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Maintenance of records for radioactive waste disposal

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FOREWORD

The safety of the radioactive waste disposal concepts does not rely on long term institutional arrangements. However, future generations may need information related to repositories and the wastes confined in them. The potentially needed information therefore has to be identified and collected. A suitable system for the preservation of that information needs to be created as a part of the disposal concept beginning with the planning phase.

The IAEA has prepared this technical report to respond to the needs of Member States having repositories or involved in or considering the development of repositories. In many countries policies and systems for record keeping and maintenance of information related to disposal are the subjects of current interest.

This report describes the requirements for presenting information about repositories for radioactive waste including long lived and transuranic waste and spent fuel if it is declared as a waste. The report discussed topics of identification, transfer and long term retention of high level information pertaining to the repository in a records management system (RMS) for retrieval if it becomes necessary in the future.

This report addresses the requirements of both near surface and geological repositories. As related to records management, the two concepts have a number of common aspects though there are some major differences arising from specific needs. Near surface disposal is practiced for low and intermediate level wastes. There are many near surface repositories in the world in planning, construction and in operation. Some repositories have been in operation for a few decades and some have already been shut down. Consequently, various kinds of records management have been practiced. They are being improved with the utilization of rapidly advancing information technology. Geological repositories are meant for long lived and high level wastes. Record keeping and information retrieval needs are of concern for much longer periods for such repositories than for near surface facilities. Depending on national policies and regulations, pre- and post-closure control needs are different for the two concepts. Overriding these differences however are some basic common features of the two concepts. These common features and differences have been taken into consideration in the preparation of this report. Importance is however given to a system for management of records containing information of wastes in repositories which have long term safety implications for future generations.

Twenty-nine experts from Member States covering near surface and deep repositories were involved in the preparation of this report. The IAEA officers responsible for the completion of this report were J.U. Heinonen and K.W. Han of the Division of Nuclear Fuel Cycle and Waste Technology.

EDITORIAL NOTE

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1. INTRODUCTION

1.1. BACKGROUND

Programmes to develop near surface or deep geological repositories in which to emplace radioactive waste have been or are being established and implemented in several Member States. The safety of the disposal site and its controlled surrounding areas must not, as a rule, rely on long term institutional arrangements or actions as necessary features of the design of the repository.

Future generations[1] will need information on the repository contents for several reasons [1, 2]. It is important that they are aware of the potential hazards involved to allow them to make informed decisions concerning the safety of the repository to avoid inadvertent intrusion at least in the near term and to assist decision making on the possible reuse of the site, its contents and surrounding controlled areas.

Societal and environmental safety may be enhanced further through institutional control measures.

During the institutional control phase, active and passive controls may be used. Active measures include controls such as exclusion of intruders by fences or other physical barriers, the maintenance of accessible barriers against migration of the radioactive inventory, and monitoring to verify that the continued, acceptable performance of the site are maintained after closure.

Passive measures are those designed to maintain knowledge of the facility location within the institutions of society or are designed to limit land use for certain types of activities. Passive controls may be intended to survive beyond the institutional control period.

Record keeping is necessary for meeting the institution control needs. Some Member States have developed policies and systems to deal with record keeping, and are investigating what and how records can best be maintained and conveyed over longer time spans. Regulations on radioactive waste management and quality assurance already establish requirements for record keeping. It is assumed that these national regulations and procedures are met. Many records are produced and maintained during the siting, design, construction, operation and closure of the repository. These records contain a large amount of information, part of which is also of value to society after closure. Maintenance of the relevant records is from the above sources believed to be the most reliable manner to convey information and its efficiency can be assessed from record keeping systems developed and used in the past [3].

Under the International Atomic Energy Agency (IAEA) safeguards arrangements and procedures for nuclear materials, arrangements exist or are being worked out for record keeping pertaining to some repositories [4]. It is assumed that the information recommended to be retained under these procedures for such repositories may be available to national authorities to augment their information data for record keeping purposes.

[1] Also referred to commonly as ‘future societies’. The term ‘future generations’ is used throughout the report to be in conformity with the use of the term in Ref. [1].

1.2. OBJECTIVE

With reference to considerations, plans and arrangements being made in some Member States for near surface and geological repositories**,** the objectives of this report are:

– to discuss and to provide technical guidance to Member States for the establishment of a records management system (RMS),
– to ensure the availability and retention of necessary information for use by future generations following closure of a repository, and
– to identify a methodology for the compilation and long term management of the records needed to convey this information.

The information presented in this report will assist Member States in ensuring that repository records, relevant for retention through the post-closure phase, are produced and identified progressively during pre-closure phases to ensure their availability at the appropriate time.

1.3. SCOPE

This report is intended to serve Member States having radioactive waste disposal facilities or planning to develop or implement radioactive waste disposal programmes. It discusses possible ways for preserving information about repositories (near surface, geological) for low and intermediate level radioactive waste, high level and long lived radioactive waste and spent fuel if it is declared a waste [5] (see Glossary).

The report identifies a methodology for the compilation and long term management of the records needed to convey necessary information about repositories to future generations. It is assumed that all established regulations applicable during operation and at the time of closure of the repository have been met at closure.

This report addresses the supply of documentation to future generations. It does not include the need of information for institutions with specific responsibilities during the lifetime of the repository (planning, construction, operation and closure phases). Maintenance of records by waste generators is not included within the scope of this report.

This report discusses information gathering and maintenance of records. It does not give advice on specific details of what these records will cover which may be governed by applicable national regulations.

1.4. STRUCTURE

This report is structured as follows:

– Section 2 discusses the needs that future generations may have for information related to the disposal of radioactive waste;
– Section 3 provides an overview of strategies for the collection and maintenance of records (including a discussion of hierarchical information systems);

- Section 4 discusses issues of the identification and transfer of high level information to future generations;
- Section 5 provides an overview of the organization and responsibility within an RMS;
- Section 6 provides basic guidance for the establishment of an RMS;
- An appendix and annexes provide examples of options for record media historic events and associated records, and Member State experience with record management.

2. INFORMATION NEEDS FOR FUTURE GENERATIONS

Systems developed for disposal of radioactive waste must meet the criteria established by the present society for the long term protection of human health and the environment from harm which could be caused by exposure to radioactive waste. Adequate information about disposal sites must exist at the time of repository closure to ensure this long term protection. Assurance therefore, is needed that some of this information will be retained in the long term following disposal site closure.

Since repositories may be subject to future unpredictable natural disaster or human actions, either inadvertent or intentional, the expected repository performance may be impaired. The likelihood of adverse health consequences from such events disturbing the repository system can be reduced by providing information and warnings to future generations regarding the presence of the waste and its potential hazard. Assuring the transfer of information to future generations can be seen as enabling them to make their own informed decisions regarding the repository design and contents. Any attempt that restricts the possibility for future generations to make their own judgements on a repository and the potential use of its contents must be avoided.

Information that is maintained about a repository may enable society, in light of new technologies, to assess the repository system with view to affecting improvements or to facilitate intentional retrieval of its contents. The availability of information would reduce adverse effects in the likelihood of unforeseen natural events or inadvertent or unauthorized intrusion. However, if such events do occur the information would enable meaningful assessments of damaged areas in order to establish safe and effective methods of repair.

To satisfy these goals, Member States need to retain basic information such as:

- The location and selected site specific data of the repository;
- The essential design features of the repository, including physical shape and barriers, description of operation and closure procedures;
- Waste records containing data on radioactive inventory, chemical composition, physical characteristics of materials, waste package identification;
- Background information to understand the function and performance of the repository system, results and data on methods used for assessment of safety and environmental impact including monitoring data;
- Data on sealing and closure of the repository;
- The identified keeper of the records for the initial period after closure of the repository.

The above items are also identified in Refs [6, 7], and the related information to be conserved is further discussed in Section 4.

In addition, retaining of other information would be required by Member States, dependent on preferred policies. The extent of information required is largely a matter of public, philosophical and political considerations on the part of the Member States. Therefore, the records may also include general information about the society, its laws and technology.

A records management system (RMS) would be established covering the following issues:

- The type of information deemed to be of most value to future generations, (repository design information sketches, description of monitoring systems and measurements data);
- The physical form for the records and their location, indexing, and retention scale within the system;
- The estimated time scale for which information of various categories are of interest;
- The measures to be taken to ensure the collection and maintenance of records;
- The measures to be taken to ensure that the information will be accessible and understandable;
- Remedial action to be taken in the event of record deterioration.

Figure 1 shows relationship of the RMS life cycle to the disposal facility life cycle.

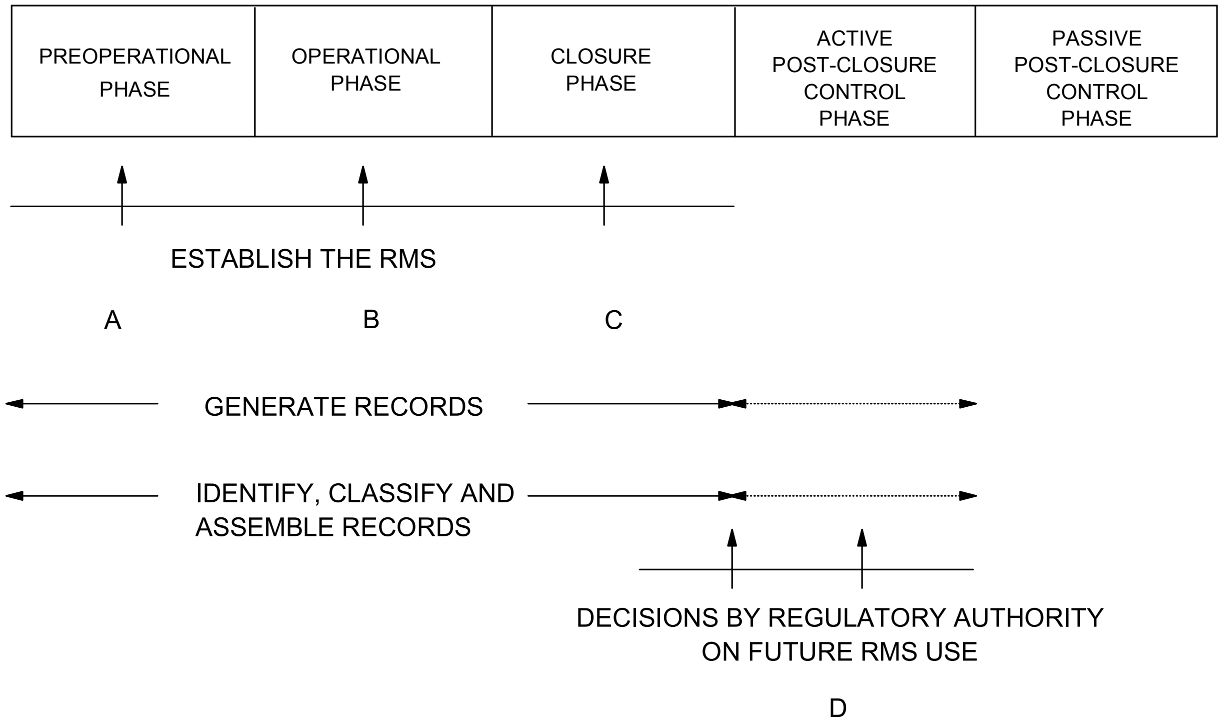
3. INFORMATION STRATEGIES

3.1. GENERAL

It is essential that the RMS is developed at the earliest time during planning of the disposal concept. All relevant repository information to be transferred must be identified, recorded and organized progressively in a timely and systematic manner in the RMS to ensure that records required for post-closure phase are produced and retained. The retention of repository information can be supported by other measures as well:

- Transmission through legislation,
- Transmission through education.

Markers can, in some instances complement these measure as demarcation zones for security and general information. They are however of limited efficiency or value. Other measures and practices could exist as well, such as transmission by historiography (oral and other historic means). The reliability is an important issue, which must always be taken into account in transmitting information.



The regulatory authority may need to decide on options and methodologies for:

- Maintenance of the RMS during institutional control,
- The disposition of RMS information sets after institutional control.

The RMS is discussed in Section 6. Examples of some historic events related to long term record keeping are given in Annex 1. Member States experiences with record management in Canada, France and Sweden are given in Annexes 2, 3, and 4.

FIG 1. Relationship of the RMS life cycle to the disposal facility life cycle.

International archiving

The threats of the long term integrity of a single repository of information in an archive are many. The best strategy to counter such threats could be to maintain information at different places. A multi-level structure, through placement in the Member State and possibly in an international archive could facilitate information protection by duplication or multiplication of records [7]. International archiving of certain types of selected information, in particular on the disposed long lived and high level wastes and spent fuel is an option which could offer some benefits and safeguards. It is recognized in some cases as an effective means of communication if it does not contradict the principle of national waste management policies and responsibilities. If multiple archiving (national and/or international) is implemented, information could be transferred at pre-determined fixed times during the life cycle of a repository; for example, when licenses are granted, performance assessments are completed or at periodic intervals.

3.2. HIERARCHICAL SYSTEM

In principle, a hierarchical structure can be built in three parts as shown in Figure 2:

– The basic part of a hierarchical structure and of all national records management systems is the primary level information set (PLI), which is continuously developed during the lifetime of a repository. The type and amount of information in the PLI strongly depends on such things as the repository system chosen, national laws and regulations, and needs for public involvement. It therefore must contain all information relevant to the repository during siting, design, construction and closure.

– The next part of a hierarchical structure may be intermediate level information set (ILI) which consists of condensed important documentation to ensure the understanding of the repository system. The bulk of this information is comprised of records required to meet the legislative and licensing requirement throughout the repository life. The ILI also contains references to specific records in the PLI and where the PLI can be found. The ILI could include important material directly extracted from the PLI and/or summaries of material in the PLI.

– The top level of the hierarchical structure is a high level information set (HLI) which consists of even more condensed information. The HLI would give sufficient information to provide a fundamental understanding of the repository system. The HLI has to meet the needs for future generations. The HLI would be placed on a national and perhaps also if decided by national authorities on an international level. A more detailed discussion of the content of an HLI is in Section 4.

Summarized below are some beneficial characteristics of a hierarchical structure:

– The PLI is present in each Member State with a radioactive waste programme, and therefore no extra work is needed to establish the PLI.

– Forming an ILI is needed within each Member State, to: (a) meet applicable legal and regulatory requirements, (b) prepare for the transfer of information to the national and possible international level if decided by the Member State, and (c) ensure that a competent organization manages the information up to and possibly after closure.

– Creating the HLI ensures that the most important information about the repository is identified and retained.

– Placing the HLI internationally if decided by national authorities may provide added confidence that information is preserved if political, social, and economic changes occur in Member States.

– A multilevel structure, creates information protection by duplication or multiplication of records.

– A hierarchical structure creates credibility and confidence for a repository programme for all levels in society.

Since this report is primarily concerned with the transfer of essential information to future generations, HLI is discussed in more detail in subsequent sections.

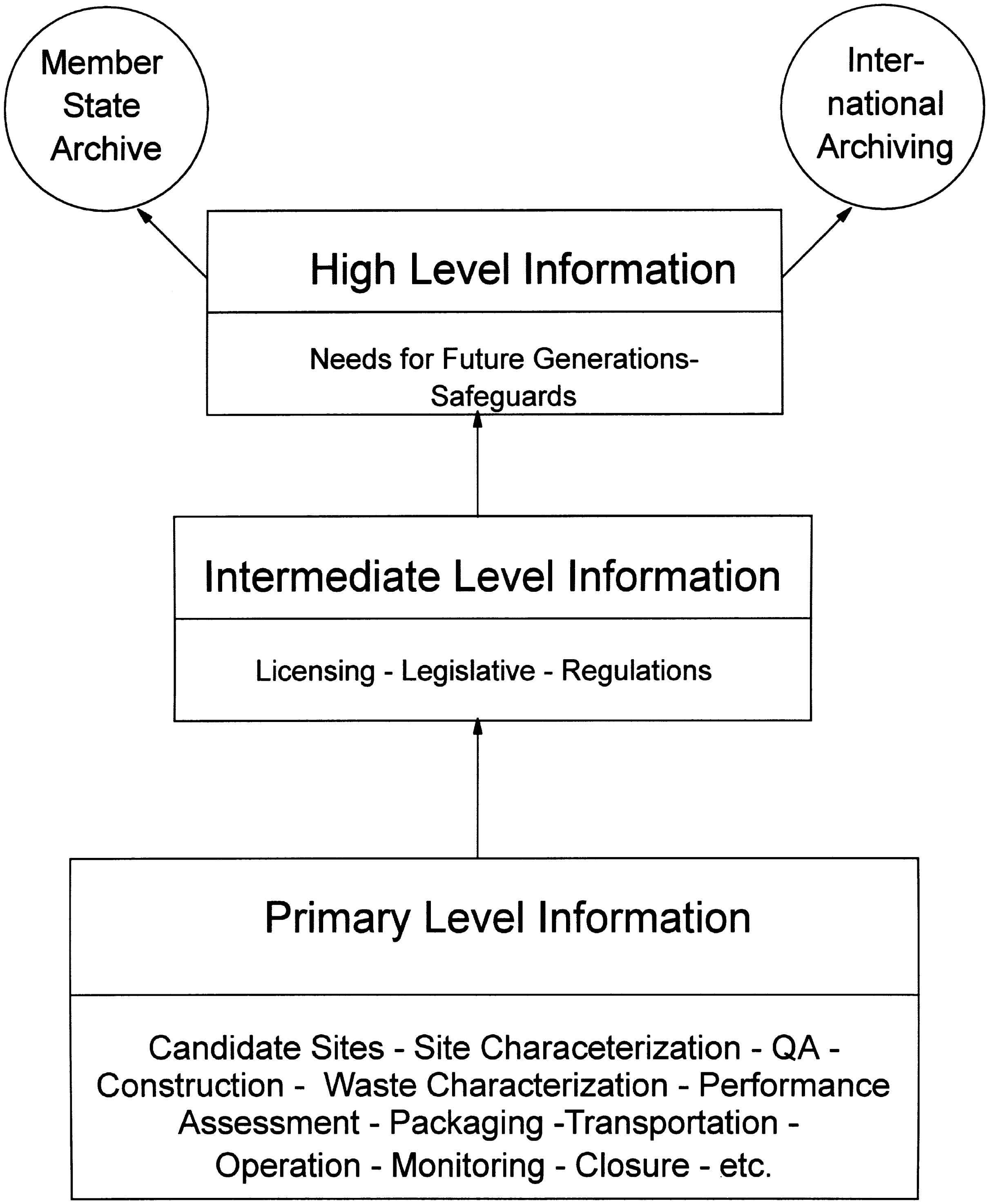


FIG. 2. The hierarchical structure of the record management system.

4. IDENTIFICATION AND TRANSFER OF HIGH LEVEL INFORMATION (HLI)

4.1. GENERAL

To provide an overview of the information retained, to ensure redundancy of records and to enable a capability to regenerate partially lost record sets, a hierarchical RMS with different information sets has been considered for geological repositories by some Member States. The same basic principles apply to near surface disposal facilities. Since the lifetime of near surface facilities is much shorter than for geological repositories, there might be less of a need for several hierarchical record sets. However, the creation and placement of overview information sets, regionally and/or nationally, may be considered.

The closure of near surface disposal sites is addressed in other IAEA publications [2, 8]. These reports state that an operator cannot commence closure activities until approval of a detailed closure plan is received from the regulatory body(ies). They further state that this detailed closure plan requires a final updated safety assessment based on available, pertinent data indicating the safe, post-closure performance of the disposal facility. Having satisfied the State or regulatory body(ies) that the facility can be safely closed, then many of the detailed records generated prior to closure may not be further required. This needs to be considered in specifying any post-closure phase record requirements.

Quality assurance (QA) aspects in nuclear installation and waste disposal facilities are addressed in IAEA publications [9, 10]. In assembling the HLI consideration must be given to the quality of information identified for transfer.

Records necessary for post-closure safety assessments and remedial actions are generated during all phases from siting through the institutional control phase. Some examples of records that may be generated are given in Tables I and II and are divided into records related to a future generations' ability to perform safety assessments or remedial actions or to use these records for historical, legal or other reasons.

Table I lists some of the records that may be generated up to and including closure that may be retained to support active institutional control activities. Table II identifies some additional records that may be both generated and retained during the active post-closure control phase.

There may also be a need to maintain information for passive post-closure controls which could follow the *active* institutional control phase. These might include marker systems, (with limited efficiency or value) as well as other means, to limit land use to certain types of activities for further periods of time. Where such controls place reliance on systems and information held by existing institutions of society (e.g. land registers, planning authorities), the responsible organization may need to verify that sufficient information is provided for the public record to control future use of the site.

Each Member State will need to determine the level and detail of information to transmit to the high level information (HLI) system based on its specific needs, i.e. regulations, taking into account that the information required will be used by future generations.

The records must be assembled prior to closure, reviewed and placed in the HLI. The level of detail in the HLI must be such that it provides sufficient in order to provide information for future generations to make informed decisions about intentional actions or adverse unpredictable and unforeseen natural disasters which may occur in spite of the best predictive robust safety assessments.

Member States would prepare HLI records in the Member State language as well as in any official language that may be recognized or established for possible international communication. The storage media selected must provide total accuracy, readability and reproducibility of the information.

4.2. IDENTIFICATION OF HLI RECORDS

Information which is transferred to the HLI would not be more detailed than that provided to the Member State regulatory body (licensing or supervising authority. See Glossary) except to include performance and/or safety assessments and safeguard required reports if they are not part of the licensing information.

The HLI information to be collected and retained in the Member State archive and to possible international archiving would cover the following subjects:

– Description of the RMS;

– Cross referencing to the location of the Member State official record;

– Site description, including descriptions and maps;
  - Geology;
  - Hydrogeology;
  - Geochemistry;
  - Geomechanics/Mechanical properties;
  - Biosphere;

– Source term;
  - Waste form;
  - Inventory of radionuclides;
  - Inventory of chemical species;

– System description;
  - Barrier systems (natural and engineered);
  - Design and layout;
  - Marker or warning systems;
  - Monitoring systems;
  - Raw data for performance and/or safety assessments;
  - Assessment: thermomechanics/heat effects;

– Safeguards requirements.

Tables I and II provide further examples of records which support the HLI subject areas.

TABLE I. EXAMPLES OF RECORDS THAT MAY BE GENERATED UP TO AND INCLUDING CLOSURE

RECORD TOPIC	**EXAMPLES**
RECORDS RELATED TO PERFORMING SAFETY ASSESSMENTS OR REMEDIAL ACTIONS	
Disposal Facility Location and Site Data	– Boundaries of area to be controlled during the post closure institutional control, and the disposal area (including marker locations) – Reference to national/international geographical references – Regional demography – Site data Geological, hydrological, meteorological, geochemical, seismic data Closure modelling data Surface water controls
Disposal Unit Design and Engineered Barriers	– Specifications/procedures for construction, including materials and methods – As-built drawings showing the construction and location of each disposal unit (trench, cell, etc.) – Construction non-conformance/deviations including corrective actions – Detailed drawings and specifications for active and passive Monitoring systems – Specifications and records for the maintenance and repair of engineered barriers
Disposal Unit Inventory	– Disposal records Location of final disposal Date of disposal Traceability to waste shipment record/waste data sheet – Facility acceptance criteria Acceptable waste forms, packaging, radiation fields and global inventory
Record Management System	– Description of the Record Management System, updated to include any changes implemented during closure, which includes its content and structure and all written instructions, procedures, and plans for its use
Operational Records	– Monitoring data Operational monitoring plans/specifications (including revisions) Monitoring results including dose and specific radioactivity in air, surface water, flora and fauna, sediment and groundwater – Operational compliance records Non-conformance, corrective actions and compliance reports
Background Information	– Information that would help future generations understand the function and performance of the repository system
RECORDS RELATED TO HISTORICAL, LEGAL OR OTHER USES	
Licensing Records	– Operating licenses, permits and requirements records – Performance objectives, including exposure limits – Monitoring requirements – Performance assessment reports
Laws	– Description of the applicable legal environment at time of operation and closure
General Information	– Information about the society that disposed the waste, such as overviews of waste management practices and technologies

TABLE II. SOME OF THE RECORDS THAT MAY BE GENERATED DURING THE ACTIVE POST-CLOSURE CONTROL PHASE

RECORD TOPIC	**EXAMPLES**
RECORDS RELATED TO PERFORMING SAFETY ASSESSMENTS OR REMEDIAL ACTIONS	
Monitoring Data	– Specifications, plans and procedures to control monitoring activities – Monitoring equipment calibration and maintenance records – Monitoring results
Facility Maintenance	– Specifications/plans/procedures – Repair/remediation records – Records of non-conformance including disposition.
RECORDS RELATED TO HISTORICAL, LEGAL OR OTHER USES	
Lawa	Description of the applicable legal environment at time of active post-closure control phase
General Information	– Information about the society that controlled the repository during the active post-closure control phase

4.3. TRANSFER OF RECORDS TO THE HLI

Information can be submitted to the HLI at periodic intervals or at different stages. The latest time is at the closure of the facility. It may be appropriate to review data at key stages of the project such as:

- final design phase;
- construction licensing;
- operation licensing;
- closure licensing;
- licensing for decommissioning of surface facilities;
- stage when safeguards requirements are finalized.

In some Member States, these stages are integrated into one single licensing phase with a possibility of additional revisions if changes are deemed to be necessary in the initially proposed total system.

At the construction licensing stage as well as the operation licensing stage some of the licensing reports, including the safety assessment reports, might be submitted to the HLI. However, some of the information at these stages might be estimations that require future revision. For example, due to reactor operation procedures or improvements in waste management, the source term may change over time of operation of a repository and the waste may differ from that originally expected. Therefore the formal review by the Member State regulatory body must take place at the time of closure.

5. ORGANIZATION AND RESPONSIBILITIES

5.1. ORGANIZATION

The organization and responsibilities for the operation and regulation of disposal facilities are addressed in detail in Ref. [6]. In particular, this report emphasizes that the State shall identify the organizations that shall be responsible for any required institutional control phase for the facility. The responsible organization may be some department of the State, an agency or any other appropriate organization designated by the State.

With respect to the objectives of this report, there is also a need for the State to clearly identify the organization(s) or body(ies) responsible for the RMS at the earliest possible time in repository inception. Within Member States, there may also be a requirement that the authorizing bodies must agree with the specification of the minimum record content and the procedures for any RMS.

As noted in Section 3, a hierarchical structure might be established, consisting of several levels of information. The RMS would contain and manage each of these information levels.

During the design, construction, operation and closing of the repository, a large amount of information will be produced to satisfy the needs of various groups. These groups include the waste generators, repository designers and operators, regulatory and licensing bodies, independent scientific and advisory and oversight groups, local governments and environmental groups, and members of the public. The organization(s) or body(ies) responsible for the RMS must decide what part of this information is needed to meet the needs of future generations.

5.2. RESPONSIBILITIES

Paragraph 521 of Ref. [6] recognizes the regulatory body, the waste generators and the operators of radioactive waste management facilities as responsible for maintaining the documentation and records consistent with the legal requirements and their own needs. The paragraph further states that the regulatory body may choose to take the responsibility for the long term retention of the records. Nevertheless, it would be prudent if Member State would identify a responsible body who will define the goals and minimum content of the RMS. The responsible body could be the established regulatory or licensing agency. This body would identify the organization(s) who are responsible for defining, developing, operating and maintaining the RMS. There are three kinds of responsibilities to be identified for different tasks. These responsibilities have to be clearly distinguished concerning:

- the regulatory process (licensing authority);
- the implementation of the HLI records (collection);
- the record keeping for the long term (this could be done for example by national archives).

Different organizations involved may use different records management systems, and therefore cross-references between systems must be defined. Finally, the responsible body must ensure the identified HLI records are transferred to the Member State archive and to possible international archiving if a Member State so chooses.

The responsible body ensures that appropriate quality assurance measures are applied throughout all of these tasks and ensures that the defined goals are achieved.

The RMS is established by drawing on existing quality assurance records and other existing information. Additional information could be collected and added as required.

Responsibilities for repositories in operation lacking in developed relevant database

Repositories of some Member States are operated but records have not been collected in the form and extent shown in the report. The responsible body may be appointed as early as possible and if the source data is not satisfactory enough to provide required information, then the following measures can be applied:

- To contact main waste generators and retrieve their data about disposal wastes,
- To confront available information with decisions of the regulatory body allowing operation of potential waste generators,
- To estimate the inventory of disposed wastes from databases of imported and produced radio nuclides if such date base exists,
- To question persons directly involved in disposal activities.

The archive information must distinguish between estimated or in other ways not fully trustworthy and data fully consistent with the real disposal activities meeting RMS requirements.

6. THE RECORDS MANAGEMENT SYSTEM (RMS)

6.1. GENERAL

The RMS is essential for long term maintenance of records. The RMS needs to be established in written instructions, procedures or plans. The establishment of the RMS would begin by reviewing existing records management systems. Quality assurance procedures are necessary at all stages of production of the RMS.

The primary focus of a RMS is the preservation of necessary information for the duration of the active institutional control phase, and where necessary beyond. The information may exist in many media forms. Issues that need to be addressed through a system of documented instructions, procedures and plans, to ensure the integrity of the information to be preserved, must include:

- Identification of records to be included in the RMS;
- Record indexing and retrievability;
- Record retention classification;
- Record form;
- Transmittal, receipt and acceptability of records;
- Protection of records from adverse environments;

- Access control;
- Control of modification of records; and
- Periodic reproduction or transfer between record forms, national and international archives requirements.

6.2. IDENTIFICATION OF RECORDS TO BE INCLUDED IN THE RMS

A detailed list of records to be included in each of the information sets of the RMS must be established and maintained up to date based on Member State requirements. This list must be generated at the earliest practical time and revised periodically. Recommendations in this regard are given in Section 4.

6.3. RECORD INDEXING AND INFORMATION RETRIEVAL

Controls are necessary to be established and documented at the earliest point in the repository program to assure that records are indexed for retrievability. Retrievability of information and therefore, record indexing, are key components of the RMS. Indexing systems link a records attributes, such as title, dates, subject and keywords to the location of the records and to other information. Information retrieval implies that once the record is located, it can be accessed and read with existing tools. The effective retrieval of information is directly related to the effectiveness of the indexing system used.

6.4. RECORD RETENTION CLASSIFICATION

The records may also be subject to varying statutory periods of retention within the Member States or may have long term value as historical records. Such requirements are to be considered when assigning a retention classification. Each Member State is responsible for establishment of adequate retention policies to ensure future generations use of the HLI information.

If records are to be classified with varying retention periods, the classifications and controls for assigning classifications need to be documented in instructions, procedures or plans. Controls may include periodic reviews to evaluate established classifications and to reclassify records if necessary. The purging of records needs to be subject to explicit, written procedures and controls to minimize the risk of losing important information.

6.5. RECORD FORM (MEDIUM)

The organization responsible for the RMS must establish documented instructions, procedures and plans at the earliest practical time to identify the record forms to be used and to control the identification, collection, and preservation of the information. Retrievability and usability of records will be dependent on the continual migration or conversion to new technologies.

The choice of the medium used to store the information is irrelevant, provided that it meets the following requirements:

(a) It must be capable of capturing and storing the required information.

(b) It must be physically and chemically stable, so that the legibility is preserved for a long period of time.

(c) It must be capable of being easily copied or transferred to another medium, without loss of information.

(d) It must be retrievable over very long periods of time.

(e) It must be readable and understandable.

(f) It must be resistant to tampering, i.e., to alteration by unauthorized individuals.

The appendix of this report and Ref. [11] provide a compilation on records media and retrievability including a discussion on advantages and disadvantages of various record forms that may be chosen.

6.6. TRANSMITTAL, RECEIPT AND ACCEPTABILITY OF RECORDS

Procedures for collecting, transmitting and incorporation into each of the information sets of the RMS need to be established and include provisions for verifying the acceptability of each record. To be acceptable, each record must be legible, authentic, accurate and complete.

6.7. PROTECTION OF RECORDS FROM ADVERSE ENVIRONMENTS

Based on the record form(s) selected, appropriate controls need to be established to protect records from deterioration due to temperature, humidity, light, microorganisms, etc.

The storage of records must also prevent loss due to a single event such as fire, flood, tornado, earthquake, etc. This protection can be accomplished by either engineered protection such as a vault or by separate storage of a duplicate set of records in a secure location.

6.8. ACCESS CONTROL

Methods of controlling access to records need to be established and documented to prevent loss, destruction or unauthorized alteration of records. Controls might include identification of organizational responsibility for authorizing and controlling access to records.

6.9. CONTROL OF MODIFICATIONS OF RECORDS

Controls need to be established to identify the personnel authorized to make modifications to records, and the conditions under which modifications may be made.

6.10. PERIODIC REPRODUCTION OR TRANSFER BETWEEN MEDIA FORMS

Document controls for periodically ensuring durability of the information contained in the RMS need to be established based on the record form(s) (e.g. microfilm, paper, digital form, etc.). The expected life for each record form needs to be established and controlled to ensure that records are reproduced or the information transferred to another form prior to the end of their expected life. Controls to ensure and verify the legibility and integrity of reproduced or transferred information also need to be established. Appropriate remedial actions must be taken to restore deteriorated records. For long term retrievability, procedures must be established to ensure that the tools necessary for reading the records (for example, microfilm readers, computer software and systems) continue to be available. Specific controls for the body of HLI information may be deemed necessary by the Member States.

Any loss of information during reproduction of records must be documented. The document may determine or estimate the extent and contents of the lost data.

6.11. NATIONAL ARCHIVE REQUIREMENTS

In some Member States, requirements exist that records from national Bodies fall under the jurisdiction of a National Archive, both during the functioning of the body and at its termination. The RMS needs then to incorporate these archive requirements into instructions, procedures and plans. Those records identified for inclusion in the HLI set are to be maintained at the highest requirement level. In the event that an international archiving body is established, that body might produce specific requirements to be incorporated in the RMS.

7. SUMMARY

7.1. GENERAL

In the design and operation of a repository, it is recognized that it may be necessary to enhance safety through institutional control over the site after closure. Such controls may include exclusion of intruders and maintenance of accessible barriers against release of hazardous material, for a period during which the majority or a significant fractions of short lived radionuclides decay, and proof of acceptable performance by continued monitoring. On the basis of experience and arrangements being made in some Member States this report provides technical information for identification and management of records that will be required to ensure that the objectives of institutional control phase are achieved.

The report further addresses the need for identifying organization(s) and body(ies) responsible for defining the content, structure, and maintenance of the records management system necessary at and for closure. Examples of operational and closure records are given that might be preserved to enhance the possibility that future safety assessments and remedial actions can be carried out effectively.

In applying information and technical guidance provided in this report, the Member States can achieve systematic control and availability of the information needed by future generations.

7.2. MAJOR OBSERVATIONS

This report recommends that some necessary information about repositories is to be retained over a long period. Such information is created progressively during all phases of the repository’s working life in accordance with Member States’ regulatory obligations and requirements.

The observations of this report are:

- The main goal of long term maintenance of information for repositories for radioactive waste is to provide sufficient information for future generations to make informed decisions about intentional actions and assess the consequences.

- Since societies may change, information may be less understandable over time. Therefore the information transferred to the HLI must be condensed and essential for future generations.

- The preservation of necessary information for the duration of the active post-closure control phase and beyond requires the establishment and maintenance of a RMS.

- Redundancy and diversity in the RMS are necessary for longevity, accessibility and understandability of the information.

- The hierarchical structure is a strategy to identify, capture and retain information at various levels.

7.3. THE KEY ISSUES

It is necessary to establish and document a RMS at the earliest possible time and to maintain it as consistent across the entire disposal programme. In creating a RMS the following issues are of paramount importance:

- It is important that tools used in the RMS would

  (i) Permit ready access to information during all stages, and
  (ii) Provide transferability of HLI information to durable media.

- The organization(s) responsible for the RMS need to be identified at the earliest possible stage.

- A hierarchical structure as described above would be appropriate for the RMS.

- The HLI set would be established at the Member States archive which may be used by the Member States for some kind of international archiving in the future if they decide to do so.

- Records in the HLI need to be reviewed periodically to identify potential content deterioration.

- The media used needs to be selected to ensure durability, readability and reproducibility of the information.

- One set of HLI records are advised to be maintained in a language that is more common in scientific publication.

Appendix

OPTIONS FOR RECORD MEDIA AND RETRIEVABILITY

This information provided below was extracted from Ref. [12].

Record media options

Most of the current information about nuclear facilities is recorded on paper and digital media. In order to create information sets for the post-closure phase, a decision may have to be taken with respect to media requirements. A short review is given below about existing media. In addition, Table A5.1 lists typical environmental conditions for these media.

Regular 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. The advantages of this medium are that it is already in a form suitable for storage, it is readable without tools, and copies easily. The disadvantages are that it may not meet the requirements of being readable during the institutional control phase of a few hundred years and it is a relatively bulky medium requiring large and costly storage facilities.

Permanent paper, which has an alkali reserve, has a lifetime of several hundred years if conserved under specified conditions (no light, low relative humidity, minimized handling, acid-free physical contact). It is directly readable and easy to copy, but it is necessary to study the characteristic of the paper and printing material combination. The disadvantages are mainly linked to the constraints of the conservation conditions and its bulk, as indicated above for regular paper.

Microfilm, can be expected to have a lifetime of 100–200 years. The advantages are its relatively small storage capacity requirements and it can be read directly with simple magnifying tools. The disadvantages are that special tools are required for copying to other media, the maximum number of replications of the microfilm itself is considered to be 4 and there are requirements for minimum handling. Another disadvantage is that transferring information from microfilm to other media has been shown to decrease the quality and readability of the output information.

The magnetic disc has a life in the order of 5–10 years. Its advantages are a large storage capacity, a wide spread use and rapid retrieval and copying capabilities. Its disadvantages include a short life requiring high maintenance (control and copying) and controlled environmental requirements. For readability reasons, it is necessary to maintain the chain of hard- and software. A potential disadvantage as compared to microfilm or paper is that in some Member States, the integrity of the data is considered insecure. Magnetic disks may not be admissible as legal documents since undocumented changes can be made easily or data can be destroyed by magnetic fields.

The optical disc itself can have a durable lifetime in excess of 100 years. It has the same advantages as the magnetic disc. Its current evolution in the market seems to show that it has a promising future in the short term. The disadvantages are in principle the same as those of the magnetic disc, but in practice it is more difficult to make documented data changes. The biggest disadvantage of optical discs is the uncertainty of their readable lifetimes, since their readability is completely tied to the availability of the tools that can access the information they contain. Currently, the readable lifetime of optical discs must be considered to be in the order of 5–10 years, the expected available life of the tools to read them.

TABLE A5.1. KEY ENVIRONMENTAL CONDITIONS

Medium	Temperature (°C)	Relative Humidity (%)
Paper	<18	30–40
Microfilm	<15	25–35
Magnetic	<18	35–45
Optic	<18	35–45

Management tools for indexing and retrievability

The management tool for indexing and retrievability is directly linked to the choice made for the media.

For paper and microfilms, one option available to search for an archived document, is to use a storage classification system, which provides a list of all categories of archived documents with their location. 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.

For paper and microfilms, a more effective system is to develop a database containing all the index parameters and document locations. It is then necessary to foresee and accommodate the unavoidable evolution of the database (hardware and software).

Records only existing on digital media are completely reliant on the use of electronic tools for management. It needs a more sophisticated graphics software in order to manage bitmap images stored on optical discs. The disadvantage of this option is the need to maintain all the electronic system over long periods. This will most likely require the transfer of the computer files to another medium, adaptation of the digital data to new technology, and maintaining the consistency and the compatibility of the different parts of the system.

Annex 1

LONG TERM RECORD KEEPING

The following reference discussions address a portion of historic events and the specific needs of long term record keeping.

A. THE NORDIC STUDY [3]

1. Archives in a short and long term perspective

The availability of nuclear waste repository information in national and/or local archives may ensure future access to the information.

An international nuclear waste archive can also be seen as a source of information, but mainly as a protected, long term source for reconstruction of national and local archives.

2. Elements in safety analyses for archives

For the medium and long term time frame, an attempt was made to carry out an archive safety analysis. That is, by analogy to the safety analysis for high level waste disposal systems, to identify potential threats to an archive's integrity and to describe possible countermeasures to protect or to mitigate the possible harm to an archive from such threats.

At a seminar held in Oslo, in 1991, reports were given about the Vatican archives and the fate of German archives in the 20th century [13, 14]. The German archives were studied to provide a case study of a dramatic period in history, while the study of the Vatican archives was meant to give an example of an archive of a 2000 year old institution. The Vatican archives contain documents more than 1000 years old, although the archive in its present form was established by Pope Paul V as late as 1612.

3. The threats

The threats identified by the two studies can be described in terms of events leading to archive losses. Examples of such losses of material from the Vatican archives are listed below:

Year	Event
410	Rome attacked by Alaric and the Goths. Rome sacked 5 times during the 5th century.
1308	The papacy transferred to Avignon. Many documents were left behind and some of them destroyed during their transfer to France.
1404	The Vatican Palace of the Roman Pope Innocent VII were sacked by a mob. Valuable manuscripts were thrown into the streets.
1527	Rome was sacked by imperial German troops.
1810	Napoleon moved the archives, in 3239 chests, to Paris. One third of the archive was lost before they were brought back after the defeat of Napoleon. The last wagon train with documents arrived in Rome in 1917.
1870	The Italian army occupied Rome. Documents were "lost" to another archive, the State Archive of Rome.
1939–1945	Few losses during World War II.

The German archives suffered most of their losses during World War II. Losses are attributable to Allied bombings, which destroyed the archive storage building and fire following the bombings. However, many losses occurred simply because of the extreme poverty during the end of the war. This poverty made the archives' insufficiently guarded paper attractive as a commodity, to be used for wrapping groceries and burning. The same type of loss happened to a substantial part of the Vatican archives in Paris during the 19th century. Some German archives' losses were technical. For example, the prevailing general poverty during the end of the war made high quality paper scarce and led to the use of "Kriegspapier" of low quality and persistence. SS troops raided some archives, like the Staatsarchiv in Danzig and removed records. Some archives, including the Staatsarchiv in Wolfenbüttel, were, in part, placed in mines for protection, and survived the war but were later plundered. Finally, the occupation powers removed records from many archives, for instance the Landeshauptarchiv in Dresden.

4. Countermeasures and strategies for preserving archives

History gives many examples of successful attempts to protect and shelter information during times of unrest. From the Vatican's history, examples can be given of hiding and "walling up" archives. At one time at the end of the 13th century, Pope Boniface VIII hid his personal archives in the caves of Mount Soracte near Rome - "the same caves in which Mussolini, during the Second World War, established an emergency headquarters and storage place for important documents" [9].

The study of the German archives also reveals efforts to protect archives. From 1933, unofficial discussions and experiments took place to study the problem of archive protection. Some archives were moved to shelters in mines. Also, because of the political and racist-defined research, church books and personal acts received special interest after the emergence of the Nazi party, leading to increased protection of these documents. As the allied bombing were stepped up gradually, various protective strategies were implemented. For example, important archives were transferred to underground shelters in mines, and archives were rearranged within existing buildings to the central parts of the buildings.

B. THE MORMON ARCHIVES [15]

The Mormon Archives near Salt Lake City, Utah, USA, contain information about ancestry from nearly every country in the world. Records are kept in duplicate in special underground rooms in Granite Mountain. To make the records more accessible, the information is maintained and distributed on microfilm and microfiche.

Annex 2

MEMBER STATE EXPERIENCE WITH RECORD MANAGEMENT — CANADA

At the time this report was written, Canada had not yet initiated radioactive waste disposal operations — only interim storage facilities were in use. However, to support current storage operations and to prepare for disposal and closure, the Waste Management and Decommissioning (WM&D) Group at Atomic Energy of Canada Ltd (Chalk River site) began to implement its information and document management strategy. The key elements of this strategy include:

- Standardization of the processes for report creation and management, which includes the standardization of:
  - Hardware and operating system (AECL corporate standard);
  - Report preparation tools;
  - Report preparation mechanics (such as standard report templates);
  - Report distribution, publishing, storage and archival procedures;

- The establishment of a report (records) management system (DMS), based on the recommendations in this IAEA guidance report;

- The specification of the organization to manage the DMS, including the appointment of a DMS manager;

- The identification of all existing reports and records associated with waste management and decommissioning activities, such as waste acceptance, processing, treatment, handling, characterization, categorization and storage;

- The establishment of a dynamic information management system (DIMS) to:
  - Identify all databases internal and external to WM&D that contain information related to waste management (such as process knowledge records needed for waste characterization);
  - Facilitate the sharing of information within the various databases or, where appropriate, to merge databases;

- The appointment of a DIMS manager.

The DMS and DIMS managers have the responsibility for identifying all records and documents needed for licensing, for on-going operations, and as the basis for selecting records for the post-closure phase.

Annex 3

MEMBER STATE EXPERIENCE WITH RECORD MANAGEMENT — FRANCE

At the time this report was written, ANDRA was operating two near surface disposal facilities. One facility is known as the Centre de la Manche, located in the north west of France and it was entering the closure phase. The other facility known as the Centre de l'Aube situated in the east of France, became operational in 1992.

This appendix describes ANDRA's experience related to the setup of a record management system (RMS) for the Centre de la Manche.

This disposal facility, which became operational in 1969, went through all phases associated with disposal: siting studies, conception, construction, operation, radiological environment monitoring, etc. At each stage, numerous documents were produced, classified, and managed by ANDRA's different departments. Some databases were created as well for specific aspects (waste traceability, monitoring data, etc.).

In order to set up a general RMS for all the documentation of interest for the institutional control period (equal to 300 years for this disposal facility), the first task undertaken was to collect all the documentation from all departments, to sort it to avoid duplicate information and to classify it to get an overview of the information available. The selection of the documents was done based, on one hand, on ministerial and regulatory requirements and, on the other hand, on a report that analyzed scenarios of incidents or anomalies, which identified the documents needed to understand the monitoring results or to perform remedial actions.

The implementation of an index system takes place as documents are identified. The challenge is to develop, on one hand, a consistent index system for a large bulk of documents and, on the other hand, to determine the right parameters for effective retrievability. All indexing parameters set up for each selected document will be included into a database in order to be able to create lists that are needed to retrieve documents according to multi-criteria requests.

The next step is to decide on what form the documentation will be stored in and how it will be stored. It is well known that regular paper has a short lifetime due to the acidity of their components. Several document storage forms and various document management tools have been studied at ANDRA in relation to the number of times per day documents are retrieved and the delay acceptable to access the searched information during the institutional control period.

Whatever the chosen system, it seems important to keep, with appropriate environmental conditions, at least two copies of the full set of documentation in two different sites and to foresee some periodic controls of the RMS during the institutional control period to verify the legibility and the access to the documents.

Annex 4

MEMBER STATE EXPERIENCE WITH RECORD MANAGEMENT — SWEDEN

At the time this IAEA report was written, the Swedish Nuclear Fuel and Waste Management Company (SKB) operated its near surface disposal facility, the Final Repository for Reactor Waste (SFR), which is located near the Forsmark Nuclear Power Plant, about 130 km north of Stockholm. SFR was commissioned in 1988 and only accepts short lived, low and intermediate level waste. SFR is an underground facility in the granitic rock about 50 m below sea bottom, 1 km out under the Baltic Sea.

After the Nordic Safety Research document was published in 1993 [11], the Swedish Radiation Protection Institute (SSI) requested that an information strategy be developed by SKB regarding the SFR facility. Such a document was submitted to the SSI in 1994 — it describes the actions SKB is taking to ensure the integrity and durability of different documents and records from the SFR. This strategy can, therefore, be considered as the initial document to form the record management system (RMS) for the SFR facility.

The actual work undertaken has so far been to:

- Identify the different types of records and documents,
- Quantify the volumes of the different records and documents,
- Identify on what media the information is stored,
- Estimate the lifetime of the different storage media, and
- Check if digital information currently stored can be transferred to durable media.

The efforts undertaken during the current operational period are judged to be of importance for creating future summaries and information sets according to this report.

GLOSSARY

archive. A well ordered collection of records to be maintained for a long time.

assessment, performance. An analysis to predict the performance of a system or subsystem, followed by comparison of the results of such analysis with appropriate standards or criteria. A performance assessment becomes a safety assessment when the system under consideration is the overall waste disposal system and the performance measure is radiological impact or some other global measure of impact on safety. Performance assessment can be used to describe the analysis and comparison of systems at a variety of levels and requirements.

assessment, safety. An analysis to predict the performance of an overall system and its impact, where the performance measure is radiological impact or some other global measure of impact on safety.

barrier. A physical obstruction that prevents or delays the movement (e.g. migration) of radionuclides or other material between components in a system e.g. a waste repository. In general, a barrier can be an engineered barrier which is constructed or a natural barrier which is inherent to the environment of the repository.

closure (permanent). The term closure refers to the status of or an action directed at a disposal facility at the end of its operating life. A disposal facility is placed into permanent closure usually after completion of waste emplacement, by covering for a near-surface disposal facility, by, backfilling and/or sealing of a geological repository and the passages leading to it, and termination and completion of activities in any associated structures.

design. The process and result of developing a concept, detailed plans, supporting calculations and specifications for a nuclear facility and its components.

engineered barrier (see **barrier**).

geological disposal. Isolation of waste using a system of engineered and natural barriers at depths up to several hundred meters in a geologically stable formation. Typical plans call for disposal of long lived and high-level wastes in geological formation.

high level waste (see **waste, high level**).

institutional control. Control of a waste site (e.g. disposal site, decommissioning site, etc.) by an authority or institution designated under the laws of a country or state. 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 disposal facility.)

long term. In radioactive waste disposal, refers to periods of time which exceed time during which active institutional control can be expected to last.

natural barriers (see **barrier**).

near surface disposal. Disposal of waste with or without engineered barriers, or below the ground surface where the final protection covering is of the order of a few meters thick or in caverns a few tens of meters below the earth's surface. Typically short lived, low and intermediate level waste is disposed of in this manner. This term replaces "shallow land/ground disposal".

performance assessment (see **assessment, performance**).

quality assurance (QA). All those 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, log books, computer print-outs, and magnetic tapes kept at each nuclear facility and organized in such a way that they provide a complete and objective past and present representation of facility operations, activities including all phases from design through closure and decommissioning (if the facility has been decommissioned). Records are an essential part of quality assurance (QA).

records management system (RMS). Is the (licensed) set methodology for collection, coding, compiling and storing (archiving) information and records to assure future retrieval.

regulatory body. An authority or a system of authorities designated by the government of a country or state as having legal authority for conducting the licensing process, for issuing licenses and thereby for regulating the siting, design, construction, commissioning, operation, closure, close out, decommissioning and, if required, subsequent institutional control of the nuclear facilities (e.g. near surface repository) or specific aspects thereof. This authority could be a body (existing or to be established) in the field of nuclear related health and safety mining safety or environmental protection vested and empowered with such legal authority.

repository. A nuclear facility (e.g. geological repository) where waste is emplaced for disposal. Future retrieval of waste from the repository is not intended.

retrievability, waste. The ability to remove waste from where it has been emplaced.

retrievability, information: The ability to retrieve repository information.

spent fuel: Irradiated fuel not intended for further use in reactors.

transuranic waste (see **waste, transuranic**).

waste, alpha bearing. Radioactive waste containing one or more alpha emitting radionuclides in quantities and/or concentrations above clearance levels, alpha bearing wastes can be short lived or long lived.

Waste, long lived. Radioactive wastes containing long lived radionuclides having sufficient radio toxicity in quantities and/or concentrations requiring long term isolation from the biosphere. The term long lived radionuclides refers to half lives usually greater than 30 years.

waste, low and intermediate level (LILW). Radioactive waste in which the concentration of or quality of radionuclides is above clearance levels established by the regulatory body but with a radionuclide content and thermal power below those of high level waste. Low and intermediate level waste is often separated into short lived and long lived wastes. Short lived waste may be disposed of in near surface disposal facilities. Plans call for the disposal of long lived waste in geological repositories.

waste, radioactive. For legal and regulatory purposes, radioactive waste may be defined as material that contains or is contaminated with radionuclides at concentrations or activities greater than clearance levels as established by the regulatory body, and for which no use is foreseen. (It must be recognized that this definition is purely for regulatory purposes, and that material with activity concentrations equal to or less than clearance levels is radioactive from a physical viewpoint — although the associated radiological hazards are considered negligible.)

waste, transuranic (TRU). Alpha bearing waste containing nuclides with atomic numbers above 92, in quantities and/or concentrations above clearance levels. Also see waste, alpha bearing; waste, long lived.

waste, high level (HLW). (a) The radioactive liquid, containing most of the fission products, and actinides originally present in spent fuel and forming the residue from the first solvent extraction cycle in reprocessing and some of the associated waste streams. (b) Solidified high level waste from (a) above and spent fuel, if it is declared a waste. (c) Any other waste with an activity level comparable to (a) or (b). High level waste in practice is considered long lived. The level of activity which distinguishes HLW from less active waste is its level of thermal power.

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