. The number of instances of records not stored centrally should be reduced and a centralized approach for record keeping initiated.

The experience gained should result in amendments to the existing legal basis. The inspection activities of the regulatory bodies should be more focused on QA for the data necessary for the preparation of decommissioning plans. The unified system of data management developed for the A1 NPP should be established for each individual nuclear installation and provided with adequate data.

# Annex I.N

## SPAIN: RECORD KEEPING CRITERIA AND EXPERIENCE IN THE VANDELLOS 1 DECOMMISSIONING PROJECT

### I.N–1. INTRODUCTION

Since data in a decommissioning project are generated by a variety of different sources there is a need for their collection and transfer.

Record keeping for a decommissioning programme has two main aspects:

- The maintenance of the records from the design and operation of a plant needed to facilitate its decommissioning. These data are available in most cases on paper.
- The maintenance of the postdecommissioning records and the process used to secure the information. It is convenient to have a computerized database system for the collection and retrieval of this information. The accessibility of the knowledge, techniques and information for decommissioning is an important factor for the success of a record keeping system.

It is intended that the system will provide those who do the decommissioning with qualified data from previous and ongoing decommissioning work, for example information on the time spent on the work, waste arisings, costs and radiation exposures.

### I.N–2. PRACTICAL EXAMPLE (VANDELLOS 1)

#### I.N–2.1. Description

Vandellos 1 nuclear power plant, which is a 497 MW, graphite moderated, gas cooled reactor, is Spain's first nuclear power plant dismantling project. ENRESA, which is a management company, prepared the necessary decommissioning and dismantling plan, which was reported on favourably by the Nuclear Safety Council and approved by the Ministry of Industry.

The Vandellos 1 decommissioning programme foresees the dismantling of all the installations except the reactor building (known as level 2 decommissioning), followed by a safe storage period of some 30 years, after which the reactor itself will be dismantled and the site remediated for reuse.

Prior to these activities, HIFRENSA, the plant owner, removed the nuclear fuel and conditioned the radioactive waste from the operating phase.

### I.N–2.2. Data collection

As a part of the decommissioning project, ENRESA collected and analysed the historical information and data from the operations of the plant and performed a pre-decommissioning radiological characterization of the plant. The aim of this project was to compare information from the two sources. The documents were mostly on paper, and included drawings of the plant as built, safety analysis reports, radiological survey reports, abnormal occurrence reports, design changes and updated drawings, spent fuel pool water analysis results, decontamination experience and operational waste data.

At the same time, workers employed at the plant when it was in operation were contracted by ENRESA to gather their knowledge and operational experience.

### I.N–2.3. Management data and information

During the dismantling operation a large amount of information was generated. This information covers many areas, including technical, organizational and planning matters. The available information exists both on paper and in a digital format.

Actual technical data from the dismantling operations were registered, evaluated and incorporated into the system.

#### *I.N–2.3.1. Records of the basic design of the organization and project planning*

These records are:

— The general organization and planning chart;
— Organization guides for each department (e.g. for jobs, functions, procedures, reports, training and the budget).

Information is recorded mainly on paper, using Microsoft Excel or Microsoft Project software.

#### *I.N–2.3.2. Records of procedures and reports*

These are basic documents and procedures and are composed of three groups:

— Operations and maintenance security documents, which are based on the procedures of the previous operator and have been adapted by ENRESA.
— Administrative QA documents, which are based on the procedures of ENRESA: these are reviewed and adapted, where appropriate.

— Execution engineering documents, which are composed of new procedures with new functions and activities.

The information is recorded mainly on paper and in Microsoft Word. It is catalogued in a specific information system that has been developed by ENRESA and is known as SGD.

*I.N–2.3.3. Records of technical data*

These are the records of:

— The management of the decommissioning process, including records of:
  - The identification and classification of materials.
  - Temporary storage.
  - The control of radioactive waste.
  - The control of declassified materials.
  - The control of conventional materials.
  - The control of transport.
— The safety and radiation protection management system.

Information is recorded in a digital format in the waste management information system (SGR).

*I.N–2.3.4. Records of administration information*

These are the records of:

— The documentation management system (SGD). This has different functions, for example registering, coding and distributing information, and procedure control.
— The financial management system.
  - The management of suppliers.
  - Budgetary control.
  - The financial management of projects.
  - Fixed asset management.
— The storage and maintenance system.
— The communication management system, including the information centre and relations with other organizations.
— The human resources system.

The information is recorded in a digital format in specific management information systems.

### I.N–2.4. Work teams

To determine which types of information will be useful to future D&D and to maintain it properly in a useful record, ENRESA has developed company management systems for use with work teams and committees.

### I.N–2.5. Maintenance

It is required that information be migrated each time computer formats change (approximately every 5 to 10 years). The advantage is easy access to the data, that information can be worked on more efficiently and that data can be protected against degradation.

Paper records will also be maintained at least until the total decommissioning stage.

### I.N–2.6. Knowledge management

Knowledge management will be the last step of the level 2 decommissioning of Vandellos 1. ENRESA is selecting from this data collection information and work teams and preparing the databases and systems that will serve as the final record keeping system.

The objective is to use the Vandellos model for future decommissioning projects and to keep a record of all the main activities carried out at Vandellos 1.

## Annex I.O

## SWEDEN: RECORD KEEPING CRITERIA AND EXPERIENCE IN DECOMMISSIONING PLANNING FOR BARSEBÄCK 1

### I.O–1. BACKGROUND

#### I.O–1.1. Nuclear power plants and other nuclear facilities in Sweden

The total net output of nuclear power in Sweden is about 10 000 MW(e). There are 12 nuclear power units in Sweden [I.O–1–4], of which three are at Forsmark, four are at Ringhals, three are at Oskarshamn and two are at Barsebäck. The Barsebäck 1 plant is no longer in service and was shut down in 1999.

Other nuclear facilities include:

— The R2 reactor at Studsvik, which is a research reactor that has been operational since 1959;
— The R3 Ågesta combined heating and power plant (CHPP), which is a heavy water reactor that operated from 1964 until 1974;
— The fuel factory at Westinghouse Atom AB;
— The Ranstad plant (owned by Ranstad Mineral AB), which processes uranium;
— CLAB (the Central Interim Storage Facility for Spent Nuclear Fuel) at Oskarshamn, which has been operational since 1985;
— SFR (the Final Storage Facility for Radioactive Waste) at Forsmark, which has operated since 1988.

#### I.O–1.2. Ownership of and agreements for Barsebäck 1 and 2

The plant assets of Barsebäck 1 and 2 are owned by Sydkraft AB [I.O–3].

In accordance with an agreement between Sydkraft AB and Barsebäck Kraft AB:

— Sydkraft is the owner of the Barsebäck plant and is responsible for its future demolition, the spent fuel and the demolition waste.
— On behalf of Sydkraft, Barsebäck Kraft AB will deal with the shutdown and service operations of Barsebäck 1 and will use Barsebäck 2 to produce electric power for Ringhals NPP. Sydkraft will take 26% of the electric power production of Barsebäck 2.
— The Swedish regulatory bodies SKI (Statens Kärnkraftinspektion, the Swedish nuclear power inspectorate) and SSI (Statens Strålskyddsinstitut, the Swedish

national institute of radiation protection) have decided that the licences to operate Barsebäck will be held by Barsebäck Kraft AB. All official contacts will take place between these parties.
- As directed by Sydkraft, Barsebäck Kraft AB will be responsible for producing a plan for the shutdown and service operations, dismantling and disposal of the spent nuclear fuel.

### I.O–1.3. Barsebäck Kraft AB's organizational structure

The following departments are at the disposal of the station manager:

- BF, which deals with the service operation and strategy, and has total responsibility for Barsebäck 1 (about 25 employees).
- BP, which deals with production, and has total responsibility for Barsebäck 2.
- BT, which deals with engineering, and is responsible for new installations, analyses and materials testing.
- BS, which deals with service, and is responsible for preventive and remedial maintenance.
- BA, which deals with administration, and is responsible for the purchase of materials and services, information technology and documentation management, etc.
- BQ, which deals with quality and safety, and is responsible for quality audits and the independent security of nuclear operations at Barsebäck Kraft AB.

## I.O–2. THE SWEDISH MODEL

Svensk Kärnbränslehantering AB (SKB) is responsible for the long term management of all radioactive waste in Sweden [I.O–5] and is owned by the Swedish nuclear generating companies. These companies are legally obliged to take care of all nuclear waste, including operational and demolition waste and spent nuclear fuel.

## I.O–3. THE DECOMMISSIONING STRATEGY FOR BARSEBÄCK

The owners have taken the following strategic decision on the future dismantling of Barsebäck 1 [I.O–6] (Fig. I.O–1):

- The dismantling of Barsebäck 1 will not be performed while Barsebäck 2 is still operational. On the basis of a 40 year life, Barsebäck 2 will not be shut down before 2017.

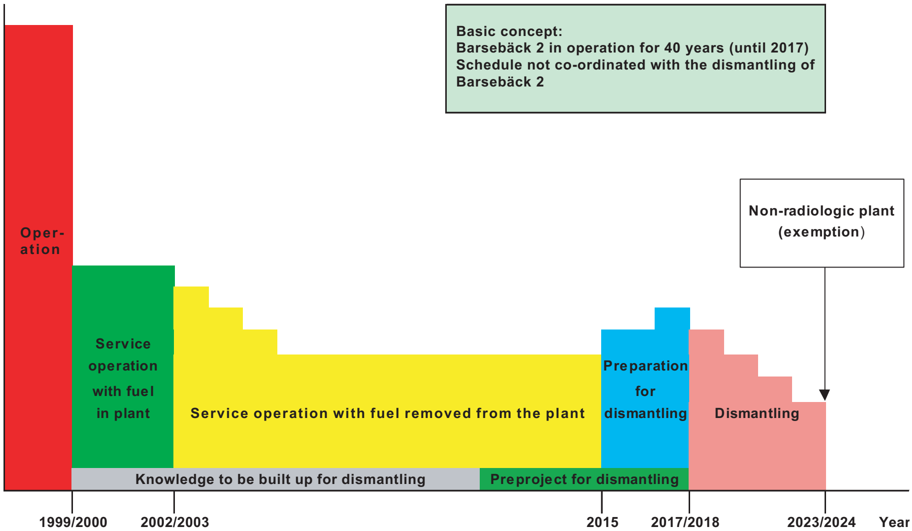


*FIG. I.O–1. Schematic schedule for the dismantling of Barsebäck 1.*

— SFR 3, which is the final storage facility for the short lived demolition waste, is planned for completion in 2015.

These decisions form the basis of the present plans, meaning that the dismantling of Barsebäck 1 will not begin until 2017 or 2018 at the earliest.

## I.O–4. DOCUMENTATION MANAGEMENT AT BARSEBÄCK KRAFT AB

### I.O–4.1. Rules and requirements concerning the documentation

Documentation management at Barsebäck Kraft AB [I.O–7–9] is mainly governed by the requirements of the authorities: the SKI and SSI, among others. An independent security department, BQ, checks that the requirements of the authorities are fulfilled. The BQ department reports directly to the station manager.

Table I.O–I is based on the Swedish regulations [I.O–9].

The documents held in Barsebäck's archives go back to the time of the construction of the plant.

#### *I.O–4.1.1. Storage media*

The following storage media are used at Barsebäck:

TABLE I.O–I. EXAMPLES OF THE TYPES OF DOCUMENT AND THE PERIOD FOR WHICH THEY ARE STORED

| Document type | Storage period |
|---|---|
| System descriptions | Long term storage |
| Diagrams and specifications | For the life of the plant |
| Object and component documentation | For the life of the plant |
| Installation documentation | For the life of the plant |
| Operational documentation | For the life of the plant |
| Analysis and calculation documentation | For the life of the plant |
| Building documentation | Long term storage |
| Safety reports | For the life of the plant |
| Inspection documentation | For the life of the plant |

**Note:** The term 'life of the plant' means the period for which nuclear engineering operations take place. Long term storage means more than 100 years.

— Paper. The signed paper original must be handed in for archiving.
— Microfilm. Microfilmed documents do not qualify as originals and are therefore not archived.
— CDs, diskettes. Software for equipment in the plant stored on diskettes or CDs is archived in special data cabinets.
— X ray films. X ray films are archived in special data cabinets.
— VHS tapes. VHS tapes are archived in special data cabinets.

*I.O–4.1.2. Archive premises at Barsebäck Kraft AB*

Barsebäck Kraft AB has five archives and a number of document and data cabinets that meet the requirements of the authorities.

**I.O–4.2. Documentation project started after the closure of Barsebäck 1**

The projects described below were started by Barsebäck Kraft AB in order to ensure that decommissioning would be as safe and economical as possible.

*I.O–4.2.1. Radioactivity, dismantling masses and volumes*

The purpose of the project is to record the radioactivity content of the systems, subsystems and buildings of Barsebäck 1 and the demolition masses and volumes. The results are to be used when decommissioning the Barsebäck 1 plant in order to:

— Determine the needs, scope, methods and times for the decontamination of process systems and parts of the buildings;
— Plan the resource requirements, time required, costs of dismantling systems and buildings, waste handling, and interim and final storage;
— Estimate the amount of scrap and dismantling waste, divided into categories by material and radioactivity content;
— Minimize doses to individuals.

*I.O–4.2.2. Building documentation*

The purpose of the project is to list and secure the building documentation and to identify that required for the future dismantling of Barsebäck 1. The assignment also includes checking the storage media currently in use in Barsebäck's building documentation archives. This is important, because it must be possible to use and read the documentation in the decommissioning phase. The resources used for this are those individuals who have been involved in the construction of Barsebäck 1 from the outset, both contractors and employed personnel.

### I.O–4.3. Management system

In order to be able to make large inventories quickly and efficiently it is essential to have access to a database that can communicate with the different modules in a management system. At Barsebäck the management system is supplied by IFS Sverige AB and is based on an Oracle database. The documentation module went into service in 2001 and is intended to facilitate searching through the hundreds of thousands of registered documents. Not all of these documents are of interest for decommissioning, so it must be possible to flag those in the database that are of interest for future use. It is important that data be held at only one location, as having it in multiple locations increases the risk of errors. It is therefore important to be able to perform QA on the information and data in accordance with the prescribed routines.

Barsebäck Kraft AB's management system comprises the following modules:

— A plant register module;
— A preventive maintenance module;
— A failure reporting and work order module;
— A module for licences and delimitations (i.e. for work permits and process and electrical delimitations);
— A safety permit module (for gas, radiation and fire permits);
— A stores module;
— A documents module (this came into service in 2001).

## I.O–5. NATIONAL EXPERIENCE IN THE AREA OF DOCUMENTATION

### I.O–5.1. Dismantling plan for Ågesta CHPP

The R3 Ågesta CHPP, which is a heavy water reactor [I.O–10, I.O–11], went into service in 1964. In its final form R3 was a pressurized heavy water moderated and cooled reactor. The calculated output was 65 MW in the first phase: 55 MW for district heating and 10 MW for electricity production. The reactor is embedded in the bedrock of the site. The district heating was provided to the nearby Stockholm suburb of Farsta. The main parties involved in the construction of R3 were AB Atomenergi (jointly owned by the State and industry, with the State having the majority holding), Vattenfall, ASEA and Stockholms Elverk.

R3 was taken out of service in 1974. Since then the fuel has been unloaded and all the radioactive operational waste has been removed from the plant. The above ground buildings have been scanned for radioactivity and classified as free from contamination and the process of returning the site to the owner has been initiated.The remaining part of the plant, in which radioactive material exists, therefore consists solely of the part inside the containment, situated in the bedrock.

A decommissioning plan for Ågesta CHPP has been drawn up by the owners, Vattenfall AB and AB SVAFO, and submitted to the SSI. The dismantling plan for Ågesta CHPP [I.O–10] was produced by Westinghouse Atom AB.

One part of this dismantling plan concerns documentation; in accordance with the plan an inventory was made in order to determine the location of the information that will be needed in the dismantling phase.

The documentation relating to Ågesta is located mainly in Studsvik's drawing archive, Vattenfall's drawing archive at Råcksta, Vattenfall AB's central archive, Stockholm Energi's drawing archive and the central archive of Westinghouse Atom AB in Västerås.

Some of the documentation that has been located includes:

- Original drawings, including drawing lists (at AB Atomenergi). However, the supplier, ASEA (as the company was known at the time), made its own drawings, so it is not certain that AB Atomenergi's original drawings correspond to the facility as built.
- The list of installation drawings.
- Installation drawings for the reactor building (at Vattenfall).
- Installation drawings (at ASEA).
- System descriptions of the reactor (at Vattenfall).
- System descriptions (at ASEA).
- Component drawings for the reactor.
- Original drawings of equipment, including the list of drawings (at Vattenfall) (e.g. for the cooling system, airlock doors and cleaning station).

— Original drawings of equipment, including the list of drawings (at ASEA).
— Technical assembly descriptions, including inspection reports for components (at Vattenfall).
— Instructions and protocols for the inspection of components and equipment.
— The originals of all building drawings.
— The operating instructions.
— The details of the radiation levels in the reactor pressure vessel.
— The radiological mapping and estimation of waste volumes.
— The electrical drawings for the control and switchgear systems.
— The lighting drawings for the reactor building.
— The descriptions and diagrams of the switchgear.
— The pipework drawings. These were found in the heating, ventilation and sanitation museum at Katrineholm.
— Other documents, such as studies by, among others, AB Atomenergi, dismantling studies, concession documents, contracts, the manufacturing follow-up, assembly plans and handover documents.

The following documents have not yet been located:

— The dimension drawings for inside the containment, as well as section drawings.
— Details of the electrical installations.
— Details of the ventilation installation.
— Drawings of the inside of the containment building.
— The installation and dimension drawings for the control system.

As stated in the dismantling report [I.O–10], however, the records essential for the future dismantling have been located and identified.

## I.O–6. LEARNING AND EXPERIENCE AT BARSEBÄCK

Over the short period that has passed since Barsebäck 1 was closed in November 1999 it has become apparent that the information possessed by personnel is valuable and extremely important for the decommissioning of the plant. Personnel in this case refers to all those present while the plant was under construction and during its operation. Since the number of employees may decline quite rapidly after a plant is closed, it is extremely important to utilize their knowledge and document it as soon as possible.

## REFERENCES TO ANNEX I.O


[I.O–1] BARSEBÄCK KRAFT AB, Kärnkraft — svarar för en Betydandedel av Sydkrafts Elproduktion, Barsebäck Kraft AB, Sydkraft (1999).

[I.O–2] STATENS KÄRNKRAFTINSPEKTION, Kärnkraftens Historia, SKI, Stockholm (1999).

[I.O–3] BARSEBÄCK KRAFT AB, Tillämpningsbestämmelser Angående Kvalitet och Säkerhet Samt Avställnings- och Servicedrift vid Barsebäcksverket, Barsebäck Kraft AB, Sydkraft (2000).

[I.O–4] HEDIN, G., Studie av Rivningslogik för Nukleära Anläggningar i Sverige, Rep. SP 00-129, Rev. 0, Westinghouse Atom AB, Västerås (2000).

[I.O–5] SVENSK KÄRNBRÄNSLEHANTERING AB, Om Sveriges radioaktiva avfall, SKB, Stockolm (1997).

[I.O–6] LORENZ, H., HÅKANSSON, J., Information Avseende Förberedelser och Planering i Samband med Avvecklingen av Barsebäck 1, Rep. F-200006-22, Barsebäck Kraft AB, Sydkraft (2000).

[I.O–7] STATENS KÄRNKRAFTINSPEKTION, Statens kärnkraftinspektions Författningssamling, Rep. SKIFS 1998:1, SKI, Stockholm (1998).

[I.O–8] BARSEBÄCK KRAFT AB, Dokumentationshandbok, VD60, 2001 issue, Barsebäck Kraft AB, Sydkraft (2001).

[I.O–9] STATENS STRÅLSKYDDSINSTIT, Arkivering vid Kärntekniska Anläggningar, Rep. SSI-FS 1997:1, SSI, Stockolm (1997).

[I.O–10] HEDIN, G., FREDRIKSSON, E., Rivningsplan för Ågesta Kraftvärmeverk, Rep. SP 00-068, Rev. 0, Westinghouse Atom AB, Västerås (2000).

[I.O–11] LEIJONHUFVUD, S., En historia om Svensk Kärnkraft, ABB Atom, Västerås (1994).

## Appendix to Annex I.O

## THE SWEDISH RADIATION PROTECTION INSTITUTE'S REGULATIONS ON RECORDS MANAGEMENT AT NUCLEAR PLANTS

The following extracts are taken from the Swedish Regulations issued on 22 April 1997[1].

On the basis of paragraph 7 of the Radiation Protection Ordinance (1988:293) the Swedish Radiation Protection Institute has issued regulations as follows:

**Para. 1:** These regulations apply to the filing of documentation that is drawn up or received in connection with the practice at nuclear plants.

**Para. 2:** The licence holder shall keep archives in which documentation related to the radiation protection aspects of the practice shall be filed. The documentation shall contain, as a minimum, that stated in Table I.O–II. Sorting out documentation in excess of that shown in Table I.O–II may only be done after consultation with the Swedish Radiation Protection Institute. For any documentation that is revised, the latest version should be taken into account.

**Para. 3:** The archives shall be handled and preserved so that all information is readable and, if necessary, transferred on to new storage media. In creating the documentation, materials and methods shall be selected that comply with the applicable regulations of the National Archives of Sweden (applicable regulations RA-FS).

Documentation that may be difficult to read due to ageing shall be transferred on to new media before defects occur. In that process, it shall be ensured that the information is correctly transferred.

**Para. 4:** The documentation shall be stored in cabinets or archive premises that comply with the regulations of the National Archives of Sweden.

**Para. 5:** If the practice ceases, the archives shall be registered and handed over to the National Archives of Sweden or a regional archive.

[1] These regulations came into force on 1 July 1997.

TABLE I.O–II. DOCUMENTATION TO BE FILED OR THAT COULD BE SORTED OUT RESPECTIVELY

| Type of documentation | Filing period[a] |
|---|---|
| Application for a concession, licence or a description of an environmental impact or an accident | Long term |
| Prerequisites of construction, plant description and the final safety analysis report (ASAR) | Long term |
| Radiation protection related local instructions and instructions for use in the event of a disturbance | 50 a |
| Reported events of significance for radiation protection | 50 a |
| Radiation protection instructions | 50 a |
| Individual doses | Until the individual is, or would have been, 75 years old; however, no less than 30 years after the individual ceased to work with ionizing radiation |
| Instructions for use in the event of an accident or preparedness plans | 25 a |
| Reports on protection and annual reports according to paragraph 32 of the Swedish Radiation Protection Institute's regulations SSI FS 1994:2; see also official letters (SSI registration numbers 8200/3315/94 (13 December 1994) and 8200/1497/95 (9 May 1995)) | 25 a |
| Environmental specimens (air, water, soil and organic specimens) | |
| Results of measurements on environmental specimens | Long term |
| Documentation on radioactive waste, their properties, treatment and final disposition | Long term |
| Documentation on radioactive waste that is stored or raised at CLAB shall be filed at the plant as long as the waste is there. When the waste is transferred to a final repository, the responsibility for filing documentation is also transferred to that plant (e.g. the SFR) | |

[a] The 'Filing period' is the period of time to keep the document after it was filed. Long term means at least several hundred years.

## Annex I.P

## UNITED STATES OF AMERICA: RECORD KEEPING FOR DECOMMISSIONING

### I.P–1. INTRODUCTION

There are two sets of key decommissioning records in the USA: those that are essential for planning the D&D of a facility and those that are the result of the decommissioning process itself. In some cases the regulatory authorities require that the licensees keep records for decommissioning, while in others they only advise that they may be useful. In this annex some important aspects of record keeping for decommissioning are highlighted.

### I.P–2. IMPACT OF IMMEDIATE AND DEFERRED D&D STRATEGIES

The selection of a D&D strategy for a particular facility will affect its record keeping needs. When a facility is shut down the process of ensuring appropriate records be kept for D&D should be the joint responsibility of the facility user and the D&D organization.

Immediate dismantling should result in adequate records to support the D&D being available. With good planning from the shutdown through and into the D&D all records should be available to support the transition to the D&D phase.

Deferred dismantling, however, poses a problem with regard to D&D records. The method used to save the records (i.e. on paper, in a digital format, etc.) is critical in determining how useful the records will be in the future. The issue of who is to maintain the records also needs to be addressed. Over time record keeping methods will and must change. Since the D&D is deferred and personnel will be gone, as will recent knowledge of operating experience, it is critical to ensure there be no lapses in the documents retained. A key issue here may really be how the records are saved — as hard copies, scanned images or by some other electronic means.

### I.P–3. REGULATORY RECORD KEEPING REQUIREMENTS FOR DECOMMISSIONING

Various regulatory agencies provide general guidance on the types of information that should be maintained by an operator or licensee for the eventual decommissioning of a facility. Although the regulations are specific to certain types of facility, in general these records are useful to any nuclear facility licensee involved in decommissioning [I.P–1]. For commercial nuclear power plants these requirements are specified in Federal regulations, which direct that those records important for safe and effective decommissioning should be kept in a central location for future use until the licence is terminated by the regulator. Some specific records to be preserved include the:

— Records of the levels and locations of radiation and/or radioactivity and the quantities of specific radionuclides present in the areas that are to be decommissioned;
— Records of spills or other unusual events that have occurred over the operating lifetime of the facility;
— Up to date drawing files (including of experimental apparatus);
— Records of the potential locations of inaccessible contamination.

These centrally located files for decommissioning should be located in a clearly identified area and designated as containing records and information pertinent to decommissioning. Facility operating procedures should clearly identify the need and responsibility for collecting, maintaining, updating and retrieving these decommissioning records. These records should be periodically reviewed by the management of the facility to ensure that they are complete and will be able to support eventually the intended decommissioning activities.

There may be other records that may be important for decommissioning but which are maintained in a different location for any of a number of reasons. If this is so, there should be a reference in the central D&D records file to this fact and also a reference to where these records can be found.

A special problem is often posed if the facility has been used for research purposes, as many of the experiment arrangements may not be well documented in the design or as built drawings. Another difficulty encountered is that the record keeping may be different from that used when the facility was operational. In other words, the record keeping requirements may have changed or there may be security reasons why certain records were not kept or made available.

## I.P–4. REGULATORY RECORD KEEPING REQUIREMENTS FOR DECOMMISSIONING

As a result of a 1989 audit of the decommissioning activities of the NRC several recommendations were made for decommissioning records. The results of the audit recommended that the NRC obtain and keep decommissioning records for a period of time longer than the 10 years for which they had previously been kept. The NRC agreed with this recommendation and established a new, uniform records retention period of

20 years after the licence termination for reactor and materials licences and a permanent retention of all records determined to have significant historical value [I.P–2].

Appendices A and B of Ref. [I.P–2], which are reproduced as Appendices I and II of this annex, give details of the records that a regulator may consider to comprise the D&D segment in a licensee file.

## I.P–5. LICENSEE RECORD KEEPING FOR D&D

Many of the same operational records that describe or document how well a facility is operating are also the most useful ones for planning the D&D of the same facility. These records will be useful for understanding the operating characteristics of the plant and will point the D&D planners to specific areas that may or will require special attention in the D&D process.

Important records are developed and created during the life of a facility and throughout its closure process [I.P–3]. With each omission in record keeping there will be an addition risk and a certain element of the unknown that the workforce will then face in carrying out the decommissioning.

Some key construction records that should be kept include:

- The complete drawings of the facility as built;
- The photographs of the construction of the facility (with captions);
- The procurement construction records, including details of the types and quantities of the materials used during the construction;
- The specifications for equipment and components, including details of the suppliers, weight, size and materials of construction.

Some key operational records that should be kept include the:

- Safety analysis reports;
- Technical manuals;
- Environmental assessments;
- Power history;
- Radiological survey reports;
- Operating and maintenance procedures;
- Abnormal occurrence reports;
- Deactivation plans, procedures and reports;
- Technical specifications;
- Design changes and updated drawings.

Regulators may stipulate that some of these records are to be maintained in the technical specifications of the facilities' operating licences.

## I.P–6. LICENSEE RECORD KEEPING FOR D&D

The key records shown in Table I.P–I should be collected and preserved to provide a detailed record for decommissioning [I.P–3].

At many USDOE sites there are project data packages (PDP) prepared for each D&D project at the time that the project is completed [I.P–4]. The PDPs detail at a high summary level the key results, lessons learned, documents and events in the life of the completed D&D project. The PDP is often used to prepare the final report for the project's sponsor and the institutional record. The PDP typically contains:

- The project title, identification and authorization;
- The physical, radiological and hazardous material characterization and analysis reports;
- The project management plan;
- The environmental compliance documentation;
- The decommissioning technical plan;
- The design reviews and safety evaluations;
- The waste management data;
- The detailed work procedures;
- The readiness reviews and assessments;
- The radiological survey records;

TABLE I.P–I. KEY RECORDS TO BE COLLECTED AND PRESERVED

| Phase | Record |
|---|---|
| Planning phase | Environmental assessments<br>Environmental impact statements (if required)<br>Decommissioning plans<br>Activity specifications<br>Project management plans<br>Funding plans<br>Cost and schedule estimates<br>Characterization surveys |
| Dismantlement and restoration phase | Detailed work procedures<br>Safety analysis reports<br>Periodic status reports<br>Final site survey reports<br>The final project report<br>Licence modifications and terminations |

— The property disposition records;
— The release criteria;
— Special problems and solutions;
— The incident reports;
— The cost and schedule status reports;
— The final radiological and chemical survey reports;
— The independent verification survey reports;
— The release restrictions;
— The project final report;
— The record of completion;
— The supporting engineering documents;
— Public notices.

The PDP is retained by the site operator and a copy is provided to the USDOE. After five years the PDP is archived in the US Government Archives as per USDOE requirements. Among the contents of the PDP are a copy of the final site survey and decommissioning plan, which details the following points:

— A summary of the survey unit measurements (survey unit averages);
— Hot spot areas;
— A survey instrument description and calibration records;
— Records of data reductions and comparisons with guidelines;
— Results of any investigations to determine the cause of elevated measurements and failures to meet criteria;
— Results of site inspections, meetings, reports and correspondence;
— Results of closeout inspections and surveys, including the split-spoon samples that were collected and evaluated;
— The completed materials licence termination/retirement form.

## I.P–7. RECORDS MANAGEMENT CENTRE

The most effective method for the management of records in our experience is to have a centralized office (a records management centre or RMC) in which the records management function is controlled. Under optimal conditions this would be an organization independent of the project team that can ensure that the proper protocols are used to add to, update or remove records from the central records centre. The work control centre, which directs the day to day decommissioning activities, draws all the pertinent details for project implementation from this centre. Fig. I.P–1 graphically depicts the interactions between the parties involved in record keeping.

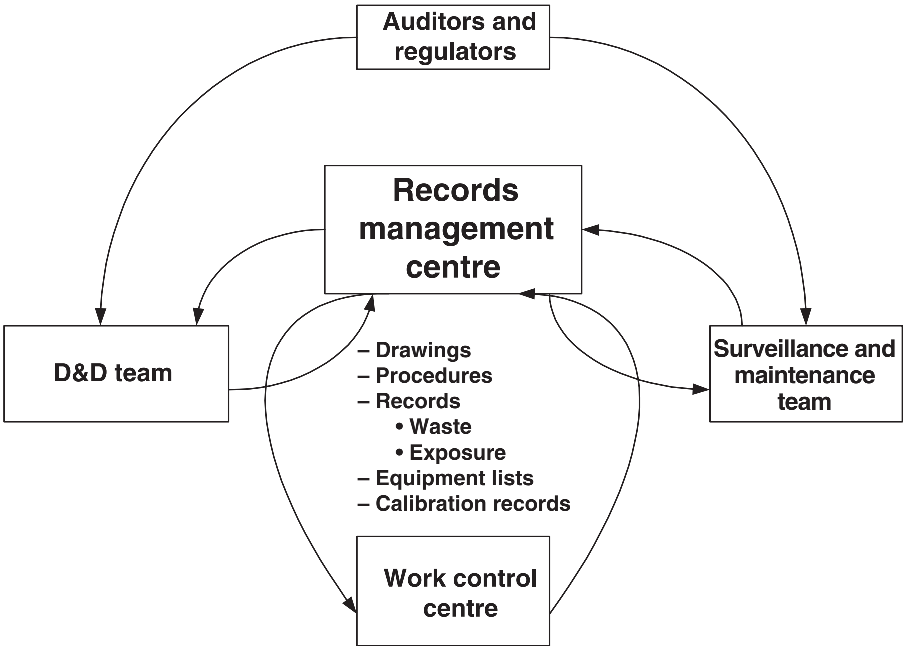


*FIG. I.P–1. Interactions between the parties involved in record keeping.*

## I.P–8. RECORDS MANAGEMENT TECHNIQUES

Records for and from D&D can be stored based on the actual D&D approach to be implemented: many D&D entities still use a central work control centre (WCC) for D&D in which all procedures, plans and records for the project are centralized. The WCC can be thought of as a subset of the RMC. Other entities may have additional copies of project records, but the WCC maintains a central file that is the record for the project. The storage locations are documented in the project QA plan. The distribution of revised copies and mark-up drawings, etc., is controlled by the RMC and WCC in compliance with the project QA plan.

Many organizations still use paper copies of drawings and other procedures and plans. These approaches are acceptable; however, some sites are transferring to more advanced systems for their record keeping functions. One example of this is a system such as the STREAM system for record keeping and for providing access to the project and records of the facility for the entire project team [I.P–5].

STREAM is a multimedia database that consolidates many of the project information and data sets into a single easily accessible place for day to day work performance and management tracking. Information inputs can range from procedures, reports and references to waste generation to logs, photographs and contaminant survey maps. Key features of this system are quick and easy information organization and retrieval, versatile information display options and a variety of visual imaging methods. These elements have been found to enhance productivity and compliance and facilitate communication with project staff, clients and regulators. This tool also gives visual access, which reduces the number of entries into contaminated work areas. STREAM can support up to 50 different workstations. STREAM was recently used on a D&D project at Hanford and proved to be very successful.

## I.P–9. LONG TERM RECORDS MANAGEMENT

Records may be maintained by using either a conventional or advanced RMS for the control and retention of drawings and documents. The typical project would use a shelved filing system that maintains hard copies or paper copies of the relevant records. As decommissioning work progresses the records are updated to reflect the progress made.

Some advanced information management systems, such as STREAM and others, have recently come on to the market. These systems are more commonly used on larger projects, although it is not unusual to find them being used on smaller projects.

If deferred dismantling is being planned as the decommissioning approach, the decision on which system is to be used for records management can impact upon how (in the future) the decommissioning will proceed.

## Appendix I to Annex I.P

This appendix, reproduced from Appendix A of Ref. [I.P–2], gives details of the records that a regulator may consider to comprise the D&D segment for a licensee file for a reactor. The documents listed below should be maintained separately within the official case file for permanent retention:

— Applications for possession-only licences;
— Possession-only licence amendments and any associated technical specifications;
— D&D plans and associated technical specification changes;
— Requests for additional information on possession-only applications and D&D plans and all responses from licensees pertaining to requests for additional information;
— Federal Register Notices for possession-only applications and D&D plans;
— D&D orders;
— Final site surveys by licensees;
— Final site surveys by regional inspectors;
— All licence amendments and associated technical specification changes following the initial application by the licensee for possession-only licenses;
— All documents related to financial assurance for decommissioning, including decommissioning funding plans, certifications of financial assurance for decommissioning, related cost estimates and records of funding methods;
— Records of spills and other unusual occurrences involving the spread of contamination in and around the facility, equipment or site;
— Licence termination orders and associated safety evaluations;
— As built drawings and modifications of structures and equipment in restricted areas in which radioactive material was used or stored and locations of possible inaccessible contamination;
— Any additional documents that refer to decommissioning, decontamination or the termination of the licence, including the interim or partial decommissioning of specific facilities at any time during the history of licensed operations.

## Appendix II to Annex I.P

This appendix, reproduced from Appendix B of Ref. [I.P–2], gives details of the records that a regulator may consider to comprise the D&D segment for a licensee file for materials. The documents listed below should be maintained separately within the official case file for permanent retention:

- All licence applications, amendment requests and renewal requests;
- The complete licence, including all amendments;
- The termination amendment;
- Any licensee request for licence termination and all supporting documentation, including plans for the completion of decommissioning;
- Forms dealing with the disposition of material (NRC/Atomic Energy Commission Form 314, AEC Form HQ-277 and others) and/or letters from licensees dealing with disposition and the status of material;
- Reports of NRC closeout inspections;
- Letters of certification from NRC officials granting the termination of the licence;
- Any closeout survey by the NRC, the licensee or a contractor working for either the NRC or the licensee;
- Any additional documents dealing with the disposition of the waste or other material or residual contamination on the site, including records of on-site burials;
- All documents related to financial assurance for decommissioning, including decommissioning funding plans, certifications of financial assurance for decommissioning, related cost estimates and records of funding methods;
- Records of spills and other unusual occurrences involving the spread of contamination in and around the facility, equipment or site;
- As built drawings and modifications of structures and equipment in restricted areas in which radioactive material was used or stored and locations of possible inaccessible contamination;
- Any additional documents that refer to decommissioning, decontamination or the termination of the licence, including the interim or partial decommissioning of specific facilities at any time during the history of licensed operations.

## REFERENCES TO ANNEX I.P


[I.P–1] NUCLEAR REGULATORY COMMISSION, Records Important for Decommissioning of Nuclear Reactors, Task DG-1006, NRC, Washington, DC (1989).

[I.P–2] NUCLEAR REGULATORY COMMISSION, NMSS Handbook for Decommissioning Fuel Cycle and Material Licensees, Rep. NUREG/BR-0241, NRC, Washington, DC (1997).

[I.P–3] AMERICAN NUCLEAR SOCIETY, American National Standard for Decommissioning of Research Reactors, American Nuclear Society, LaGrange Park, IL (1994).

[I.P–4] ARGONNE NATIONAL LABORATORY, Decontamination and Decommissioning Program Management Plan, Revision B-0, ANL, Argonne, IL (1998).

[I.P–5] UNITED STATES DEPARTMENT OF ENERGY, System for Tracking Remediation, Exposure, Activities and Materials (STREAM), Innovative Technology Summary Report, USDOE D&D Focus Area, Rep. DOE/EM-0376, USDOE, Washington, DC (1998).

## Annex II

## LESSONS LEARNED

The following examples present lessons learned, some brief technical details of each decommissioning project and a description of the problems encountered. The situations described are typical of the difficulties that can arise when planning or implementing decommissioning activities for which there are no appropriate records. The information presented is not intended to be exhaustive. The reader is encouraged to evaluate the applicability of the lessons learned to his or her specific decommissioning project. The general categories of problem and the relevant section in which they are discussed are shown in Table II–I.

TABLE II–I. CATEGORIES OF PROBLEM AND THE RELEVANT SECTION IN WHICH THEY ARE DISCUSSED

| Problem category | Section | Title |
|---|---|---|
| Lack of records | II–2 | Saxton reactor, USA |
| | II–3 | Trawsfynydd nuclear power station, UK |
| | II–4 | Berkeley nuclear power station, UK |
| | II–6 | Hot laundry, USA |
| | II–7 | Auxiliary reactor area II facility, USA |
| | II–12 | Buildings B47, B48 and B54, Harwell, UK |
| | II–14 | Jason reactor, UK |
| Unchecked or inaccurate records | II–1 | Ames Laboratory research reactor, USA |
| | II–5 | Janus reactor, USA |
| | II–9 | East Tennessee Technology Park (former Oak Ridge Gaseous Diffusion Plant), USA |
| | II–11 | Decommissioning of Italy’s old facilities |
| | II–13 | Niederaichbach NPP, Germany |
| | II–16 | Decommissioning record keeping experiences in the CEA |
| | II–17 | Vandellos 1 reactor, Spain |
| Wrong interpretation of records | II–8 | IRT-M research reactor, Belarus |
| | II–10 | AM-1 research reactor, Russian Federation |
| | II–15 | Korea research reactors |

## II–1. AMES LABORATORY RESEARCH REACTOR

### II–1.1. Problem

To assist in the proper alignment of the thermal shield of the Ames Laboratory research reactor [II–1] during its construction, the six vertical plates were tack welded together at several locations on the top and ends of the shield. The existence of the end welds was not anticipated as they were not shown on drawings or photographs. When visually checked, one could clearly see that the top welds were broken, but the end welds were not visible. On attempting to transfer the plates to the pool, the end welds between the five inside plates were found to be intact. Efforts by the contractor to break the welds in the tank were not successful, and the five plates were transferred to the pool as a unit.

### II–1.2. Solution

Attempts at mechanically breaking the welds with a chisel or saw did not succeed. They were separated with a plasma arc torch operated from above through six feet (1.83 m) of water. The planned procedure for segmenting the plates could then be followed.

### II–1.3. Lessons learned

Question or verify the drawings of the facility as built where possible. Extreme care is needed when using unchecked records.

## II–2. SAXTON REACTOR

### II–2.1. Problem

GPU Energy's Saxton Nuclear Experimental Corp. (SNEC) expects that the decommissioning of the Saxton facility [II–2, II–3] will cost about US $17 million more than the original 1995 estimate of US $22 million. This cost increase is mostly due to the removal of the low levels of radioactivity discovered in an underground steam discharge tunnel. SNEC plans to complete the project by mid-2001, but additional testing and review stemming from the discovery could add time to the NRC's review of the company's licence termination plan. In detail, GPU's historical survey of the Saxton site found unexpected contamination in a steam discharge tunnel about 30 feet (9.1 m) underground. The tunnel, which belonged to a coal fired plant that was on the site before Saxton was built, runs into the Raystown branch of the Juniata

River. Saxton, a research and training reactor, was shut down in 1972. SNEC will not have an exact assessment of the contamination levels until workers remove and test about 80 $m^3$ of water and about 30 $m^3$ of contaminated sediment.

### II–2.2. Lessons learned

A lack of contamination records can be a major issue in the decommissioning of older nuclear facilities and can have significant cost and schedule impacts.

## II–3. TRAWSFYNYDD NUCLEAR POWER STATION

### II–3.1. Problem

During the decommissioning of the Trawsfynydd nuclear power station [II–4] it was proposed to convert a workshop into a storage facility for heavy items. Structural drawings of the workshop building, particularly the extent of the reinforcing of the floor slab, were not available. This made it difficult to assess whether the workshop floor was capable of supporting the proposed loads.

### II–3.2. Solution

Core samples were cut from the floor and tests conducted to confirm the extent of the reinforcing and the load capability of the floor.

### II–3.3. Lessons learned

The drawings of structures as built should be included in the design and construction documentation retained for decommissioning. Although such drawings may have a limited use during operation, they are essential for decommissioning.

## II–4. BERKELEY NUCLEAR POWER STATION

### II–4.1. Problem

During the decommissioning of Berkeley nuclear power station [II–4] it was planned to lift each of the 16 main heat exchangers and move them intact to another location on the site. No definitive information on the weight of the heat exchangers was available from drawings or other sources. This information was required in order to plan the lifting process and ensure an appropriate lifting capacity.

### II–4.2. Solution

Special actions had to be taken to weigh a heat exchanger using a jacking system prior to starting the removal and to ensure an adequate lifting capacity.

### II–4.3. Lessons learned

Design and construction information (such as material or component specifications) should be documented and retained for use in the eventual decommissioning of a facility.

## II–5. JANUS REACTOR

### II–5.1. Problem

Early in the project for the Janus reactor [II–5, II–6] the wiring of two energized circuits (which were supposedly de-energized) was cut while dismantling the reactor control panels. After performing lock out/tag out on all identified circuits to the reactor control panels, technicians verified the procedure by performing voltage and current checks at the breaker panels. One live circuit was discovered and dismantling work was delayed until the circuit was removed by qualified electricians. The technicians then proceeded to cut the wires at the point where the wires entered the panels, instead of disconnecting the wires, pulling the wires free of the panel and then cutting the wires. The technician, as part of what he believed to be an added measure of safety, was checking each wire after he cut it to verify that it was de-energized.

This method led to two live wires being cut and subsequently capped with wire nuts. These wires had been installed in the early 1990s as part of the installation of an emergency power system. The emergency circuits had been incorrectly routed through the reactor control panels instead of through their own conduit. The problem was identified when it was noticed that, in the stairway, the exit lights were off while the emergency lights were on.

### II–5.2. Solution

The failure to disconnect and remove each wire as prescribed was the primary cause of the event. To prevent a recurrence of the problem the contractor provided additional electrical detection equipment, enhanced procedures and increased personnel hazard awareness. The severed wiring was rerouted through a new conduit and the proper emergency circuits were re-energized for the duration of the project.

### II–5.3. Lessons learned

There were three lessons learned from this event:

- The drawings of the facility as built do not always reflect the current conditions;
- The procedure should have been more detailed as to the method of wire removal;
- Personnel need to be continuously reminded that when conditions or events do not meet expectations, work must be stopped and management notified before work continues.

## II–6. HOT LAUNDRY, USA

### II–6.1. Problem

Containers of various chemicals were left at the Hot Laundry [II–7] when it was shut down in 1981. The labels on some of these containers were missing and some containers were in a poor physical condition. Since the chemicals were not identified and documented during the predecommissioning characterization, the disposal of these chemicals required considerable time and effort, which resulted in unanticipated costs and project delays.

### II–6.2. Lessons learned

Predecommissioning records and characterization should include the identification and documentation of stored chemicals in order to plan properly for their disposal.

## II–7. AUXILIARY REACTOR AREA II FACILITY, USA

### II–7.1. Problem

A radiological characterization of known or suspected radiologically contaminated areas at the auxiliary reactor area II facility [II–8] was performed in 1983 to provide data for hazard evaluation and waste disposal. Radiation surveys of the interiors of buildings and structures were performed and smear samples for detecting removable contamination were collected. Surface and subsurface soil samples were collected and analysed. Samples were also taken of building materials such as insulation, lumber, metal sidings and sheet rock to identify the extent of the hazards and to establish possible waste streams for the demolition process. Radiation surveys from the 1983 characterization indicated that most of the buildings contained no smearable (transferable) contamination. However, as the decommissioning progressed, it was discovered that most of the metal building had been painted over with a heavy metallic paint after the SL-1 reactor (Stationary Low Power Reactor No. 1) accident to fix contamination in place. It was also discovered during decommissioning that concrete caps had been poured over the top of the original floors to cover and fix the contamination in place. This is why the smears from the original survey were negative — the smears were collected from on top of the clean covers. The samples of insulation taken from the buildings also showed measurable contamination on them.

Additional surveys performed during the interior dismantlement process confirmed that contamination had concentrated behind the sheet rock walls and in the attic space of the buildings. All the building components in these spaces (lumber, insulation, sheet rock, ceiling tiles, electrical wiring and conduits) were contaminated above allowable release limits. All this material had therefore to be manually disassembled, size reduced, placed in waste boxes and disposed of at the Idaho National Engineering and Environment Laboratory low level radioactive waste burial grounds. Contamination was also found under the concrete floor caps and under the heavy metallic paint, which required that unexpected amounts of the metal structures and concrete from the buildings be sent to the Radioactive Waste Management Complex instead of being released or sent to the landfill site for disposal.

### II–7.2. Lessons learned

The characterization surveys performed before the project, both physical and radiological, are not always a good indication of the levels of contamination that will be found on the site or of the actual physical characteristics of the site. Those who do the decommissioning should be prepared to deal with these unknowns in the process. Incident occurrence and associated remediation reports are extremely valuable for future decommissioning.

## II–8. IRT-M RESEARCH REACTOR

### II–8.1. Problem

During the dismantling of the thermal column of the IRT-M research reactor it was planned to extract all the graphite blocks from the thermal column vessel. The works initially conformed with the project requirements in accordance with the drawings of the facility as built. However, after the removal of most of the graphite bricks it was detected that the remaining bricks had turned into a monolithic mass as a result of graphite radiation swelling and thermal column vessel distortion after 25 years of operation. The dismantling of the construction would demand the implementation of a complicated and laborious action involving graphite cutting in an unfavourable radiological work area.

### II–8.2. Solution

To minimize radiation doses to the personnel a new plan for dismantling was developed. Taking into account the decommissioning plan, which provided for the preservation of the reactor vessel and biological shielding, the solution was to create biological shielding for the thermal column. This was done by filling its niche with concrete blocks and covering them with concrete until the level of reactor vessel biological shielding was filled.

### II–8.3. Lesson learned

Even if well preserved as built drawings exist, other operational factors can impact upon dismantling options.

## II–9. EAST TENNESSEE TECHNOLOGY PARK (FORMER OAK RIDGE GASEOUS DIFFUSION PLANT), USA

### II–9.1. Problem

A three building D&D project is currently underway at the former Oak Ridge Gaseous Diffusion Plant [II–9]. This project entails the D&D of materials and equipment within the K-33, K-31 and K-29 buildings, which comprise over 5 million square feet (464 500 m$^2$) of floor space and contain over 325 million pounds (147 million kg) of metal. The equipment to be removed includes 640 converter units, 1540 compressors and motor units. The following incidents resulted from ‘as found/as built’ conditions that were not in accordance with the design of the facility or the expected conditions according to the as built drawings available during the decommissioning:

- While workers were dismantling two sections of ventilation ducts, one section unexpectedly came loose from the other and fell to the floor. The workers discovered that the ducts, which were designed to be interconnected with duct pocket locks, were not connected.

— A worker strained her shoulder while trying to unbolt a ventilation duct riser. The nut was tack welded, which was not the normal configuration for this type of bolt on the duct work.
— Workers believed that a section of piping being removed as part of asbestos abatement activities was adequately supported on two pipe supports. However, one of the pipe supports was not properly connected, which allowed the piece of pipe to fall after the workers had cut the pipe free.
— A worker making a cut in a section of structural steel assumed that the steel was anchored at its connection points as indicated in the structural design. However, the steel piece was not anchored (one side had no bolts and the other side had bolts without nuts) and as the worker was making the cut it fell and resulted in an injury.
— While workers removed a section of ductwork damper on a filter housing roof, the damper fell through the roof. The workers discovered that the bolts that normally connect the damper assembly to the filter house roof were missing.

### II–9.2. Solution and lessons learned

In each of these incidents the facility or equipment being disassembled was not in the condition expected as based on the design records of the facility. These incidents showed that the ‘as found/as built’ conditions of redundant components cannot always be assumed to be as shown on as built drawings.

## II–10. AM-1 RESEARCH REACTOR, RUSSIAN FEDERATION

### II–10.1. Problem

The AM-1 research reactor is a light water cooled, graphite moderated reactor. It is the oldest Russian research reactor, was started in June 1954 and has operated for over 45 years. A decommissioning plan has been developed. During the initial planning stage, the radioactive inventory definition, many samples of reactor materials were collected, including graphite sleeves of the spent control rod unit. According to the operational data the operation period for one of them is 44.5 years. Activity calculations consistent with this time period were performed, but agreement with experimental data for long lived nuclides was not reached.

### II–10.2. Solution

Discussions with operations staff, especially the older engineers and their assistants, confirmed a misunderstanding. The confusion occurred between the old and young sleeves, which are stored together and have negligible differences in construction. In fact, the operating period for the investigated sleeve was only 11 years, not the 44.5 years as expected. Calculations were corrected accordingly and a good agreement of the calculated and experimental results was achieved. If this misunderstanding had not been corrected, incorrect data would have been used for the development of the decommissioning plan, resulting in an overestimation of the radiation hazards from the reactor construction materials and associated radioactive waste.

### II–10.3. Lesson learned

For decommissioning purposes and proper identification, components should be marked with tags or other means before storage to provide clear identification. Consistent records of these marks should be available at all times.

## II–11. DECOMMISSIONING OF ITALY’S OLD FACILITIES

### II–11.1. Problem: As built documentation

A general verification of the plant status before decommissioning was made for all the reactors to be dismantled, based on documentation and in-field verification. Some general discrepancies were found that showed a generic as built problem.

#### *II–11.1.1. Solution*

A specific in-depth analysis of every part of each plant was included in the decommissioning activities. The drawings and other pertinent technical documents were revised based on in-field observations and measurements. The personnel involved in the operation of the plant played an essential role in this activity.

#### *II–11.1.2. Lessons learned*

It seems unrealistic to expect that problems with the as built documentation will not be found. Decommissioning projects should be started soon after the shutdown of the facility, when the operating personnel can still assist and support the verification of the documentation.

### II–11.2. Problem: Activation of aluminium in core components of the RANA reactor

Activation measurements made on an aluminium reactor core component from the RANA research reactor showed a level due to $^{59}Co$ activation generally higher than that expected from the chemical composition reported in the facility documentation.

*II–11.2.1. Solution*

The core components involved were reclassified as nuclear grade material and dismantled accordingly.

*II–11.2.2. Lessons learned*

The documentation of the original chemical composition of materials is often not, especially for older facilities, as accurate as that currently encountered. In-field measurements may assist in correctly classifying material before the start of dismantling operations.

## II–12. BUILDINGS B47, B48 AND B54, HARWELL, UK

### II–12.1. Problem

Buildings B47, B48 and B54 at Harwell [II–10] were originally commissioned for the military in 1936. B47 was representative of the building structures and the main project works. At one end of B47 was a two-storey brick construction with a flat roof. The building was a steel framed construction, clad with 6 mm thick mild steel panels and a steel trussed roof that was then clad with timber and roof tiles. The building was in use as workshops, stores, laboratories and process areas. In 1947 it was taken over by the Atomic Energy Research Establishment and was used as a beryllium processing facility. The facility ceased operation in 1991, at which point the building was vacated.

The contract awarded by the United Kingdom Atomic Energy Authority comprised the demolition of B47, the removal of active, surface and sewage drainage systems, the removal of concrete hardstandings and the delay tank, and returning the area to an unrestricted greenfield status. The demolition of B48 and B54 was included during the programme of works. Work commenced in January 1996 and progressed well up until May, when an unidentified and unknown pipe was encountered during the excavation. The pipe was found to be heavily contaminated.

### II–12.2. Solution

The unexpected discovery of the pipe required the construction of a ventilated enclosure for the removal of the pipe, associated contaminated backfill and surrounding subsoil. All the materials removed were segregated and processed to minimize waste arisings. This work was carried out during the period from May to July, allowing work to recommence in August. Full landscaping was completed in September 1996.

### II–12.3. Lessons learned

Unknowns are commonly encountered in the dismantling of old facilities with few or poorly maintained records such as as built drawings. Failure to document such issues during design and operation add significant costs to decommissioning.

## II–13. NIEDERAICHBACH NPP, GERMANY

### II–13.1. Problem

The first remote controlled dismantling step [II–11] was the removal of the pressure tube internals. Following this, the side welds connecting the 351 pressure tubes and their respective shield sleeve to the lower neutron shield had to be opened. For this, a tube grinder unit was used.

The tool was lowered down inside the pressure tube by means of a purpose made lifting attachment and positioned at the level of the side weld to be treated, approximately 6 m below the upper end of the pressure tube. The grinding process was performed as planned, followed by an inspection of the weld, which was intended to be removed. However, although extensive mock-up tests at the factory had demonstrated that the process was effective in removing the weld, the inspection showed that this was not the case in practice. Further investigations led to the conclusion that the side weld had not been carried out as indicated in the drawing (in which it was 3 mm wide) but was, instead, a seam 9 to 16 mm wide.

To remove the weld a second cut had to be performed. This created problems with further increases in temperature at the cut position and delays to the project programme arising from the need to reduce the dust produced by the cutting and the need to replace the grinding wheels.

### II–13.2. Lessons learned

The design features of the pressure tube reactor were complicated and the internals could not be readily viewed. The drawings were inaccurate; therefore, in spite of the mock-up tests, each remote controlled dismantling step had to be carefully planned and the tools used made as flexible as practicable so that modifications could be carried out in a simple and quick manner.

## II–14. JASON REACTOR, UK

### II–14.1. Problem

Following the installation of the Jason reactor [II–12] (an Argonaut type, water and graphite moderated low power training and research reactor) in 1962 comprehensive records of the facility's operations, modifications and incidents had been kept and were available to the decommissioning contractors and the licensee oversight team. However, the installation records, and in particular the records of previous nuclear or radiation related operations in the facility prior to the installation of Jason, were not so comprehensive. The less than comprehensive installation and previous building use records had the potential to delay the completion of the decommissioning, particularly regarding meeting the final radiological site clearance criteria.

### II–14.2. Solution

As decommissioning progressed the contractors made good use of the most recent records and of the Jason decommissioning superintendent's knowledge of the layout of the reactor. In addition, former Jason operational and engineering personnel became important, as they were able to provide the project with valuable insights and suggestions as the project progressed. This first hand knowledge became increasingly important during the final stages of the project, in which unexpected extensive tritium contamination was found in the concrete floors outside the reactor hall, which lead directly to a two month delay to the anticipated early completion of the project. This tritium contamination was caused by previous neutron accelerator operations that predated Jason operations, traced primarily through personal contacts with retired personnel, rather than through existing records. Had this matter been known about or considered at the beginning of the decommissioning of Jason, the project would have been completed about two months earlier.

### II–14.3. Lessons learned

The site licensee should ensure that comprehensive and accurate records of previous building use, nuclear facility installations, through life operations, modifications and incidents are kept and updated and made fully available at the start of any decommissioning project. In addition, the site licensee should also ensure that at least one member of its client overseeing staff has previous experience of the operation of the facility to help to mitigate any shortfall in previous records.

## II–15. KOREA RESEARCH REACTORS

### II–15.1. Problem

It is required that the radioactive solid waste arising from decommissioning activities be stored until the operation of the low and intermediate level radioactive waste repository can begin. Thus the option of changing the reactor hall of KRR 2 into a temporary storage site for the radioactive waste was selected. Unfortunately, it was very difficult to read the construction drawings, as KRR 2 was built more than 30 years ago.

### II–15.2. Solution

An investigation of the structural analysis of the reactor hall of KRR 2 was required to satisfy the requirements for the temporary storage of radioactive waste. Some information was obtained from the drawings. Since some detailed records were lost, additional investigations such as non-destructive examination and electric resistivity prospecting could be necessary to acquire the required information on the reactor hall of KRR 2. This may cause an increase in the decommissioning cost.

### II–15.3. Lessons learned

The lesson learned is that record keeping for design and construction is necessary to ensure information is available for eventual decommissioning.

## II–16. DECOMMISSIONING RECORD KEEPING CRITERIA AND EXPERIENCES IN THE CEA

### II–16.1. Problem

Three shielded cells, Oris cells 22, 23 and 24, at Saclay, were used for the production of $^{137}$Cs and $^{90}$Sr sources for medical purposes.

Operations ceased in these cells in 1972, and they were taken out of service in 1973. The cells remained unused until 1987, when a first cleaning campaign was undertaken by the operators. Decommissioning work started in 1990 and reached unrestricted release levels in 1994.

The decommissioning encountered severe problems of missing records.

Owing to the age of the plant the blueprints did not necessarily reflect the conditions of the site as built, and the engineers in charge of the dismantling were not fully aware of which operations had occurred when the cells were in use. Contamination was sometimes discovered in places in which there should have been none and objects were discovered that were not shown on the plans.

The drawings showed pits inside the cells; these, however, were not at the locations indicated. Oil moistened rags and lead marbles were unexpectedly found inside the cell walls during their decommissioning and water was encountered during the decontamination of the concrete and the removal of the floor. When this water was discovered decommissioning operations stopped and, after an investigation, it was discovered that the cells were built above small water pipes (several centimetres in diameter) used by the centre's central heating system.

### II–16.2. Lessons learned

Drawings, when they exist, do not always represent the current situation and the necessary precautions have therefore to be taken. Unknowns are common in the dismantling of old facilities with few records.

## II–17. VANDELLOS 1 D&D PROJECT

### II–17.1. Problem

When ENRESA began the dismantling works of the turbo blower at the Vandellos 1 site it was discovered that the thermal insulation of the turbo blower, and of the surrounding set of pipes, included an asbestos layer.

This asbestos layer was not recorded in any documentation and the plant operator, who had informed ENRESA some time before that no asbestos was present at the plant, was unaware of its existence. After some former workers were contacted it was learned that the asbestos layer was the consequence of a repair done some time ago.

ENRESA had to prepare a project and the corresponding procedures for asbestos safety works and asked for official acceptance of a delay in the dismantling schedule. It was also necessary to prepare a special access hatch and to provide workers with the appropriate protection to perform the work.

### II–17.2. Lessons learned

This occurrence shows the importance of recording all the activities at the plant during its operational stage.

With regards to decommissioning, it is important to note that existing documentation does not always reflect the current conditions of the plant. Operating personnel should always be involved to verify the records of the operational stage.

## REFERENCES TO ANNEX II


[II–1] VOIGT, A.F., Decommissioning of the Ames Laboratory Research Reactor, Final Report, IS-4789, Ames Laboratory, Ames, IA (1981).

[II–2] BROSEY, B.H., HOLMES, R.D., Site Characterization Efforts at the Saxton Nuclear Experimental Corporation, Best of D&D (Proc. Top. Mtg Chicago, 1996), American Nuclear Society, LaGrange Park, IL (1996) 78–83.

[II–3] NUCLEONICS WEEK, Unexpected Contamination Raises Saxton Decommissioning Costs, 15 June (2000) 15–16.

[II–4] INTERNATIONAL ATOMIC ENERGY AGENCY, Design and Construction of Nuclear Power Plants to Facilitate Decommissioning, Technical Reports Series No. 382, IAEA, Vienna (1997).

[II–5] FELLHAUER, C., "Reactor D&D at Argonne National Laboratory — lessons learned", Nuclear and Hazardous Waste Management (Spectrum '98) (Proc. Int. Conf. Denver, CO, 1998), American Nuclear Society, LaGrange Park, IL (1998) 3–8.

[II–6] FELLHAUER, C.R., CLARK, F.R., GARLOCK, G.A., Decontamination and Dismantlement of the JANUS Reactor at Argonne National Laboratory–East, Project Final Report, ANL/D&D/97-1, Argonne National Laboratory, Argonne, IL (1997).

[II–7] SMITH, D.L., PERRY, E.F., Decontamination and Dismantlement of the Old Hot Laundry, CFA-669, INEL-94/0139, Idaho National Engineering Laboratory, Idaho Falls (1995).

[II–8] NELSON, R.V., HORSBURGH, J., Final Report of the Decontamination and Dismantlement of the Auxiliary Reactor Area II Facility, Rep. INEEL/EXT-99-00905, Idaho National Engineering and Environmental Laboratory, Idaho Falls (1999).

[II–9] UNITED STATES DEPARTMENT OF ENERGY, Operating Experience Weekly Summary 99-01, USDOE, Washington, DC (1999).

[II–10] NUKEM NUCLEAR, Decommissioning/Demolition of Buildings B47, B48 and B54, Harwell, NUKEM Nuclear, Risley, Warrington (1997).

[II–11] INTERNATIONAL ATOMIC ENERGY AGENCY, State of the Art Technology for Decontamination and Dismantling of Nuclear Facilities, Technical Reports Series No. 395, IAEA, Vienna (1999).

[II–12] LOCKWOOD, R.J.S., BEELEY, P.A., BARRATT, K.L., "Decommissioning the Jason low power research and training reactor at Greenwich — An overview of the project, the nuclear safety management arrangements and important lessons learnt", Decommissioning of Nuclear Facilities (Proc. Int. Conf. London, 2000), IBC Global Conferences, London (2000).

# GLOSSARY

Definitions are taken from the IAEA Safety Glossary rev. April 2000, except those marked by an asterisk, which are additional definitions extracted from various sources and are only for the purposes of this report.

**archive.** A well ordered collection of records to be maintained for a long time.*

**barrier.** A physical obstruction that prevents or inhibits the movement of people, radionuclides or some other phenomenon (e.g. fire), or provides shielding against radiation.

**database.** A record that contains information concerning other records or data and that can be interrogated to retrieve information.*

**decommissioning.** Administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility (except for a repository which is closed and not decommissioned).

**decommissioning plan.** A document containing detailed information on the proposed decommissioning of a facility.

**design.** The process and result of developing a concept, detailed plans, supporting calculations and specifications for a facility and its parts.

**dismantling.** The disassembly and removal of any structure, system or component during decommissioning. Dismantling may be performed immediately after the permanent retirement of a nuclear facility or may be deferred.*

**enclosure, safe (during decommissioning).** A condition of a nuclear facility during the decommissioning process in which surveillance and maintenance of the facility takes place.*

**institutional control.** Control of a waste site by an authority or institution designated under the laws of a country. This control may be active (monitoring, surveillance, remedial work) or passive (land use control) and may be a factor in the design of a nuclear facility (e.g. near surface repository).

**nuclear facility.** A facility and its associated land, buildings and equipment in which radioactive materials are produced, processed, used, handled, stored or disposed of on such a scale that consideration of safety is required.

**operation.** All activities performed to achieve the purpose for which a facility was constructed.

**operating life/lifetime.** The period during which an authorized facility is used for its intended purpose, until decommissioning or closure.

**operating organization.** The organization (and its contractors) which undertakes the siting, design, construction, commissioning, operation and/or decommissioning of a nuclear facility.

**quality assurance (QA).** Planned and systematic actions necessary to provide adequate confidence that an item, process or service will satisfy given requirements for quality, for example, those specified in the licence.

**records.** A set of reports, including instrument charts, certificates, logbooks, computer printouts and magnetic tapes kept at a nuclear facility organized in such a way that they provide a complete and objective past and present representation of facility operations and activities, including all phases from design through to closure and decommissioning (if the facility has been decommissioned). Records are an essential part of quality assurance.*

**records management system (RMS).** Is a methodology or organized set of processes, procedures and tools for collecting, coding, compiling and storing (archiving) information and records to assure their proper management and future retrieval.*

**regulatory body.** An authority or a system of authorities designated by the government of a State as having legal authority for conducting the regulatory process, including issuing authorizations, and thereby regulating nuclear, radiation, radioactive waste and transport safety.

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**Consultants Meeting**

Rome, Italy: 15–19 May 2000; Vienna, Austria: 14–18 January 2002

**Advisory Group Meeting**

Vienna, Austria: 26–30 March 2001