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Waste inventory record keeping systems (WIRKS) for the management and disposal of radioactive waste

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WASTE INVENTORY RECORD KEEPING SYSTEMS (WIRKS) FOR THE
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FOREWORD

Over the last decade, significant developments have taken place regarding radioactive waste management:

(1) The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, concluded under the auspices of the IAEA, was opened for signature in September 1997. The Convention establishes commonly shared safety objectives and sets out the specific obligations of Contracting Parties aimed at achieving those objectives. When it enters into force, adherence to these national obligations will be monitored through an international process of peer review by the other Contracting Parties. Each Contracting Party must prepare a report on the measures taken to meet its obligations under the Convention, which will be distributed for review by all Contracting Parties. In Review Meetings, each national report will be discussed along with the comments and questions from other Contracting Parties.

(2) Agenda 21 was issued from the United Nations Conference on Environment and Development, held in Rio de Janeiro in June 1992. The IAEA was assigned the responsibility to develop indicators of sustainable development (ISD) for radioactive waste management. Among other issues, the ISD are to be developed according to the following criteria:
    - primarily national in scale or scope,
    - relevant to the main objective of assessing progress towards sustainable development, and
    - dependent on data that are readily available or available at a reasonable cost to benefit ratio, adequately documented, of known quality and updated at regular intervals.

Both the reporting requirements under the Joint Convention and in support of the ISD will rely on information about national radioactive waste management programmes, activities, plans, policies, relevant laws and regulations and waste inventories in Member States.

Regarding waste inventories, historically Member States have developed and implemented a variety of waste classification systems in support of national radioactive waste management programmes. For those Member States that have implemented waste inventory record keeping systems (the term WIRKS is coined in this publication to facilitate discussions of and references to these systems), their waste databases are used to record waste inventories according to national classification systems. In addition, the scope and quality of information in these WIRKS not only varies from Member State to Member State, it can also vary from organization to organization within a Member State.

Differences in waste management record keeping at the national level complicates reporting at the international level if the information is to be reported in a format that facilitates comparisons between Member State or Contracting Party submissions. The IAEA has undertaken a number of initiatives that address the issue of nationally based reporting versus international reporting of waste management information. This publication provides technical guidance on developing and implementing nationally based waste inventory record keeping systems that consider issues such as (a) consistency in reporting for national and international obligations, (b) the need to provide information to future generations and (c) the possibility of a future international archive for waste repository records.

The IAEA officers responsible for this publication were K.W. Han and G.W. Csullog of the Division of Nuclear Fuel Cycle and Waste Technology.

EDITORIAL NOTE

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1. INTRODUCTION

1.1. Background

Some IAEA Member States have established and implemented programmes to develop near surface [1] or geological repositories [2] to dispose of their radioactive wastes. These Member States have also established and implemented systems for managing records associated with the operation and closure of their repositories.

To manage radioactive wastes over a long time period, there is a need to compile, manage and maintain the variety of records that are generated [3] [4] [5]. The requirements for record keeping and its implementation may be documented in an individual Member State's national regulations and policies (see Section 2). The long term management of these records is discussed in IAEA-TECDOC-1097, "Maintenance of Records for Radioactive Waste Disposal" [6], which summarizes the benefits of a hierarchical records management system (RMS), and discusses the concepts of high level information (HLI), intermediate level information (ILI), and primary level information (PLI).

Within the PLI, a wide variety of information in support of radioactive waste repositories may be generated and managed by a variety of organizations within a Member State using one or more record keeping systems. An important component of the PLI is a Waste Inventory Record Keeping System (WIRKS), which provides a comprehensive and detailed description of waste repository inventories.

Figure 1, which is based on TECDOC-1097, illustrates the elements of a hierarchical RMS. Prior to closure of a repository, records are generated from activities such as:

(1) waste generation, processing, and transportation,

(2) monitoring (such as operational control, health protection, environmental),

(3) repository site selection/characterization,

(4) repository design, construction, operation, closure and performance assessment, and

(5) repository inventory management.

These pre-closure records comprise the PLI set, which is generated and managed principally to support waste management facility licensing, operation and closure. Among other records, the PLI includes waste inventory records as well as documentation such as facility license applications, which may include repository performance assessments (PA) and environmental assessments (EA). The record keeping system for waste inventory records is the WIRKS, which is a subset of the overall PLI.

Many records may be generated during pre-disposal waste management (generation, handling, processing, storage) prior to repository operation. As such, a WIRKS is likely to be needed prior to repository operation, notably to support storage operations. Additionally, storage operations may be integrated with other operations, such as waste processing. Therefore, implementation of a WIRKS is needed as early as possible even if disposal has not yet been implemented.

After closure, a Member State may implement an active institutional control phase. Prior to this phase, a Member State may decide that some of the pre-closure information that is compiled may not need to be retained after closure. IAEA-TECDOC-1097 indicates that much of the information that may be suitable for retention after closure may be in documentation such as the license application, the PA and the EA for a repository. A principal use of this information, called the ILI set, is to assist in repository intervention activities (remediation or waste retrieval) should this be deemed desirable or necessary.

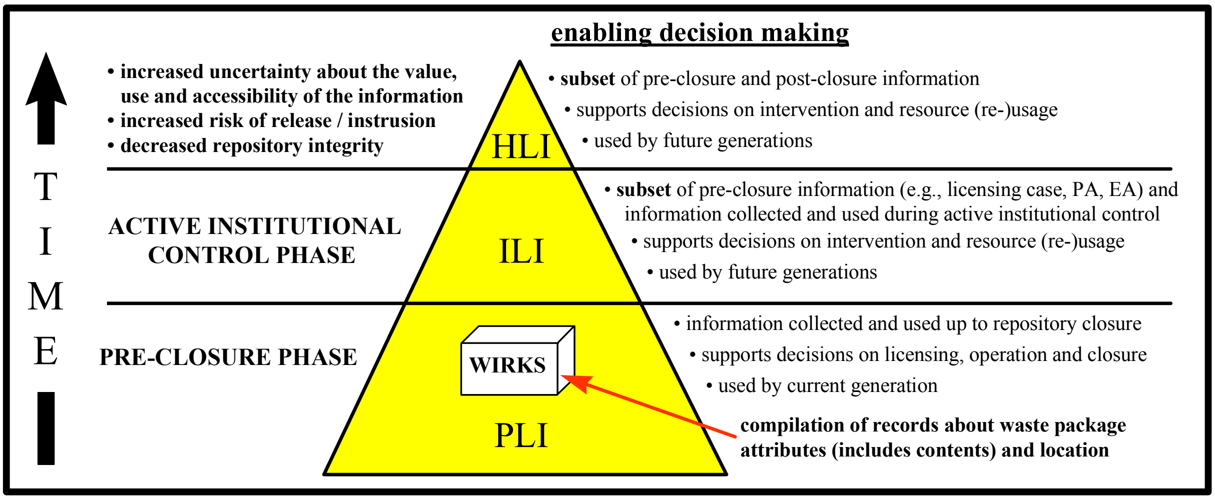


FIG. 1. Elements of a records management system.

If there is no active institutional control phase or after this phase has concluded, Member States have to decide what records will need to be retained for future generations since it is important that future generations are aware of the potential hazards involved. This will allow them to make informed decisions concerning the safety of the repository, to avoid inadvertent intrusion and to assist decision making on the possible reuse of the site, its contents and surrounding controlled areas. This last set of records is called the HLI set.

IAEA-TECDOC-1097 provides technical guidance to Member States for the establishment of an RMS. However it does not give specific advice for what these records will cover, which may be governed by applicable national regulations. TECDOC-1097 also states that maintenance of relevant records from the PLI is believed to be the most reliable manner to convey information to future generations. It further states “The PLI is present in each Member State with a radioactive waste programme, and therefore no extra work is needed to establish the PLI”.

At the second consultants meeting called for the preparation of this TECDOC, participants concluded that the above statement should have stated “The PLI *will be* present in each Member State with a radioactive waste programme, and, therefore, establishment of the PLI is outside the scope of this document”, which is believed to be the intent of the original statement. Currently, some Member States with radioactive waste management programmes do not have a WIRKS, which is part of the PLI, and other Member States do not have a documented framework for all of the information in their PLI set. One Member State recently announced [7] the implementation of a record archive in support of the institutional control phase of a closed repository. This archive could serve as a reference point for developing guidance for implementing a PLI set.

The concerted opinion of the participants at the second and third consultants meetings for this TECDOC was that more time, effort and cost is involved with the generation, compilation, processing, management, and maintenance of the overall PLI set, excluding WIRKS information, than for the WIRKS information alone. Therefore, the preparation of this TECDOC is envisaged to be only one step towards the assembly of Member State experiences with the PLI set.

A WIRKS represents a subset of the PLI. While this report provides technical advice about the development and implementation of a WIRKS, it does not cover any other aspects of the PLI, which could be the area where most Member State data are compiled and which represents a significant cost to those Member States with large nuclear programmes. The participants at the third Consultants meeting recommended that technical advice on the development and implementation of a comprehensive PLI should be provided.

The information accumulated in a WIRKS is the primary information for a disposal facility and arises from data created for individual waste packages. A significant step is the formation of individual waste package records, which are compiled in a WIRKS. Systems need to be in place to create the necessary data at the appropriate time, which may be before or at the time of waste packaging as well as at the time of transfer to a repository.

1.2. Objectives

With reference to considerations, plans and arrangements being made in some Member States, the objectives of this report are to:

(1) discuss and provide technical guidance to Member States for the establishment of a WIRKS; and

(2) identify a methodology for the compilation and management of appropriate records for a WIRKS.

The information and technical guidance presented in this publication may assist Member States in ensuring that records for a WIRKS are identified and compiled at appropriate times during the pre-operational, operational and closure phases of their repositories.

1.3. Scope

This report is intended to serve Member States planning to develop or implement radioactive waste disposal programmes and to discuss possible ways for compiling and managing information about the inventories in their radioactive waste repositories, which includes low and intermediate level radioactive waste (short lived and long lived) and high level radioactive waste [8]. It is not intended to serve as a mechanism to qualify or certify existing WIRKS in Member States.

This report identifies generic information that may be recorded in a WIRKS, as identified by consultants and based on their collective expertise in radioactive waste management. The report only addresses the information to be recorded in a WIRKS, other information categorized as PLI information is not addressed in detail.

It is recognized that advances in information management technology may have a significant impact on the implementation of new or upgraded WIRKS. Discussions of existing WIRKS in Member States are provided solely as examples of how WIRKS have been implemented in these Member States in the context of their national waste management programmes. These discussions provide technical guidance on the information that could be managed by a WIRKS. The data models discussed merely provide a framework to facilitate an understanding of the information that would be managed.

This report does not include reporting requirements for safeguards purposes (see Section 2.8).

1.4. Structure

This TECDOC addresses questions on why a WIRKS is needed (Section 2), what information could be recorded (Section 3) and how, when and by whom a WIRKS could be implemented (Section 4).

Section 7 provides information about experiences with WIRKS in several Member States.

2. THE NEED FOR A WASTE INVENTORY RECORD KEEPING SYSTEM

This section describes the needs for information that could be maintained in a WIRKS.

To support the implementation of a radioactive waste repository, where the intention is to isolate waste from humans and the environment for hundreds to thousands of years, there is a need to create records [1]–[5] and, therefore, there is a need for record keeping systems.

Since repositories may be subjected to either inadvertent or intentional future human actions after they are closed, the expected long term performance of a repository may be impaired. The likelihood of inadvertent human actions disturbing the repository system can be reduced by the long term maintenance of records that provide warnings and information regarding the presence of the waste and its potential hazard. Such information could also facilitate a possible retrieval of repository contents if future societies determine that retrieval is desired or warranted.

Assuring the transfer of information to future societies enables them to make informed decisions regarding the repository design and contents. Present day societies should facilitate the possibility for future societies to make their own judgements about a repository and the continued management of its contents.

Adequate information about repositories should exist at the time of repository closure. In addition, assurance is needed that some of this information will be retained for a long period of time following repository closure.

WIRKS records in support of one repository can assist with the provision of information to WIRKS at other repositories or to other waste management related information systems, such as national or regulatory information systems within a Member State. The implementation of multiple WIRKS within a Member State should consider the exchange of information between these systems.

The implementation of a WIRKS in a Member State can support the exchange of information with other Member States (in the event that multi-national repositories are established) and with international systems, such as the IAEA’s Waste Management Database (WMDB) [9]. Consideration of issues related to information exchange during WIRKS implementation can reduce or eliminate redundancies in the reporting of information and, therefore, can reduce or eliminate inconsistencies. They can also reduce the costs associated with data reporting.

The implementation of WIRKS in Member States could support reporting requirements arising from the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* [10].

The following subsections list specific needs for implementing and maintaining a WIRKS in support of radioactive waste disposal, including pre-disposal activities.

2.1. Planning and repository operations

A repository may have limitations reflected in waste acceptance conditions that are based on a safety assessment or other means [11]. For example, there may be limitations on the quantity of waste, the quantities of specific radionuclides, toxic/hazardous materials, and chelating agents that are authorized for disposal or for other considerations, such as operational constraints. Therefore, repository operators maintain detailed records of the waste that has been disposed to help optimize operations for their repositories [12] (refer to "Member State experience with WIRKS – Germany" in Section 7). Operators may also use these records, in conjunction with surveys of predicted future arisings and a knowledge of the quantities of waste in storage, to forecast when their repositories will be filled and to plan future repositories.

A WIRKS can be used to plan for waste receipts and to track wastes from the agreement to accept them from a generator through to their final disposal. Tracking could include the recording of changes made to wastes such as compaction, concentration, repackaging or grouting, as well as the waste's final location. Some data that are recorded at the time wastes are placed into a repository may have been generated at earlier times, for example at or before the time that the waste was processed.

Even if a Member State's disposal strategy may not include provisions for waste retrieval, that is, there may be no intention of retrieving waste, waste retrieval may become necessary. For example:

(1) prior to closure, ongoing assessments of the repository may lead to retrieval of some of the waste (either permanently or to perform remedial actions, such as providing new containers),

(2) during the active institutional control phase, intervention may be required, which may involve modification to the repository and this may also include waste retrieval, and

(3) future societies may decide to retrieve part or all of the repository inventory.

Regarding (1) and (2) in the above list, a WIRKS needs to accommodate the accumulation of waste as well as the removal of waste from a repository in order to maintain an up-to-date, actual repository inventory. It is unlikely, but still possible, that future societies will use a present day WIRKS to adjust a repository's inventory.

2.2. Licensing

Member States may have legal or regulatory requirements to implement and maintain a WIRKS as a prerequisite to obtaining a disposal facility license and for maintaining the license [13], [14]. For example, the Hungarian Government's Ministerial Decree 25/1997 (VI.18.) IKIM [15] on record keeping for radioactive materials requires that the National Registry of Radioactive Materials keep records of the amount and activity of all radioactive waste at storage and disposal facilities. These records should be based on the waste inventory record keeping systems maintained by the operators of storage and disposal facilities. An operator's waste inventory record keeping system has to be approved by the Hungarian Atomic Energy Authority.

2.3. Approval/compliance records

A WIRKS can be used to record the approval of a generator's waste conditioning processes, (for example, vitrification) or waste streams as a means to pre-approve waste packages for acceptance. It can also be used to record the approval of individual waste packages or consignments of waste packages.

To ensure that waste packages conform with acceptance requirements, facility operators may perform a number of routine quality checks on packages. These checks result in a variety of records, which can include:

(1) checks versus limits for radiation field, contamination, heat generation, etc.;

(2) non-conformance records, corrective action records.

2.4. Reporting

A WIRKS could serve as the basis for producing reports that may be required by regulatory or license conditions or that are created to support operations and planning. For example, periodic reports can provide volume and activity totals in storage or disposal facilities [16]–[21].

Other reports, based on information recorded in a WIRKS, could include lessons learned and could cover experience gained with the operation and monitoring of repositories to provide feedback about how to improve both current and future repository operations, including waste acceptance.

2.5. Inputs for performance, safety and environmental impact assessments

To assess the performance and safety of repositories, which can span very long time periods (e.g., geological scale), computer models may be used. An essential input to these models is a repository's inventory. Prior to operation of a repository, safety assessments may use estimates of the repository's inventory based on WIRKS data for stored waste. As waste is received into an operating repository, a WIRKS is used to record the emplacements, which can be used to provide data for operational and post closure assessments. For example, it can be used to add up and decay correct the activities of the radionuclides that are in the waste that is actually placed into a repository.

2.6. Remediation or selective retrieval activities

The objectives of radioactive waste disposal are to remove waste from the human environment and to ensure that it remains isolated from that environment and inaccessible to humans until the radioactivity has decayed away. This may be impossible to achieve for very long lived radionuclides. Therefore the intention is to design repositories that ensure that any radioactivity that enters back into the environment in the future does so at levels that result in acceptable risks to humans and the environment.

Repositories may not perform as expected. For example, there may be unexpected package or engineered barrier failures, resulting in a need or a desire to perform remedial actions, which may include waste retrieval. Retrieval requires a knowledge of not only the overall inventory of a repository but also a knowledge of the contents of individual packages, or groups of packages, and their locations in the repository, which requires a knowledge of the repository's structure.

Retrievability is the ***theoretical ability*** to recover wastes from a repository, regardless of how difficult that may ultimately prove to perform. Retrieval is the actual act of waste recovery from a repository. Organizations responsible for implementing repositories tend to refer to retrievability as an unlikely and probably unnecessary option. On the other hand, the public tends to express concern about how retrieval could actually be performed.

The issue of retrievability centres on:

(1) storage (intent to retrieve) versus disposal (no intent to retrieve),

(2) disposal, including the accessibility of waste for retrieval, and

(3) the impact of accessibility on waste confinement and containment.

A variety of terms have been suggested to distinguish a repository without retrievability features from one with retrievability features, such as *'very long term interim storage'*, *'reversible geological storage'*, and *'monitored geological repository'*.

2.7. Information for other repository owners

In some jurisdictions, the performance and safety assessments of one repository may require a consideration of the impact of other nearby repositories. As such, it may be necessary to provide information about the inventory of one repository to another repository proponent in line with paragraph 2.26, Part (b) of the Basic Safety Standards [22].

2.8. Safeguards

Safeguards are essentially a technical means of verifying the fulfilment of political obligations undertaken by States in concluding international agreements relating to the peaceful uses of nuclear energy. The technical objective of safeguards is the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection.

The IAEA has identified specific requirements for records and reports related to safeguards [23]. The IAEA's Reference Manual on Safeguards [24] contains extensive and explicit instructions for the recording and reporting of inventories of materials under safeguard (Inventory Change Reports, Physical Inventory Listings, and Material Balance Reports). These instructions are provided in the Reference Manual under Model Code 10.

Final disposal of spent fuel will accumulate large inventories in a disposal site creating a long term proliferation risk. Safeguards for spent fuel disposal in geological repositories, therefore, have to be continued even after the repository has been back filled and sealed. The effective application of safeguards must assure an unbroken continuity of knowledge that the nuclear material in the repository has not been diverted for an unknown purpose. For effective and efficient application of safeguards, the IAEA requires vital information on facility design and operation. Part of the required information will also flow from the other obligations, for example, safety, waste disposal, environmental protection, etc. An integrated approach to document all required information will be an advantage to all concerned. Safeguards confirmation that the material has not been diverted, established by confirmation of integrity of containment, can also ensure that safety criteria have not been breached. The IAEA has proposed requirements for records and reports related to safeguards for geological repositories [25].

This TECDOC does not provide guidance for integrating reporting requirements for safeguards material into the WIRKS data set. Member States intending to integrate safeguards accounting into their WIRKS should refer to the references cited above.

2.9. Financial

A WIRKS can assist with invoicing generators for cost recovery for disposal. It can also be used to assess future liabilities for wastes that have not yet been emplaced into a repository.

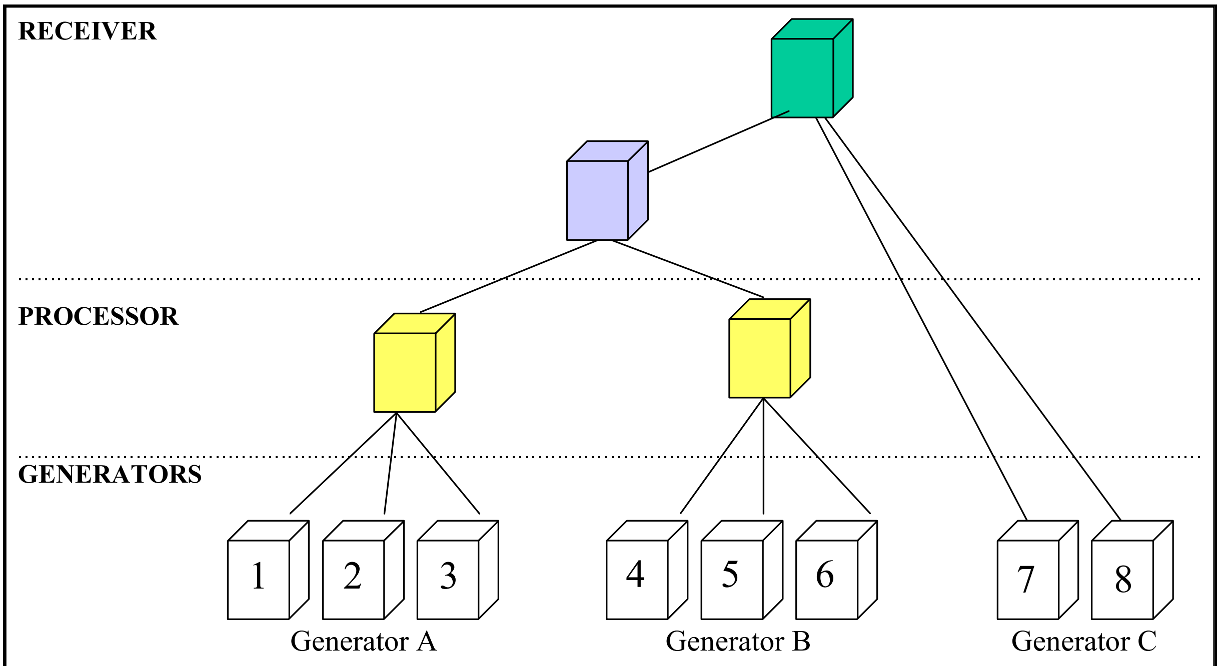
3. WIRKS INFORMATION

This section provides technical guidance for defining WIRKS information, which is based on the experiences of experts from several Member States (see "Contributors to Drafting and Review") to meet the needs of users identified in Section 2. It is worth noting that the information that is to be managed by a Member State within a WIRKS should be identified based on consultations with the organizations or groups that will use the waste inventory data, such as regulators, generators, the public, computer modelers and repository operators. The identification of information should also be considered in the context of information exchange with international organizations.

A WIRKS represents what is commonly referred to as a waste inventory database, which is used to record the properties of waste packages and their locations, which, in turn, are used to compile a repository inventory. With regards to package properties and location, a single waste package may contain other waste packages that originated from one or more generators, as illustrated in Fig. 2. The placement of packages within packages is referred to as package nesting in this TECDOC.

In some Member States, a waste receiver only needs to track packages back to the organization that created the package, which is considered to be the sole generator of the waste. In other Member States, the receiver must track the waste back to each generator if a package contains waste from more than one generator [26]. For the latter case, there are various models for implementing the requirement to track back to each generator. In this TECDOC, two possible implementation models are described — see Figs 3 and 4.

In these models, the important factor to note is that tracking can be performed only at the waste package level. If a package contains nested packages from more that one generator, the waste can be tracked back to each generator only if (a) prior to nesting, each package only contains waste from a single generator and (b) each nested package can be clearly identified. Tracking cannot be performed at the sub-package level, that is, it cannot be performed on individual items within a package.



In this example, three generators have waste. Generators A and B transfer their waste packages to a processor, which processes their wastes separately and creates two new packages. These new packages are transferred from the processor to a waste receiver, which puts these new packages into another new package. The third generator transfers packages directly to the waste receiver.

The receiver places all waste packages that it created or that it received into another new package. If all packages use the record model shown in Figure 1, then all packages can be tracked from point of generation to final disposition.

FIG. 2. Schematic representation of waste package nesting.

Models 1 and 2 are similar in that they both can enable the tracking of nested packages. However, for Model 1:

(1) all waste package records have the same structure,

(2) there is no limit to the levels of nesting of packages (since all packages have the same record structure), and

(3) the model can be used whether or not tracking is required for nested packages.

For Model 2:

(1) there are two waste package record structures if nested packages have to be tracked, one for the main package (which contains the nested packages) and one for nested packages,

(2) there can be a single waste package record structure if nested packages do not have to be tracked, which is comprised of information that would have been otherwise contained in separate waste package record structures,

(3) the model is best suited to cases where a single level of nesting is used, and

(4) if the tracking of nested packages is not required initially and a single record structure is implemented, the database structure would have to be redesigned to implement a dual record structure if a decision is made later to track nested packages.

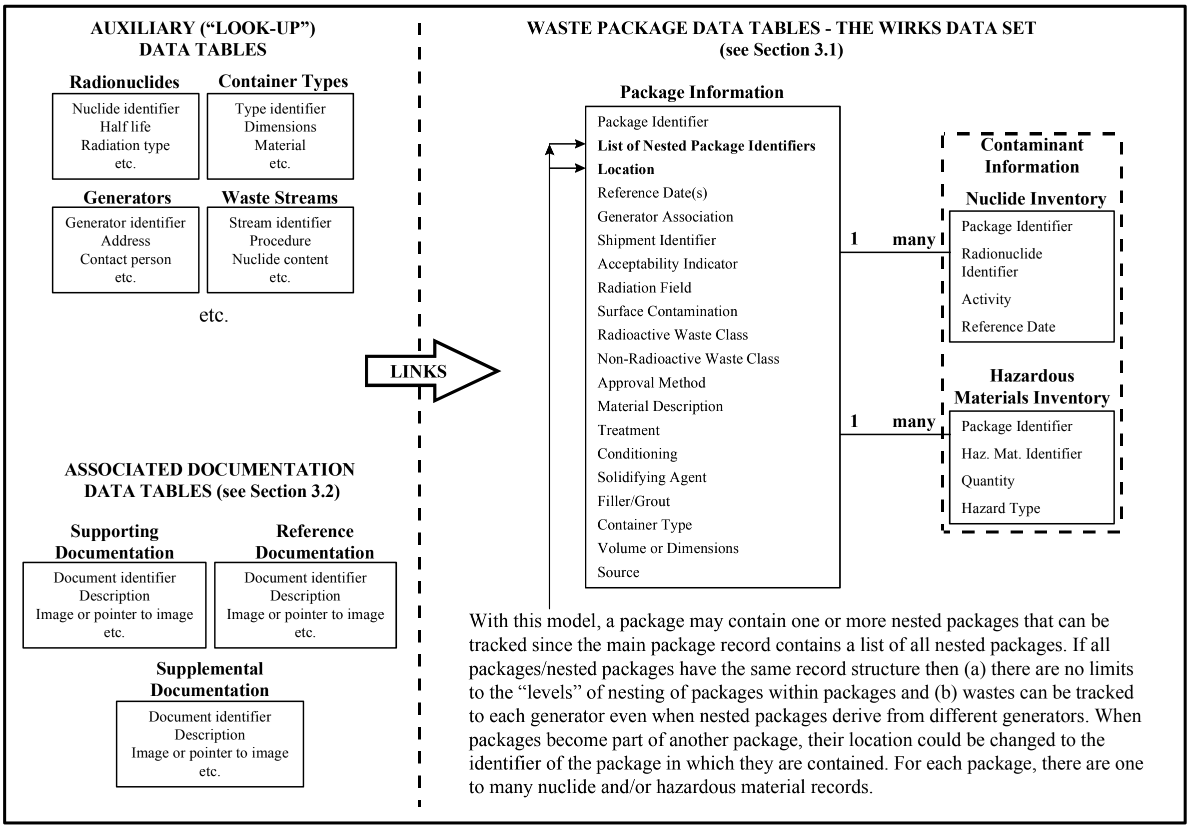


FIG. 3. Schematic representation of possible WIRKS information (Model 1).

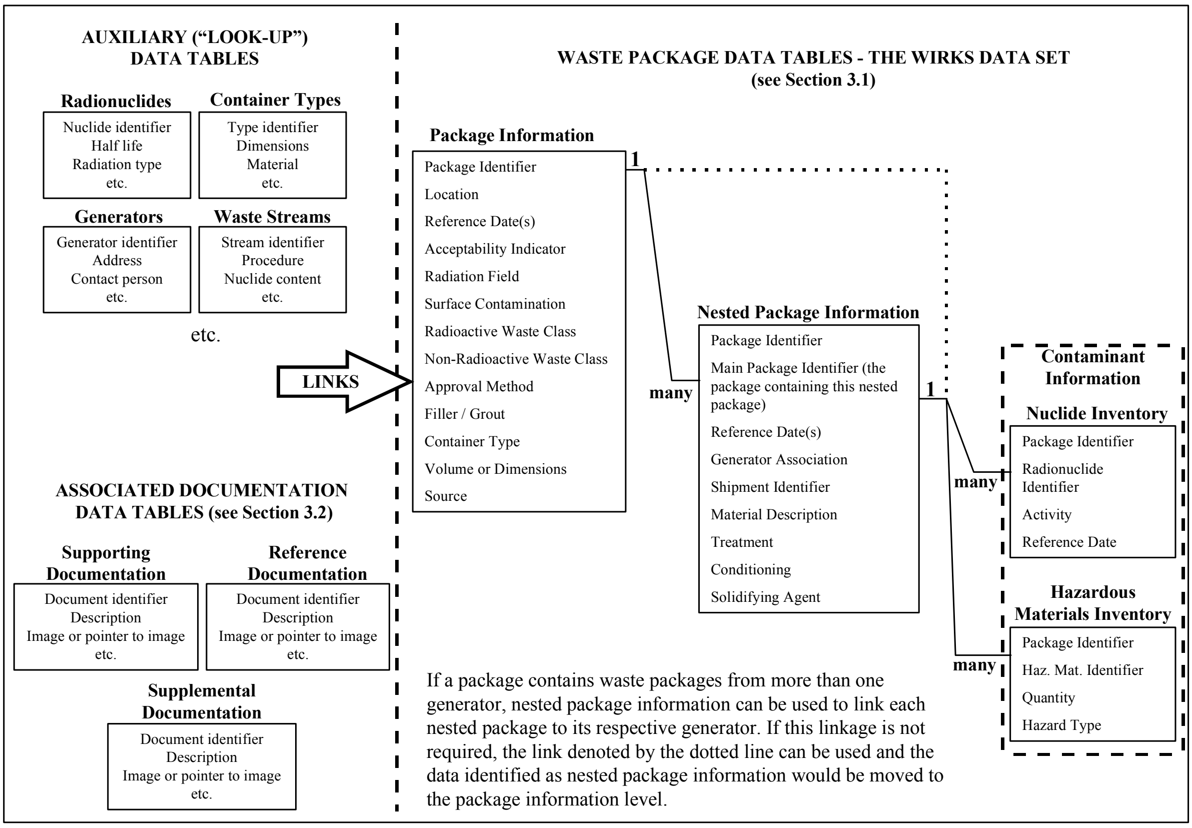


FIG. 4. Schematic representation of possible WIRKS information (Model 2).

For Model 1 (see Fig. 3), the Package Information Table contains a "List of nested package identifiers" field. This field is used to record the identifier numbers of all packages that are placed into another package. For Model 2 (see Fig. 4), the Nested Package Information Table contains a "Main package identifier" field to record the identifier number of the package that contains this nested package.

Nested packages would no longer be physically managed as individual packages since they would be located inside another package that is handled as a single entity. However, the original data records for the nested packages would be retained as separate records in the WIRKS because the information for these packages needs to be retained. Since the physical location of nested packages would be identical to the physical location of the package in which they are placed, the location field in Model 1 could be updated for nested packages to contain the identification number for the package in which they are contained.

Model 1 allows the greatest flexibility for package nesting and it is simpler to implement since a single record structure can be used for the Waste Package Information Table. In addition, Model 1 applies whether nested packages are tracked or not, whereas Model 2 would require either (a) modification of an existing WIRKS to add nested package tracking or (b) implementation of a dual record structure model to allow for the addition of nested package tracking, whether or not it is implemented. It is worth noting that WIRKS have been implemented in some Member States using a dual record structure to track nested packages, per Model 2, and these WIRKS have been reported to work well.

A waste inventory database is not a stand alone information set. While it lists package properties and locations, normally it would not include information about how those properties were derived. In addition, while an inventory database may define where a waste package is located within a repository, it is unlikely to provide information about the repository's structure, which would be needed by someone unfamiliar with the repository design if that person wanted to locate a package. As such, a WIRKS can be considered to be comprised of a data set (see Section 3.1) and associated documentation (see Section 3.2), as represented in either Fig. 3 or Fig. 4.

3.1. Example WIRKS data set

The example WIRKS data set is represented by different tables of data. The package information tables contain data that are uniquely associated with an individual waste package. The contaminant information tables identify the radioactive and non-radioactive contaminants in a package, which are used to determine the radioactive and non-radioactive hazard classes. The package information tables are summarized in Table I.

Prior to the nesting of packages using Model 2, all of the information in the Package Information Table and in the Nested Package Information Table would be in only the Package Information Table. When nesting occurs, this information would be split between the Package Information Table and the Nested Package Information Table for the following reasons:

Table I. Possible WIRKS Package Information Tables with Example Data Set Fields

Model 1 (see Fig. 3) Package Information Table	Model 2 (see Fig. 4) Package Information Table	 Nested Package Information Table
Package Identifier	Package Identifier	Package Identifier
List of Nested Package Identifiers		Main Package Identifier
Location	Location	
Reference Date(s)	Reference Date(s)	Reference Date(s)
Generator Association		Generator Association
Shipment Identifier		Shipment Identifier
Acceptability Indicator	Acceptability Indicator	
Radiation Field	Radiation Field	
Surface Contamination	Surface Contamination	
Radioactive Waste Class	Radioactive Waste Class	
Non-Radioactive Waste Class	Non-Radioactive Waste Class	
Approval Method	Approval Method	
Material Description		Material Description
Treatment		Treatment
Conditioning		Conditioning
Solidifying Agent		Solidifying Agent
Filler/Grout	Filler/Grout	
Container Type	Container Type	
Volume or Dimensions	Volume or Dimensions	
Source	Source	

(1) Prior to nesting, each individual package would contain information for some or all of the following:
- Acceptability Indicator
- Radiation Field
- Surface Contamination
- Radioactive Waste Class
- Non-Radioactive Waste Class
- Approval Method
- Filler/Grout
- Container Type
- Volume or Dimensions
- Mass
- Source

However, once packages are placed into another package, the information in these data fields is needed only at the level of the final package, not at the nested package level. For example, prior to nesting, each of two packages may have the same or different radioactive waste class. After nesting, the resultant package may not have the same radioactive waste class of either of the original packages. As such, the resultant value is recorded in the Radioactive Waste Class field in the Package Information Table after nesting.

(2) After nesting, packages that are placed within another package would have the information that is listed in the Nested Package Information Table because each nested package could contain different information for the data fields listed. There may be no effective way to add or convert the information for various packages, as it would exist prior to nesting, into single data values for the Package Information Table after nesting.

Some of the information in WIRKS records may be time dependent. For example, radionuclide activities decay with time. As such, one of the reference dates associated with waste packages may be a reference date for performing radioactive decay calculations. Depending upon how a WIRKS is implemented, this decay reference date may be recorded in the Package Information Table, the Nested Package Information Table or in the Contaminant Information Table.

Over time, changes to data field values may be required for other than time dependent reasons. For example, improvements in waste characterization may require changes to contaminant data values. The maintenance of data histories can be very beneficial for tracking changes. Some Member States have implemented data histories to maintain records of old and new data values (for as many times as data are changed) plus they record who changed the data and why the changes were made.

Both Fig. 3 and Fig. 4 indicate that the possible WIRKS data set contains contaminant information tables, which are represented by a Nuclide Inventory Data Table and a Hazardous Materials Inventory Data Table. These tables would contain one record for each contaminant associated with each package (Model 1) or with each nested package (Model 2).

The left hand side of Fig. 3 and Fig. 4, separated by the vertical dashed line, shows possible, additional data tables. The auxiliary ("look up") data tables typically are used to facilitate data recording in the WIRKS data set. They may be used by data entry personnel to select information from lists, such as the names of radionuclides or the types of containers. They may also be used to maintain information that is associated with the data set. For example, for a given waste package, the data set may be used to record the type of container used. The auxiliary data tables could be used to record specifications for the container, such as dimensions, displacement volume, manufacturing data and qualification results. When a data entry person selects a container type from a look up list, the container's displacement volume could be referenced from an Auxiliary Data Table to speed up data entry and to ensure that the correct container volume is used for the package.

An Auxiliary Data Table could be used to record the physical data of radionuclides (half-life, radiation type, daughter nuclides, etc.), data related to waste generating companies (address, contact person, etc.), and information on waste streams, for example, for "pre-approved" waste from specific processes [27]. Some or most of this information could be directly maintained in the WIRKS data set. However, for a complex WIRKS there are significant advantages in maintaining some information in auxiliary data tables that are separate from but linked to the WIRKS data set. Typically, auxiliary data tables are maintained by a system administrator and cannot be modified by data entry personnel (a quality assurance measure).

The maintenance of histories for values in auxiliary data tables can also be very beneficial for tracking changes. Some Member States have implemented histories to maintain records of old and new values in auxiliary data tables (for as many times as values are changed) plus they record who changed the values and why the changes were made.

As discussed previously, while the WIRKS data set is used to record the properties and location of a package in a repository, typically it is not used to record how those properties were determined nor is it used to record the structure of the repository, which is needed to locate the package. As illustrated in Fig. 3 and Fig. 4, this information is typically maintained separate from the WIRKS data set. However, Fig. 3 and Fig. 4 illustrate that this associated documentation could be linked to the WIRKS data set. Section 3.2 discusses the nature of this associated documentation and Section 4 discusses possible implementations for linking (or merging) associated documentation to (into) the WIRKS data set.

Table II lists the various data fields that were identified in Table I for the example WIRKS data set. In addition, Table II lists typical uses for the data fields and it provides examples of the types of information that could be recorded in those fields.

The following provides additional information about the example data fields listed in Table II.

***Package Identifier**:* The package identifier, including nested package identifiers and main package identifiers, should be unique. It can be any combination of numbers and characters that conforms to a scheme specified by a WIRKS. The package identifier can be allocated by the waste receiver or by the waste generator, in which case it could be of benefit to include a generator-code component to ensure uniqueness.

Regarding the issue of uniqueness, a unique identifier for individual packages can be implemented various ways, as indicated by the examples below:

ID numbers assigned by waste receiver to each generator; includes a generator code component to ensure uniqueness		ID numbers assigned by individual waste generators — may not be unique	
Generator	Package ID format	Generator	Package ID format
AECL	AECL-12345	AECL	AA-12345
OPG	OPG-12345	OPG	AA-12345
		To ensure uniqueness in the WIRKS, the Package Identifier field can be combined with information from the Generator Association field to form a unique identifier (this is a commonly used database approach)	

Typically, this data field is used to locate package records in a WIRKS, which are, in turn, used to retrieve additional package characteristics, including the physical locations of packages. Determining the physical location of packages facilitates retrieval, which is particularly important for packages placed into storage facilities.

The package identifier can also be used to link information in a WIRKS to other information systems, be they automated or paper systems.

***Location**:* This field records the physical location of a package within a waste management facility (processing, storage or disposal). The level of detail recorded for the location of a waste package can be highly variable. For example, the location of waste packages with similar characteristics may only indicate which part of a repository they are located within, for example Vault 5. In other cases, the precise location of individual packages may be specified, such as Disposal Unit A, Vault 5, Cell B, Grid X, Y, Z.

While a Member State may specify that it has no intention of retrieving waste once it is placed into a repository, the location of a package within a repository should be recorded in a WIRKS (refer to Sections 2.1 and 2.6).

Table II. Example WIRKS Data Set Fields, Typical Field Uses and Examples of Field Values for the Package Information Tables

Example Data Field	Typical Use	Example(s) of Information Typically Recorded
Package Identifier, Nested Package Identifier or Main Package Identifier	**ID, Link, QC, FM**	99-12345, ACME-12345
Location *	**ID, Link, FM**	vault 62H: grid 34-12-2
Reference Date(s)	**QC, FM**	2000.07.04
Generator Association *	**ID, Link**	ACME Waste Company, GEN-123
Shipment Identifier	**ID, Link**	12345, ACME-123
Acceptability Indicator *	**QC, Link, FM**	Acceptable, HQ123.6
Radiation Field	**QC, FM**	2.1 μSv/hour (see Note 1)
Surface Contamination	**QC, FM**	5 kBq alpha/cm^2 (see Note 1)
Radioactive Waste Class *	**FM, Link**	high level waste, LILW-SL, A, 220
Non-Radioactive Waste Class *	**FM, Link**	non-hazardous, acutely toxic, HazClass1
Approval Method	**QC, FM, Link**	waste stream 123, reference to document XYZ
Material Description*	**QC, FM**	trash, resin, equipment
Treatment *	**QC, FM**	incineration, compaction, reverse osmosis, none
Conditioning *	**QC, FM**	bituminization, cementation, vitrification, none
Filler/Grout *	**QC, FM**	concrete, grout, none
Quantity of Filler	**QC, FM**	0.3 m^3, 5 kg, % of package (see Note 1)
Solidifying Agent *	**QC, FM**	cement, SA1, none
Quantity of Solidifying Agent	**QC, FM**	0.6 m^3, % of package (see Note 1)
Container Type *	**ID, Link, FM**	drum, Type 1, none
Container Volume or Dimensions *	**FM**	15 m^3, 1 m × 10 m × 1.5 m (see Note 1 and Note 2)
Mass	**QC, FM**	kg
Source (origin) of waste	**FM**	Reactor Operations, Nuclear Applications

Data Field Use

ID: information that uniquely identifies something (e.g., a package or a generator)

Link: information that links one or more things together (e.g., generator ID is linked to generator information such as name, address, contact person, et cetera)

QC: quality control — information related to the quality of waste packages and/or the quality of the information that describes the properties of waste packages

FM: facility management — information related to the management of an operating waste management facility, such as package location, package dimensions, et cetera

Note 1: The measurement unit is either a specified default or is recorded in addition to the quantity

Note 2: Some waste may not use a container (such as equipment); in this case the volume or dimensions of the item itself would be entered into the database along with Container Type = none

* Denotes information that could reference or be copied from Auxiliary Data Tables

The location field can be used to track waste through treatment and conditioning. For example, solid waste may be removed from its containers and processed (or the containers could be retained and processed as well, for example, by super compaction). The location of the packages that were put into the process could be changed to indicate that the original packages no longer existed. For example, location could be “processed”. The data associated with the original packages would be retained and could be used to compile the characteristics of the packages that are generated as a result of processing.

Reference Date(s)*:* One or more reference date fields may be implemented to allow the recording of various dates, which serve various purposes. If more than one reference date field is to be used, each field is typically assigned a different field name, such as decay reference date, received date, radiation/contamination measurement date, processing date, storage date, disposal date, etc.

One reference date is typically the date that the information pertaining to a waste package was last updated This is often the date that the package was emplaced into a repository (the last data field that is updated would likely be the location of the package in the repository). Waste receivers can use this date, along with the radioactivity reported in the package in a “decay reference date” field, to determine the radionuclide inventory in a package at the time that it was emplaced into a repository.

Generator Association*:* The generator association field identifies the generator or other agent that delivered the waste to a receiver. The field could contain either a generator’s name or a coded ID and typically is linked to additional information about the generator elsewhere within an information network.

If a waste generator cannot be identified for waste (for example for radioactive materials from an abandoned site), then it may be more appropriate to record a geographical location for the generator association code. Some Member States specify that any organization that processes waste (packages, re-packages, treats, and/or conditions) is considered to be the generator of the resultant waste. Therefore, any organization that manages waste from an abandoned site is considered to be the generator of that waste and is identified in the WIRKS as the generator. This approach eliminates the possibility that a generator cannot be identified.

Shipment Identifier*:* This field is used to record the unique identifier of the shipment or consignment for the waste when it was received. The shipment or consignment can consist of one or many waste packages from one of more waste generators and there may be one or more waste data sheets that document the properties of those packages. The shipment identifier can be allocated by the waste receiver or by the waste generator, in which case it could be of benefit to include a generator-code component to ensure uniqueness.

The shipment identifier links individual packages to a specific shipment, which can assist the invoicing for waste management services rendered by the waste receiver. This link can also help identify potential non-conformances and/or it can facilitate remedial actions (if one package in a shipment has non-conformances, others in the same shipment may also have non-conformances).

Acceptability Indicator*:* This field typically records or references the result(s) of document and/or waste inspections (e.g., receipt monitoring) that were carried out before or when waste was received. This field could contain the actual conformance report(s) or it could contain a link to data maintained elsewhere within an information network. The indicator could be a reference to any documentation used at the time the waste was received including, but not limited to, waste acceptance compliance issues.

This field:

(1) indicates whether or not the waste was accepted in accordance with specified criteria,

(2) may be complemented by a data field that records non-conformances or corrective actions, and

(3) may be complemented by a data field that records an agreed (between generator and receiver) deviation from specified criteria.

Radiation Field*:* This field is used to record the radiation emanating from a waste package. Radiation measurements may be carried out at various distances from the package. In addition, waste packages may or may not have shielding that is an integral part of the package or that is provided by way of an overpack. A WIRKS should record the distance at which the measurements were made, unless there is a default distance, and it should also record whether or not shielding was used to reduce the radiation emanating from the package. If a standard procedure is not followed, a WIRKS should record details of how specific measurements were carried out.

Radiation measurements are typically used to ensure radiation protection to persons involved in the transport and handling of waste. In some cases, waste forms have prescribed limits for radiation (for example, there may be a limit on the lifetime, accumulated beta-gamma dose in bituminized waste) and measurements are taken to ensure that radiation for a package is within these limits.

Surface Contamination*:* This field is use to record the type(s) and quantity(ies) of non-fixed radioactive material on the external surface of a package. Typically, this involves the measurement of non-fixed material for a specified surface area (e.g. 100 cm^2). If a standard procedure is not followed, a WIRKS should record details of how specific measurements were carried out.

Surface contamination measurements are typically used to ensure radiation protection to persons involved in the transport and handling of waste.

Radioactive Waste Class*:* This field records the classification of waste based on its radiological characteristics. At the time this report was written, there was no international consensus on the use of a standard classification system for radioactive waste. Typically, individual Member States use classification systems that are different from and pre-date the IAEA's proposed waste classification system [8].

Classification systems can be related to radiological protection during transport and handling and/or they can be related to the long-term management of waste. A dual classification system can be used to support both storage and disposal facility operation and licensing (see Member State experience with WIRKS – Canada in Section 7).

The radiological class of a package can be a name (e.g., high level waste) or a code (e.g., LILW-SL) that is linked to data maintained elsewhere within an information network.

Radiological waste classification systems are used assist decision making regarding the future management of the waste and to levy charges for processing, storage and/or disposal services.

Non-Radioactive Waste Class*:* This field records the hazard classification of waste that contains non-radioactive toxic or hazardous substances in amounts defined by the relevant regulatory body(ies) in a Member State.

This field could record either the names of the hazard class (e.g., acutely toxic) or a code (e.g., HazClass1) that is linked to data maintained elsewhere within an information network.

Non-radioactive hazard classification systems are used assist decision making regarding the future management of the waste and to levy charges for processing, storage and/or disposal services.

Approval Method*:* This field is used to identify whether or not a waste package was approved by the receiver on a case-by-case basis, typically for non-routine waste, or according to a stream/process approval method, typically for routine waste (see Section 3.2.1).

An approval method can record:

(1) the name of a stream or process (e.g. primary cooling circuit ion exchange resin),

(2) a code (e.g., waste stream 123), or

(3) a reference to documentation that describes the case-by-case approval method or the stream/process approval method.

The approval method could be complemented by a "waste stream ID" field. In this case, the approval method field would not be used to record the name or code of a waste stream (per bullets 1 and 2 above), it would only be used to record the actual approval method used.

The information for the bullets above is typically linked to data maintained elsewhere within an information network, which describes how limits for parameters (e.g., contaminants) were defined (e.g., how the average characteristics of a routine waste were established).

The approval of waste streams or processes in lieu of the case-by-case approval of packages upon receipt:

(1) facilitates the waste approval process,

(2) links waste packages to the process or activity that generated the waste, and

(3) helps identify potential non-conformances and/or it can facilitate remedial actions.

Material Description: This field is used to record a general description of the physical characteristics of the waste, such as trash, metals, resins, etc. It is often advantageous to maintain a list of material descriptions in look up lists in an Auxiliary Data Table.

The information that is recorded can assist repository operators in assessing issues such as biodegradability and gas generation from waste packages under repository conditions [27].

Treatment, Conditioning: These fields describe the waste processing (treatment and/or conditioning) method(s) applied to the waste. The processing methods can be either a name (e.g., bituminization) or a code (e.g. Process 2) that is linked to data maintained elsewhere within an information network.

If waste processing facilities are considered to be an integral part of the waste inventory system, then data management for these facilities may be considered to be an integral part of a WIRKS. For example, it may be necessary or desirable to track waste volumes and contaminant inventories through conditioning cycles. A record of the processing method(s) applied could be used to perform cost/benefit analyses of the various methods.

The processing (treatment and/or conditioning) method applied to the waste is an indicator of the waste's form, which influences the efficiency of disposal facility usage. It is also an important input for disposal facility performance assessment.

It is worth noting that the solidifying agent field (see below) and/or the treatment/conditioning fields can be replaced or complemented by a "waste form" field. For example, if the waste form is "cemented waste", then the solidifying agent is cement and the processing method is cementation. However, the reverse may not necessarily apply. For example, if the conditioning method is "polymerization", the solidifying agent may not be known.

Filler/Grout: This field contains a description of the material used to fill void volumes in a package. Typical fillers are cement or grout, which are used to improve a waste package's ability to resist deformation during stacking, which is important information for repository operators. If a filler is not used, typically the field contains the word "none".

Solidifying Agent: This field contains a description of the solidifying agent(s) that typically is added to waste to absorb or chemically bind free liquid. The solidifying agent can be either a name (e.g., cement or none) or a code (e.g., SA1) that is linked to data maintained elsewhere within an information network.

The type of solidifying agent(s) used is an indicator of the waste's form, which is important for disposal facility performance assessment.

Quantity of Filler or Solidifying Agent: These fields record the quantity of filler or solidifying agent contained in a package or it records the percentage of the package (e.g., the weight percent or volume percent) that can be attributed to the filler or solidifying agent.

Waste management facilities typically track the quantity of filler or solidifying agent in waste packages because it influences the efficiency of disposal facility usage.

Container Type: This field identifies the type of container used for the waste. The type can be either a name (e.g., drum, box, can, none) or a code that is linked to data, such as drawings, specifications, and dimensions, which are maintained elsewhere within an information network.

Container/Waste Volume or Dimensions: This field records the volume of the container or its physical dimensions. Typically, for standard containers, the selection of a container type results in a reference to the container's volume or dimensions from an Auxiliary Data Table to the WIRKS data set. If a container is not used, i.e., container type = none, (e.g., for bulk waste) this field would be used to record the volume or dimensions of the waste itself.

In some WIRKS, the volume recorded is the displacement volume of the package. For example, when cylindrical drums are placed into storage or disposal, some void space occurs between drums. As a result, a waste management facility operator may record the volume that the package would occupy in a storage or disposal facility, not the volume of the package itself. The approach that is used needs to be documented.

Typically, the container volume or dimensions are used to monitor the usage of available space within a storage or disposal facility.

Mass: This field is used record the mass of the waste package. If a default measurement unit is not used, the WIRKS should record the measurement units in an associated field.

In some cases, operators of waste management facilities may want to record various masses. For example, for handling purposes, the recorded mass may include both the mass of the package and the mass of a temporary shielding overpack to indicate the overall mass, which determines the type of equipment needed to handle the package. In other cases, only the mass of the waste, excluding the mass of the container, may be recorded. If the mass that is recorded is not always the mass of the package (container plus waste form), the WIRKS should indicate what the recorded mass value covers.

Source: This field is used to record the origin of the waste, which can be used to (a) focus attention on operational issues (current needs) and (b) assess liabilities (future needs). The IAEA intends to collect source information from Member States for its upgraded WMDB [28] according to the following:

Nuclear Fuel Cycle Waste	Non-Nuclear Fuel Cycle Waste
Reactor Operations *	Nuclear Applications **
Reprocessing	Defence
Fuel Fabrication, Fuel Enrichment	Decommissioning, Remediation
Decommissioning, Remediation	

* Includes waste from associated activities such as hot cell and wet fuel storage operations.

** Includes waste from isotope production and isotope use (including spent, sealed radioactive sources).

Table III lists the various Contaminant Information Table data fields that were identified in Fig. 3 and Fig. 4. In addition, Table III lists typical uses for the data fields and it provides examples of the types of information that could be recorded in those fields.

Table III. Example WIRKS Data Set Fields, Typical Field Uses and Examples of Field Values for the Contaminant Information Tables

Example Data Field	**Typical Use** (see Table II)	**Example(s) of Information Typically Recorded**
Package Identifier	see Table II	see Table II
Radiouclide Identifier *	**ID**	Co-60, Ag-110m
Activity	**QC, FM**	1.5 TBq (see Note 1)
Reference Date	**FM**	2000.01.01
Package Identifier	see Table II	see Table II
Hazardous Material Identifier *	**ID**	mercury, contaminant 123
Quantity	**QC, FM**	5 kg (see Note 1)
Hazard type *	**QC, FM**	toxic, flammable, non-hazardous

* Denotes information that could reference or be copied from Auxiliary Data Tables.

Note 1: The measurement unit is either a specified default or is recorded in addition to the quantity.

Package Identifier: see page 14

Radionuclide Identifier: This field identifies the radionuclide(s) contained in each package. The field can be linked to either the Package Information Table (Model 1 or Model 2 if nested packages are not tracked) or the Nested Package Information Table (Model 2 if nested packages are tracked).

The names of radionuclides could be linked to additional information, such as half-life, that is maintained in an Auxiliary Data Table.

For routine wastes, where the average characteristics may be the basis for waste acceptance by a storage facility or repository operator, the list of radionuclides, their quantities and their variability in a waste package may be referenced from look up tables that contain the average characteristics of a package (see Member State experience with WIRKS – Canada in Section 7).

The information in this field is typically used to determine the appropriate storage and/or disposal option if a Member State has implemented or plans to implement multiple options. For example, wastes may be segregated and stored and/or disposed according to a radiological classification scheme (see page 17) and/or to safeguard requirements, which are determined by the type(s) and activity(ies) of radionuclides in a package.

Activity*:* This field records the radioactivity of each radionuclide in a package or nested package. If the default unit Bq is not used, the units used (e.g., GBq, TBq) should be recorded in an associated data field.

Reference Date: If this field is in the Contaminant Inventory Table, it is likely to be the decay reference date (see page 16), which is used to perform radioactive decay calculations.

Hazardous Material Identifier: This field identifies the non-radioactive contaminants contained in each package or nested package. The field can be linked to either the Package Information Table (Model 1 or Model 2 if nested packages are not tracked) or the Nested Package Information Table (Model 2 if nested packages are tracked).

The contaminant can be either a name or a code that is linked to data maintained elsewhere within an information network. Contaminants could be linked to additional data, such as a toxicity rating, that are maintained in an Auxiliary Data Table.

The information in this field, in combination with the next field, is typically used to determine the non-radioactive waste class of the waste (see page 17).

Quantity: This field records the quantity of each non-radioactive contaminant in each package or nested package. Measurement units are typical mass units (g, kg) or they may be expressed as a percentage of the mass of the waste in a package. If a default unit is not used, the WIRKS should record the measurement units in an associated field.

Hazard type: This field identifies the hazard classification of a non-radioactive contaminant, such as toxic, acutely toxic, pyrophoric, etc. There may be a need or desire to track non-hazardous, non-radioactive components in waste packages, such as chelating agents that can mobilize radionuclides. Therefore, a possible entry in the hazard type field could be “non-hazardous”.

It is also important to record the uncertainty of data. This may be implemented by including uncertainty fields in a Contaminant Information Table and/or by providing this information in the form of supporting documentation.

3.2. Associated documentation

3.2.1. Supporting documentation

In addition to recording and managing waste package information within a WIRKS data set, it is necessary to record and maintain descriptions of how this information was derived in order to provide a basis for assessing or reassessing the performance, safety and environmental impact of repositories, not only by current societies, but also by future societies. Supporting documentation either describes how the average characteristics of a waste stream were determined or it describes how one or more waste packages were characterized on a case-by-case basis.

Typically, supporting documentation is used by a waste receiver to qualify the waste for acceptance into a repository. A WIRKS data set should provide a link to supporting documentation (see “Links” in Figs 3 and 4).

This section provides technical guidance for defining the kind of information that could be maintained as supporting documentation.

Examples of how WIRKS data set values could be documented include:

- information on a manifest, shipping record, data sheet, or disposal record/form;
- descriptions of how raw data were collected;
  - methods used to determine radionuclide activities in packages,
  - methods to treat waste (e.g., evaporation) which affects contaminant concentrations,
  - methods to assess non-radioactive hazards of wastes (e.g. leach rates of contaminants from waste forms),
- descriptions of quality assurance/quality control mechanisms;
  - inspections (e.g., methods to measure wall thickness of waste packages),
  - calibrations and standards used,
  - limits of detection on instrumentation,
  - calculation of data variability,
  - approval of a waste generator’s waste management QA system(s),
- descriptions of how raw data were processed/manipulated;
  - identification of numerical algorithms used,
  - list of assumptions and parameter values used in calculations.

Raw and processed data would be collected/derived by both generators (e.g., waste characterization) and waste receivers (e.g., inspection, compliance/receipt monitoring).

The distinction between routine and non-routine waste

Supporting documentation may not be the same for all wastes. As an example, some Members States have found that they need to manage supporting documentation from routine and non-routine wastes differently.

Routine wastes

Some processes or activities generate radioactive wastes that have consistent characteristics within some defined envelope and these are commonly known as routine wastes or waste streams. For these wastes, it is often possible to derive and document their average characteristics. In addition, some waste processing activities, e.g., vitrification, use process control to establish the average characteristics of the product. The product itself is not characterized — the product's characteristics are inferred (estimated) based on process knowledge.

In these cases, waste streams or waste products can be pre-approved for acceptance by the receiver. Documentation is created as a result of this approval process and it should be linked to the data set (see Section 3.3 for examples of linking).

Non-routine wastes

In some cases, average characteristics cannot be established for wastes (e.g., clean-up waste, decontamination waste, waste that does not conform to a receiver's general specifications, etc.). In these cases, generators are generally required to provided supporting documentation, case-by-case, which describes the waste's characteristics and how they were determined. This documentation should also be linked to the data set (see Section 3.3 for examples of linking).

The type and quality of documentation may be the same for routine and non-routine waste. The difference is typically how the information is presented.

A single document or set of documents may be used as the basis for routinely accepting routine waste. Waste shipments could merely reference the supporting documentation. For non-routine wastes, the format of supporting documentation may be the same as used for routine wastes, however, for individual waste shipments, information such as who characterized the waste, when it was characterized, how it was characterized, etc. would be provided on a case-by-case basis.

The preparation of supporting documentation for the case-by-case characterization of waste may be much more costly than establishing the average characteristics for routine waste. As such, it is likely to be advantageous for a waste management organization to identify and establish the average characteristics of routine wastes to the greatest extent practicable.

3.2.2. Reference documentation

As mentioned in Section 3.2.1, supporting documentation can indicate the parameters and assumptions that were used in determining WIRKS data set values, such as radionuclide activities. However, these parameter values and assumptions are typically not described in detail. For example, a supporting document may state that waste was "decay corrected" to a specific date; however, a supporting document is unlikely to list the radionuclide half-lives or describe the algorithms used for the calculations.

Future societies (see Section 1.1) may use different approaches to data manipulation and, therefore, maybe unable to understand how the work that is described by supporting documentation was performed unless relevant information is provided. Reference documentation provides a means to record and maintain such information.

A WIRKS data set would not typically provide a link to reference documentation. As such, the organization responsible for WIRKS Information should consider mechanisms to establish a link to reference documentation (see "Links" in Figs 3 and 4).

3.2.3. Supplemental documentation

Supplemental documentation has additional information related to the WIRKS data set but it typically would not be a part of either supporting or reference documentation. As an example, a repository owner may have detailed drawings showing chambers or sub-sections within a repository. This information would be needed, along with a description of a package's location in repository (which chamber or sub-section) for someone to locate the package.

A WIRKS data set would not typically provide a link to supplemental documentation. As such, the organization responsible for WIRKS information should consider mechanisms to establish a link to supplemental documentation (see "Links" in Figs 3 and 4).

3.3. Document management

The linking of a WIRKS data set with associated documentation can be based on a integrated WIRKS, in which all information is maintained within in a single record keeping system, or by using multiple record keeping systems. For the latter case, a WIRKS and a separate document management system could be used to manage all relevant information.

One organization within a Member State (see Member State experience with WIRKS – Canada in Section 7) has implemented a partially integrated WIRKS that includes both waste inventory data set values and supporting documentation. Currently, this WIRKS does not include either reference or supplemental documentation. A separate document management system exists for reference and supplemental documentation, which could also serve as a system for backup copies of supporting documentation.

Two Member States (see Member State experience with WIRKS – United Kingdom and Member State experience with WIRKS – France in Section 7) each have a WIRKS to manage data set values and separate document management systems for supporting, reference and supplemental documentation. The UK and France also use their WIRKS to track wastes through processing steps and they have national-based inventory systems to indicate the current national inventory and to predict future inventories.

Decisions about integrating information into a single record management system or the linking of separate record management systems are typically based on organizational, financial and technical considerations.

4. IMPLEMENTATION

4.1. Responsibility and timing for WIRKS implementation

The WIRKS has been identified in IAEA-TECDOC-1097 [6] as a component of an overall record management system for radioactive waste disposal facilities. The responsibility for and timing of a WIRKS, based on IAEA-TECDOC-1097, are as follows:

Member States should clearly identify the organization(s) that would be responsible for WIRKS at the earliest possible time. It would be prudent if Member States identified a lead organization that would define the goals, minimum record content and procedures of a WIRKS. This lead organization, which could be the regulatory body, should:

(1) identify the other organization(s) that would be responsible for defining, developing and operating WIRKS,

(2) ensure that information can be readily exchanged between various national organizations that have WIRKS and any central, national organization (and possibly exchanged with organizations in other Member State and/or international organizations),

(3) ensure that any identified high level information records [6] are transferred to the Member State's archive and possibly to an international archive (at the time this TECDOC was written, no such international archive existed), and

(4) ensure that appropriate quality assurance measures are applied.

The identification of organizations with responsibility for WIRKS needs to consider the long time scales of radioactive waste management. Business needs for document/information management typically consider time scales in the order of tens of years, whereas document/information management in support of radioactive waste management can consider time scales on the order of many decades or centuries. As such, it may be prudent to assign responsibility for WIRKS to a radioactive waste management organization, rather than to a generic document/information management group with relatively near-term business goals.

WIRKS implementation is best done in a step-wise manner. Waste management organizations should develop a WIRKS plan as early as possible in the development and implementation of their waste management infrastructures. They should also consult with organizations that have experience with WIRKS to obtain advice on what to do and what not to do. Even in the absence of a WIRKS, waste management organizations should organize their physical, hard-copy records in preparation for WIRKS implementation. International experience has shown that early planning and implementing for WIRKS can result in lower overall effort and cost to implement a WIRKS.

4.2. Data collection

The IAEA publication entitled The Principles of Radioactive Waste Management [3] states "*The identity, location and inventory of a radioactive waste disposal facility should be appropriately recorded and the records maintained*". As such, Member States should develop formal mechanisms for the collection of waste inventory data. This would include the specification of data entry forms and data formats as well as quality assurance–quality control measures to ensure completeness and accuracy of data. For data formats, international standards such as SI units [29] should be used.

4.3. Data reporting

The preparation of reports represents the most common use of data from a WIRKS. Data can either be reported "as-is" (for example, total quantities of contaminants in a package or repository) or processed (for example, radioactive decay algorithms can be used to determine radionuclide inventories at a specified time point).

Operational reports could include *ad hoc* reporting, which typically is not subject to formal specifications and provides quick looks at data for day-to-day, operational needs. In addition, formal operational reports, to report WIRKS data on a periodic basis, are used and typically are subject to formal specifications and quality checks. Descriptions of how data are processed for formal reporting should be maintained (see Section 3.3 for approaches to linking documentation to data sets).

A closure report would define the state of the repository inventory at a specified closure date and would be subject to formal specification and quality checks. Descriptions of how data are reported at closure should also be maintained (see Section 3.3 for approaches to linking documentation to data sets).

4.4. Maintenance of the WIRKS

A WIRKS is not a self-sustaining entity once it is initially implemented. Throughout its lifetime, changes may be necessary for some of the following reasons:

(1) problems are encountered (glitches or "bugs"),

(2) WIRKS users may request enhancements or improvements,

(3) additional data set items may be specified or existing items may be removed, and

(4) technological changes (e.g., hardware/software changes) may force a re-engineering of a WIRKS.

Therefore, an organization should be identified to ensure that the WIRKS is properly maintained, which, in turn, will ensure data integrity, security and accessibility during facility operation and upon closure [6]. This organization should also ensure that change control mechanisms are established to ensure that changes to the WIRKS are properly documented. The identified organization should have a extensive knowledge of the purpose of database fields and an extensive understanding of the nature of the values recorded in those fields. In France, this responsibility has been assigned to the waste management operators at ANDRA facilities.

5. SUMMARY AND CONCLUSIONS

(1) A WIRKS represents only part of an overall primary level information (PLI) set in support of radioactive waste disposal, which includes pre-disposal waste management activities (see Section 1.1).

(2) This TECDOC focuses only on the WIRKS component of the PLI. A separate document should be developed to deal with the overall PLI.

(3) The purpose of this TECDOC is to provide technical guidance for the development of new WIRKS in Member States, whether or not they have any existing WIRKS. It is not intended to serve as a means to qualify or certify existing WIRKS.

(4) The fundamental unit is the waste package — a WIRKS is principally a database for recording, maintaining and reporting on the characteristics and locations of waste packages.

(5) Some Member States currently have multiple WIRKS that do not have consistent structure, format or content. This TECDOC can provide guidance for implementing a consistent approach to these existing systems (i.e., for upgrading these WIRKS).

(6) WIRKS implementation is Member State specific. However, the type and quality of data should be examined in the context of international perspectives, such as waste classification systems, the IAEA's Waste Management Database [28], the possibility of regional repositories and the possibility of a future, international archive for repository information.

(7) If multiple WIRKS are implemented in a Member State, consideration should be given to the exchange of information between these systems and between any existing, planned or possible central, national radioactive waste management information system.

(8) Member States should implement a WIRKS in support of disposal during the pre-disposal phase. It is better to take a series of small, incremental steps than to wait and take one big step. Even without the actual implementation of a WIRKS, an implementation plan should be prepared as soon as practicable.

(9) This TECDOC does not provide guidance or recommendations on record keeping requirements for safeguards (see Section 2.8) as an integral part of WIRKS.

(10) A lead organization in each Member State should define the goals, minimum record content and procedures of a WIRKS. This lead organization could be a regulatory body.

(11) An organization should be identified to ensure that the WIRKS is properly maintained, which, in turn, will ensure data integrity, security and accessibility during facility operation and upon closure.

(12) Physical, hard-copy records should be organized in preparation for WIRKS implementation. International experience has shown that early planning and implementing for WIRKS can result in lower overall effort and cost to implement a WIRKS.

(13) Member States planning a WIRKS should consult with organizations that have extensive experience with these systems to obtain advice on what to do and what not to do.

(14) The identification of organizations with responsibility for WIRKS needs to consider the long time scales of radioactive waste management. Document/information management in support of radioactive waste management can consider time scales on the order of many decades or centuries. It may be prudent to assign responsibility for WIRKS to a radioactive waste management organization that has longer term goals that most other organizations.

6. GLOSSARY

Many of the terms used in this TECDOC are commonly used by the nuclear industry. However, some definitions are provided here for clarification.

Terms in square braces, [ ], are, in general, not used by the IAEA.

activity the quantity, A, for an amount of radionuclide in a given energy state at a given time, defined as:

$$A(t) = \frac{dN}{dt}$$

where dN is the expectation value of the number of spontaneous nuclear transformations from the given energy state in the time interval dt (which represents the rate at which nuclear transformations occur in a radioactive material)

the SI unit of activity is the reciprocal second (s^{-1}), termed the becquerel (Bq)

formerly expressed in curie (Ci)

becquerel

name for the SI unit of activity, equal to one transformation per second

supersedes the curie (Ci)

1 Bq = 27 pCi (2.7 10^{-11} Ci) approximately

characterization, waste

determination of the physical, chemical and radiological properties of the waste to establish the need for further adjustment, treatment, conditioning, or its suitability for further handling, processing, storage or disposal

cleanup

any measures that may be carried out to reduce the radiation exposure from existing contamination through actions applied to the contamination itself (the source) or to the exposure pathways to humans

the terms rehabilitation, remediation and restoration are sometimes used, with essentially the same meaning

clearance

removal of **radioactive materials** or radioactive objects within authorized **practices** from any further **regulatory control** by the **regulatory body** — removal from control in this context refers to control applied for **radiation protection** purposes.

various terms are used in different States to describe this concept, for example, 'free release'

closure

administrative and technical actions directed at a repository at the end of its operating lifetime, for example, covering of the disposed waste (for a near surface repository) or backfilling and/or sealing (for a geological repository and the passages leading to it) and termination and completion of activities in any associated structures

for a mill tailings impoundment or other deposit of waste from mining and milling, the term closeout is used — for all other facilities the term decommissioning is used

the terms siting, design, construction, commissioning, operation and decommissioning are normally used to delineate the six major stages of the life of an authorized facility and of the associated licensing process — in the special cases of mining and milling facilities and waste disposal facilities, decommissioning is replaced in this sequence by closeout and closure respectively

compaction

a treatment method where the bulk volume of a compressible material is reduced by application of external pressure — results in an increase in density

conditioning

see **waste management, radioactive**

confinement

a barrier that surrounds the main parts of a facility containing radioactive materials and is designed to prevent or mitigate the uncontrolled release of radioactive material to the environment in operational states or design basis accidents

confinement is similar in meaning to containment, but confinement is typically used to refer to the barriers immediately surrounding the radioactive material, whereas containment refers to the additional layers of defence intended to prevent the radioactive materials reaching the environment if the confinement is breached

in a repository, confinement may be provided by the waste form and its container, whereas containment may be provided by the surrounding host rock

this is not the meaning of confinement implied in Transport Regulations (INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material — 1996 Edition (Safety Requirements), Safety Standards Series No. ST-1, IAEA, Vienna (1996))

container, waste the vessel into which the waste form is placed for handling, transport, storage and/or disposal

the outer barrier protecting the waste from external intrusions

the waste container is a component of the waste package

the term waste canister is often considered to be a specific term for a container for spent fuel or vitrified high level waste

containment methods or physical structures designed to prevent the dispersion of radioactive substances

although approximately synonymous with confinement, containment is normally used to refer to methods or structures that prevent radioactive substances being dispersed in the environment if confinement fails — see **confinement** for a more extensive discussion

contamination (scientific definition): radioactive substances on surfaces, or within solids, liquids or gases (including the human body) where their presence is unintended or undesirable

also used less formally to refer to a quantity (activity) present on a surface or on a unit area of a surface

translation of the term contamination into some other languages may introduce a connotation that is not present in English — the English language term contamination refers only to the presence of activity and gives no indication of the magnitude of the hazard involved

(regulatory definition): the presence of a radioactive substance on a surface in quantities in excess of 0.4 Bq/cm^2 for beta and gamma emitters and low toxicity alpha emitters, or 0.04 Bq/cm^2 for all other alpha emitters — this is a definition specific to Transport Regulations (see **confinement**); levels below 0.4 Bq/cm^2 or 0.04 Bq/cm^2 would be considered contamination according to the scientific definition

fixed contamination — contamination other than non-fixed contamination (see next)

non-fixed contamination — contamination that can be removed from a surface during routine conditions of transport (this is a definition specific to Transport Regulations, see **confinement**)

control the function or power of directing or regulating

the usual meaning of the English word control in safety related contexts is somewhat ‘stronger’ (more active) than that of similar words in some other languages — for example, ‘control’ typically implies not only checking or monitoring something, but also making sure that corrective or enforcement measures are taken if the results of the checking or monitoring indicate an unsatisfactory situation

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)

most commonly used to describe controls over a repository after closure or a facility undergoing decommissioning

the term institutional control is more general than regulatory control (i.e. regulatory control may be thought of as a special form of institutional control) — in particular, institutional control measures may be passive, they may be imposed for reasons not related to protection or safety (although they may nevertheless have some impact on protection and safety), they may be applied by organizations that do not meet the definition of a regulatory body, and they may apply in situations which do not fall within the scope of facilities and activities — as a result, some form of institutional control may be considered more likely to endure further into the future than regulatory control

regulatory control: any form of control applied to facilities or activities by a regulatory body for reasons related to protection or safety

corrective action action(s) undertaken to correct non-conformances

data field a component of a database record

data set all data stored in the database according to the database record structure

database an organized collection of information (in this TECDOC, this definition is restricted to an electronic database)

database record a logical unit of information within a database (in the context of this TECDOC, a record can normally be considered to be all the information that, collectively, describes the characteristics, including location, of a waste package)

disposal the emplacement of waste in an approved, specified facility without the intention of retrieval — while retrieval is not intended, this does not mean that retrieval is not possible

in many cases, the important element is the distinction between disposal (with no intent to retrieve) and storage (with intent to retrieve)

some States use the term disposal to include discharges of effluents to the environment

in some States, the term disposal is used administratively in such a way as to include, for example, incineration of waste or the transfer of waste between operators — in this TECDOC, disposal uses the more restrictive definition given above

direct disposal: disposal of spent fuel as waste

geological disposal: disposal in a geological repository

near surface disposal: disposal, with or without engineered barriers, in a near surface repository

sub-seabed disposal: disposal in a geological repository in the rock underlying the ocean floor

deep sea disposal: disposal of waste packaged in containers on the deep ocean floor as practised until 1982 in accordance with the requirements of the London Convention 1972 (Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, International Maritime Organization, Geneva (1972) — the commonly used, but informal, term ‘sea dumping’ should not be used in IAEA publications

seabed disposal: emplacement of waste packaged in suitable containers at some depth into the sedimentary layers of the deep ocean floor — may be achieved by direct emplacement, or by placing the waste in specially designed ‘penetrators’ which, when dropped into the sea, embed themselves in the sediment

the terms deep sea disposal and seabed disposal do not strictly satisfy the above definition (since retrieval is not possible), but they are consistent with the everyday meaning of disposal and are used as such

disposal facility synonymous with **repository**

facilities and activities a general term encompassing nuclear facilities, uses of all sources of ionizing radiation, all radioactive waste management activities, the transport of radioactive material and any other practice or circumstances where people may be exposed to radiation from naturally occurring or artificial sources

facilities include nuclear facilities, irradiation installations, mining and milling facilities, waste management facilities and any other place where radioactive materials are produced, processed, used, handled, stored or disposed of, or where radiation generators are installed on a scale that consideration of protection and safety is required

activities include the production, use, import and export of radiation sources for industrial, research and medical purposes, the transport of radioactive material, the mining and processing of radioactive ores and the closeout of associated facilities, the cleanup of sites affected by residues from past activities and radioactive waste management activities such as the discharge of effluents

the term "facilities and activities" is intended to provide an alternative to the terminology of sources and practices (or intervention) to refer to general categories of situations — for example, a practice may involve many different facilities and/or activities, whereas the general definition of source is too broad in some cases: a facility or activity might constitute a source, or might involve the use of many sources, depending upon the interpretation used

the term "facilities and activities" is very general and includes those for which no or little regulatory control may be necessary or achievable — the more specific terms authorized facility and authorized activity should be used to distinguish those facilities and activities for which any form of authorization has been given

facility see **facilities and activities**

fuel cycle see **nuclear fuel cycle**

half-life, T½ for a radionuclide, the time required for the activity to decrease, by a radioactive decay process, by half

where it is necessary to distinguish this from other half-lives (see below), the term radioactive half-life should be used

the half-life is related to the decay constant, λ, by the expression:

$$T_{1/2} = \frac{\ln 2}{\lambda}$$

the time taken for the quantity of a specified material (e.g. a radionuclide) in a specified place to decrease by half as a result of any specified process or processes that follow similar exponential patterns to radioactive decay

biological half-life: the time taken for the quantity of a material in a specified tissue, organ or region of the body (or any other specified biota) to halve as a result of biological processes

effective half-life, Teff: the time taken for the activity of a radionuclide in a specified place to halve as a result of all relevant processes

$$T_{eff} = \frac{\prod_i T_i}{\sum_i T_i} \quad (\text{or } \frac{1}{T_{eff}} = \sum_i \frac{1}{T_i})$$

where *Ti* is the half-life for process *I*

	radioactive half-life: for a radionuclide, the time required for the activity to decrease, by a radioactive decay process, by half. The term ‘physical half-life’ is also used for this concept
incineration	a waste treatment process of burning combustible waste to reduce its volume and yield an ash residue
[intermediate level waste (ILW)]	see **waste classes**
intervention	any action intended to reduce or avert exposure or the likelihood of exposure to sources which are not part of a controlled practice or which are out of control as a consequence of an accident
long lived waste	see **waste classes**
low and intermediate level waste (LILW)	see **waste classes**
[low level waste (LLW)]	see **waste classes**
[medium level waste (MLW)**]**	see **waste classes**
near surface disposal	see **disposal**
near surface repository	see **repository**
non-conformance	a deficiency in characteristics, documentation or procedures that renders the quality of an item, process or service unacceptable or indeterminate
non-radioactive hazard	a Member State specific classification of waste according to non-radioactive hazards, such as toxic components
nuclear facility	a facility and its associated land, buildings and equipment in which radioactive materials are produced, processed, used, handled, stored or disposed on a scale that requires consideration of safety — essentially synonymous with authorized facility
nuclear fuel cycle	all operations associated with the production of nuclear energy, including: mining and milling, processing and enrichment of uranium or thorium; manufacture of nuclear fuel; operation of nuclear reactors (including research reactors); reprocessing of nuclear fuel; any related research and development activities; and all related waste management activities (including decommissioning)

nuclear material plutonium except that with isotopic concentration exceeding 80% in plutonium-238; uranium-233; uranium enriched in the isotope 235 or 233; uranium containing the mixture of isotopes as occurring in nature other than in the form of ore or ore-residue; any material containing one or more of the foregoing

the Statute of the IAEA uses the term special fissionable material, with essentially the same meaning, but explicitly excluding source material

operating organization an organization authorized by the regulatory body to operate a facility (authorization may predate the start of operations) — the operating organization is normally also the licensee or registrant; however, the separate terms are retained to refer to the two different capacities

the organization (and its contractors) that undertakes the siting, design, construction, commissioning and/or operation of a nuclear facility — this usage is peculiar to waste safety documentation, with the corresponding understanding of siting as a multistage process (this difference is partly a reflection of the particularly crucial role of siting in the safety of repositories)

operator any organization or person applying for authorization or authorized and/or responsible for nuclear, radiation, waste or transport safety when undertaking activities or in relation to any nuclear facilities or sources of ionizing radiation — this includes, among others, private individuals, governmental bodies, consignors or carriers, licensees, hospitals, self-employed persons, etc.

synonymous with operating organization — operator is sometimes used to refer to operating personnel; if used in this way, particular care should be taken to ensure that there is no possibility of confusion

package, waste the product of conditioning that includes the waste form and any container(s) and internal barriers (e.g. absorbing materials and liner), as prepared in accordance with requirements for handling, transport, storage and/or disposal

packaging see **waste management, radioactive**

practice any human activity that introduces additional sources of exposure or exposure pathways or extends exposure to additional people or modifies the network of exposure pathways from existing sources, so as to increase the exposure or the likelihood of exposure of people or the number of people exposed

radioactive waste management activities are normally considered to be part of the practice that gave rise to the waste and do not constitute a separate practice

contrasting term: intervention (see also **facilities and activities**)

terms such as ‘authorized practice’, ‘controlled practice’ and ‘regulated practice’ are used to distinguish those practices that are subject to regulatory control from other activities that meet the definition of practice but do not need or are not amenable to control

predisposal see **waste management, radioactive**

processing, waste see **waste management, radioactive**

quality the total of features and characteristics of an item, process or service that bears on its ability to satisfy specified requirements

radiation	when used in IAEA publications, the term radiation normally refers only to ionizing radiation — the IAEA has no statutory responsibilities in relation to non-ionizing radiation for the purposes of radiation protection, radiation capable of producing ion pairs in biological material(s)
radioactive (adjective)	(scientific definition) exhibiting radioactivity (regulatory definition) designated in national law or by a regulatory body as being subject to regulatory control because of its radioactivity
radioactive contents	the radioactive material together with any contaminated or activated solids, liquids, and gases within the packaging
radioactive material	material designated in national law or by a regulatory body as being subject to regulatory control because of its radioactivity some States use the term radioactive substance for this regulatory purpose; however, the term radioactive substance is sometimes used to indicate that the scientific use of radioactive is intended, rather than the regulatory meaning of radioactive (any such distinctions in meaning must be clarified) any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the values specified in paragraphs 401-406 of the Transport Regulations (see **confinement**)
radioactive substance	see **radioactive material**
radioactive waste	see **waste, radioactive**
radioactive waste management	see **waste management, radioactive**
radioactive waste management facility	see **waste management facility, radioactive**
radioactivity	the phenomenon whereby atoms undergo spontaneous random disintegration, usually accompanied by the emission of radiation — in IAEA publications, radioactivity should be used only to refer to the phenomenon to refer to an amount of a radioactive substance, use activity
regulatory authority	an authority or authorities designated or otherwise recognized by a government for regulatory purposes in connection with protection and safety the term Regulatory Authority may be used (with initial capitals) when consistency with the Basic Safety Standards is necessary [22] in general, the term regulatory body is preferred
regulatory body	an authority or number of authorities designated by the government as having legal authority for conducting the regulatory process, including issuing authorizations, and thereby regulating nuclear, radiation, waste and transport safety and radiation protection

regulatory control see **control**

remedial action action taken when a specified action level is exceeded, to reduce radiation doses that might otherwise be received, in an intervention situation involving chronic exposure

remedial actions could also be termed longer term protective action, but longer term protective actions are not necessarily remedial actions

remediation see **cleanup**

repository a facility where waste is emplaced for disposal

geological repository: a facility for radioactive waste disposal located underground (usually several hundred metres or more below the surface) in a stable geological formation to provide long term isolation of radionuclides from the biosphere

near surface repository: a facility for radioactive waste disposal located at or within a few tens of metres of the Earth's surface

rock cavity: a facility for radioactive waste disposal located at depths intermediate to geological and near surface repositories

requirement a condition defined as necessary to me be met by an item, product or service

sealed source see **source**

segregation see **waste management, radioactive**

short lived waste see **waste classes**

siting the process of selecting a suitable site for a facility, including appropriate assessment and definition of the related design bases

the siting process for a repository is particularly crucial to its long term safety — it may, therefore, be a particularly extensive process and is typically divided into the following stages

concept and planning,
area survey,
site characterization and
site confirmation

source (a) anything that may cause radiation exposure, such as by emitting ionizing radiation or by releasing radioactive substances or materials and can be treated as a single entity for protection and safety purposes

natural source: a naturally occurring source of radiation, such as the sun and stars (sources of cosmic radiation) and rocks and soil (terrestrial sources of radiation)

(b) radioactive material used as a source of radiation, such as those used for medical applications or in industrial instruments — these are sources as defined in (a) above but this usage is less general

disused source: sources that are currently not in use ***and*** are not intended to be used by the current user (for example because they are no longer suitable for their intended purpose for any reason, which may not be due to radioactive decay) but recycle and reuse by another user cannot excluded (the Joint Convention [10] refers to 'disused sealed sources', but does not define them)

orphan source: a source which poses sufficient radiological hazard to warrant regulatory control, but which is not under regulatory control because it has never been so, or because it has been abandoned, lost, misplaced, stolen or otherwise transferred without proper authorization *sealed source*: radioactive material that is (a) permanently sealed in a capsule, or (b) closely bonded and in a solid form (the Joint Convention definition is identical, except that the words "excluding reactor fuel elements" are added). The Basic Safety Standard definition [22] is as above, but continues: "The capsule or material of a sealed source shall be strong enough to maintain leak tightness under the conditions of use and wear for which the source was designed, also under foreseeable mishaps."

the term special form radioactive material, used in the context of transport of radioactive materials, has essentially the same meaning

spent source: a disused source that is declared as waste by its current user, typically based on radioactive decay, and is awaiting conditioning and/or disposal

unsealed source: a source that does not meet the definition of a sealed source

spent fuel nuclear fuel removed from a reactor following irradiation, which is no longer usable in its present form because of depletion of fissile material, poison build-up or radiation damage

the adjective 'spent' suggests that spent fuel ***cannot*** be used as fuel in its present form; however, in practice, however, spent fuel is commonly used to refer to fuel that has been used as fuel but ***will*** no longer be used, whether or not it could be

spent fuel management all activities that relate to the handling or storage of spent fuel, excluding off-site transportation [10]

spent fuel management facility any facility or installation the primary purpose of which is spent fuel management [10]

spent source see **source**

storage the holding of spent fuel or of radioactive waste in a facility that provides for its containment, with the intention of retrieval [10]

storage is by definition an interim measure, and the term interim storage would therefore be appropriate only to refer to short-term, temporary storage when contrasting this with the longer term fate of the waste — storage as defined above should not be described as interim storage

unsealed source see **source**

use *authorized use*: use of radioactive materials or radioactive objects from an authorized practice in accordance with an authorization — intended primarily for contrast with clearance, in that clearance implies no further regulatory control over the use, whereas authorization may prescribe or prohibit specific uses (a form of restricted use)

restricted use: the use of an area or of materials subject to restrictions imposed for reasons of radiation protection and safety — restrictions would typically be expressed in the form of prohibition of particular activities (for example, house building, growing or harvesting particular foods) or prescription of particular procedures (for example, materials may only be recycled or reused within a facility)

unrestricted use: the use of an area or of materials without any radiologically based restrictions

waste — material for which no further use is foreseen — implies that the person/organization in possession of the material at the time foresees no use; however, in some cases waste can be considered a resource, for example, waste wood could be incinerated to generate heat/electricity

see also **waste, radioactive** and **waste classes**

waste, radioactive — for legal and regulatory purposes, waste that contains or is contaminated with radionuclides at concentrations or activity greater than clearance levels as established by the regulatory body — this definition is purely for regulatory purposes; waste with activity equal to or less than clearance levels is radioactive from a physical viewpoint but the radiological hazards may be considered to be negligible

waste acceptance requirements — quantitative or qualitative criteria specified by the regulatory body or by an operator for storage or disposal according to facility license conditions

waste classes — in past years, the IAEA's Waste Management Database [9] has been used to compile information about national waste management programmes, activities, plans, policies, relevant regulations and laws and waste inventories in Member States according to the following waste classes:

low and intermediate level waste – short lived (LILW-SL),
low and intermediate level waste – long lived (LILW-LL),
high level waste (HLW),
alpha bearing waste (TRU),
spent, sealed radioactive sources (SRS),
spent fuel (SF),
decommissioning waste (DW), and
uranium mine and mill tailings (UMMT)

the waste classes listed above are based on both qualitative criteria (wastes are grouped according to their origin, activity content, radiotoxicity and thermal power) and quantitative criteria (waste are grouped according to the safety aspects of their management). The classification of waste according to LILW-SL, LILW-LL and HLW is based on Section 3 of IAEA Safety Guide 111-G-1.1, "Classification of Radioactive Waste" [8], which proposed the following quantitative classification system for radioactive waste:

Table G-1: The IAEA's Proposed Waste Classification System

Waste classes	Typical characteristics	Disposal options
1. Exempt waste (EW)	Activity levels at or below clearance levels… …based on an annual dose to members of the public of less than 0.01 mSv	No radiological restrictions
2. Low and intermediate level waste (LILW)	Activity levels above clearance levels… …and thermal power below about 2 kW/m^3	
2.1. Short lived waste (LILW-SL)	Restricted long lived radionuclide concentrations (limitation of long lived alpha emitting radionuclides to 4000 Bq/g in individual waste packages and to an overall average of 400 Bq/g per waste package)	Near surface or geological disposal facility
2.2. Long lived waste (LILW-LL)	Long lived radionuclide concentrations exceeding limitations for short lived waste	Geological disposal facility
3. High level waste (HLW)	Thermal power above about 2 kW/m^3 and long lived radionuclide concentrations exceeding limitations for short lived waste	Geological disposal facility

most Member States that responded to the IAEA's 1997/98 Waste Management Database Questionnaire indicated that they did not have national waste classification systems that conformed to the proposed classification scheme that is described in Table G-1. The "Radioactive Waste Management Profiles — Compilation of Data from the Waste Management Database", No. 3 [9] contains an internal sub-report (Report 1) that describes the various of waste classification systems that are in use in Member States

from the IAEA's current perspective, the only waste classes are LILW (LILW-SL and LILW-LL), HLW and Spent Fuel (only if the fuel is declared to be waste). Other waste, such as decommissioning waste and spent sources, et cetera, are not classes of waste but, instead, represent origins of waste based on specific practices

the following are not considered waste classes by the IAEA; they are discussed below only because they are commonly used terms

decommissioning waste (DW): radioactive waste from decommissioning activities — (a) can represent relatively large sources of waste, (b) arises late in the life cycle of a facility, (c) usually represents a future liability that requires advanced planning, such as the establishment of decommissioning funds, to ensure that adequate resources are available to manage them when they arise, (d) comprised mainly of LILW but might include HLW

[heat generating waste (HGW)]: radioactive waste that is sufficiently radioactive that the decay heat significantly increases its temperature and the temperature of its surroundings — in practice, HGW is HLW although some types of LILW may qualify as HGW

[medium level waste (MLW)]: included in LILW

NORM waste: Naturally Occurring Radioactive Material that has been declared to be waste

technologically enhanced NORM waste (TE NORM waste): TE NORM (see the definition of naturally occurring radioactive material) that has been declared to be waste

uranium mine and mill tailings (UMMT): wastes arising from the mining and/or milling of ores containing uranium series or thorium series radionuclides (Note, in some Member States, UMMT are not considered as waste — instead, they are considered as a minerals resource.)

[very low level waste (VLLW)]: radioactive waste considered suitable by the regulatory body for authorized disposal, subject to specified conditions, with ordinary waste in facilities not specifically designed for radioactive waste disposal

waste characterization see **characterization**

waste conditioning see **waste management, radioactive**

waste container see **container, waste**

waste disposal see **disposal**

waste form waste in its physical and chemical form after treatment and/or conditioning (resulting in a solid product) prior to packaging

a component of the waste package

waste generator

the operating organization of a facility or activity that generates waste

for convenience, the scope of the term waste generator is sometimes extended to include whoever currently has the responsibilities of the waste generator (e.g. if the actual waste generator is unknown or no longer exists, and a successor organization has assumed responsibility for the waste)

waste management, radioactive

all administrative and operational activities involved in the handling, pretreatment, treatment, conditioning, transport, storage and disposal of radioactive waste

conditioning: operations that produce a waste package suitable for handling, transport, storage and/or disposal — may include the conversion of the waste to a solid waste form, enclosure of the waste in containers and, if necessary, providing an overpack

disposal: defined elsewhere in this glossary

immobilization: the conversion of waste into a waste form by solidification, embedding or encapsulation. Immobilization reduces the potential for migration or dispersion of radionuclides during handling, transport, storage and disposal (also known as solidification)

overpack: a secondary (or additional) outer container for one or more waste packages, used for handling, transport, storage or disposal

packaging: the preparation of radioactive waste for safe handling, transport, storage and disposal by means of enclosing conditioned waste in a suitable container

predisposal: any waste management steps carried out prior to disposal, such as pretreatment, treatment, conditioning, storage and transport activities — decommissioning is considered to be included within the scope of predisposal

predisposal, a contraction of ‘pre-disposal management’, is not a form of disposal

processing: waste treatment and/or conditioning

segregation: an activity where waste or materials (radioactive and exempt) are separated or are kept separated according to radiological, physical and/or chemical properties, which can facilitate handling, processing, storage and/or disposal.

storage: defined elsewhere in this glossary

treatment: operations intended to benefit safety and/or economy by changing the characteristics of the waste — the basic treatment objectives are (a) volume reduction, (b) removal of radionuclides from the waste, and (c) change of composition of the waste

volume reduction: a treatment method that reduces the physical volume of waste (should not be confused with minimization)

waste management facility, radioactive

facility specifically designated to handle, treat, condition, temporarily store or permanently dispose of radioactive waste

waste package

see **package, waste**

waste stream

a collection of waste items, for example packages, that have similar properties or characteristics within some defined boundaries (for example, upper and/ or lower limits for radioactivity)

a flow of waste materials with specific definable characteristics that remain the same throughout the life of the process that generates the waste — a waste stream is produced by a single process or sub-process; however, that process or sub-process may be one that combines two or more input waste streams together to produce a single output waste stream

7. MEMBER STATE EXPERIENCES

7.1. Member State experience with WIRKS – Canada

At the time this TECDOC was written, Canada had not yet initiated radioactive waste disposal. To support current storage operations and to prepare for future disposal and closure, the organization responsible for radioactive waste management at Atomic Energy of Canada Limited’s (AECL) Chalk River Laboratories (CRL) engineered and implemented a comprehensive WIRKS that meets all the needs identified in Section 2.

Currently the WIRKS, which is known as the Waste Inventory Programs (WIP) – Version III [30–33], does not meet the data recording or reporting requirements for materials under safeguards [23], [24]. AECL-CRL maintains a separate “Safeguards Database” that pre-dates both the IAEA requirements and the development of WIP-III. AECL has not yet determined whether or not to merge the Safeguards Database and WIP-III. This issue needs to be carefully examined in the context of the IAEA’s specified requirements.

Until 1999, waste processing was not considered to be a part of waste inventory management and, therefore, data associated with processing, such as volume reduction factors achieved from incineration, compaction or processing systems for liquids, were not considered to be part of the AECL-CRL WIRKS. Instead, waste processing facilities at CRL or outside of CRL were considered to be waste generators and the information that they provide is entered into WIP-III in the same way as for all other waste generators. Based on a decision to implement a super compactor in the waste management areas, the need arose to track nested packages. As such, a minor modification of WIP-III was made to conform to the WIRKS Model 1 (see Section 3) by implementing a “list of nested packages” field.

WIP-III supports the receipt and management of wastes from several hundred waste generators both internal and external to CRL. However, on an annual basis, only about 30–50 generators routinely transfer their wastes to the receiver at CRL. It is worth noting that once waste has been transferred to the receiver at CRL, AECL assumes ownership and long-term responsibility for the waste.

The main features of the AECL-CRL WIRKS are:

(1) an integration of a variety of waste management functions, not just waste inventory management, into a single system (see Fig. 5), which includes:
   - the recording of inventory information for waste storage facilities,
   - the performance of and recording of information for waste inspection, compliance monitoring, non-conformance reporting and corrective actions reporting,
   - financial modules for automated invoicing for waste management services and for the forecasting of future liabilities for wastes in storage,

(2) a design structure that fits low level to high level waste repository inventory management,

(3) reporting functions that meet the needs of WIRKS customers who were surveyed prior to WIP-III implementation to ensure that their needs were identified and would be met (regulator, generators, computer modelers for performance assessments, etc.),

(4) the partial integration of the data set (see Section 3.1) and associated documentation (see Section 3.2) into a single information system by merging supporting documentation for both routine and non routine wastes with inventory data (see Figs 6 and 7).

Figure 8 shows the AECL-CRL data entry form for non-routine wastes and Fig. 9 shows the AECL-CRL data entry form for routine waste, which are used to compile the WIRKS data set values, and

(5) tools to assess historic waste inventories that were not previously documented according to present day standards (see Fig. 10).

To meet change control requirements, a separate database named GRIPES (Glitches, Requests, Improvements, Problems and Enhancements) was implemented to record why changes to the AECL-CRL WIRKS were made and how these changes were made.

Within the AECL-CRL WIRKS, changes to data field values are recorded. The initial value, the new value, the identity of the person who made the change, and the reason for the change are recorded as a "data history record". Currently, changes to the values of parameters in Auxiliary Data Tables, such as the half-lives of radionuclides, are not tracked.

With respect to the issues identified in this TECDOC:

(1) AECL-CRL does not have a documented strategy for the implementation of a comprehensive PLI set,

(2) Currently, there are no regulatory requirements to establish a comprehensive PLI in support of radioactive waste disposal,

(3) Historical wastes were not tracked by way of individual package identifiers or by way of spatial locators (e.g., x, y, z co-ordinates) in storage facilities, which is being addressed by the Historical Inventory Project [32],

(4) Much of the cost and effort associated with development of WIP-III can be attributed to the integration of the WIRKS data set with other data and waste management operations (see Fig. 5). It is expected that a significant cost and effort would be required to create a comprehensive PLI system that integrates the AECL-CRL WIRKS.

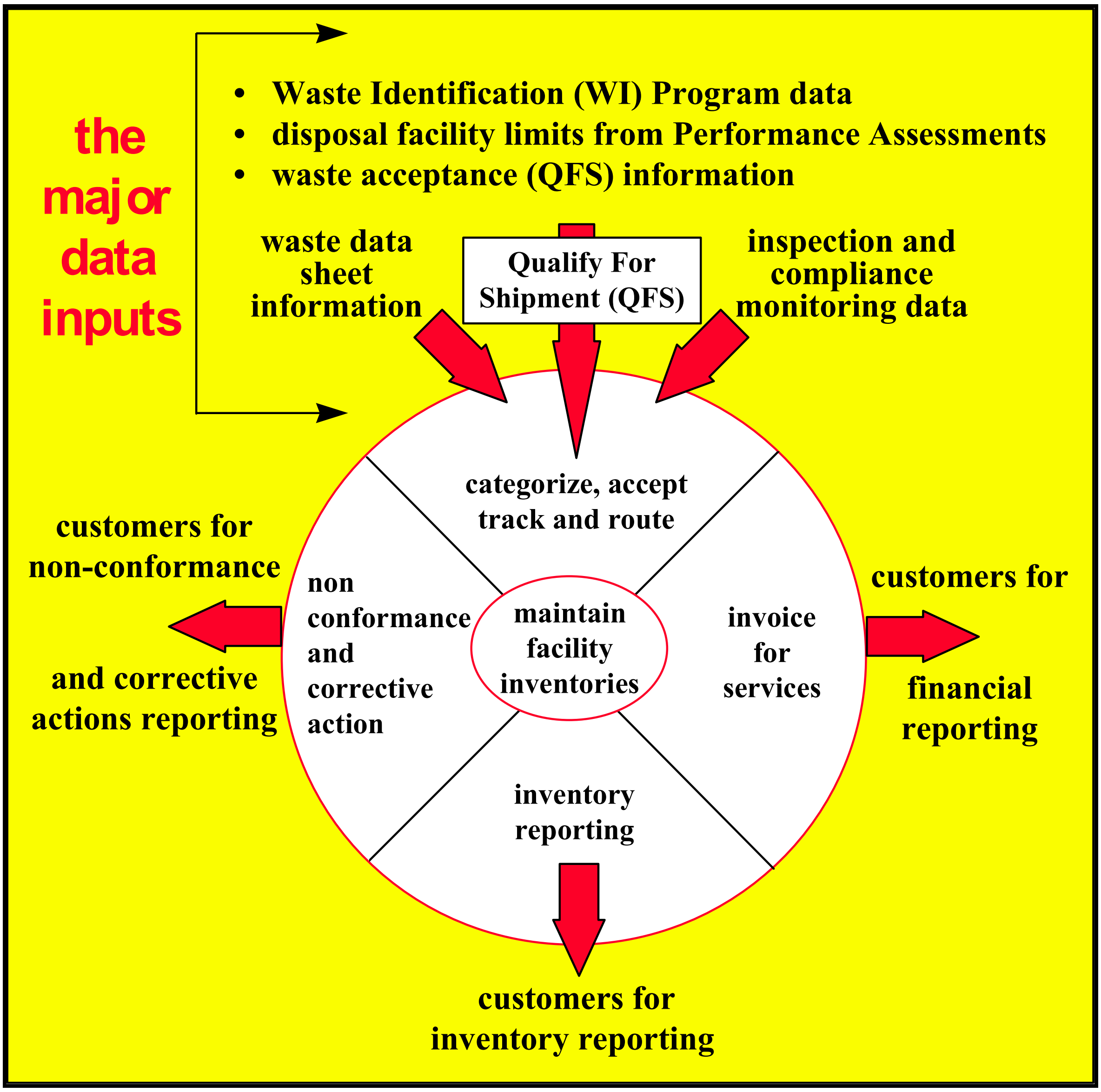


FIG. 5. Waste management functions that are integrated in the AECL-CRL WIRKS.

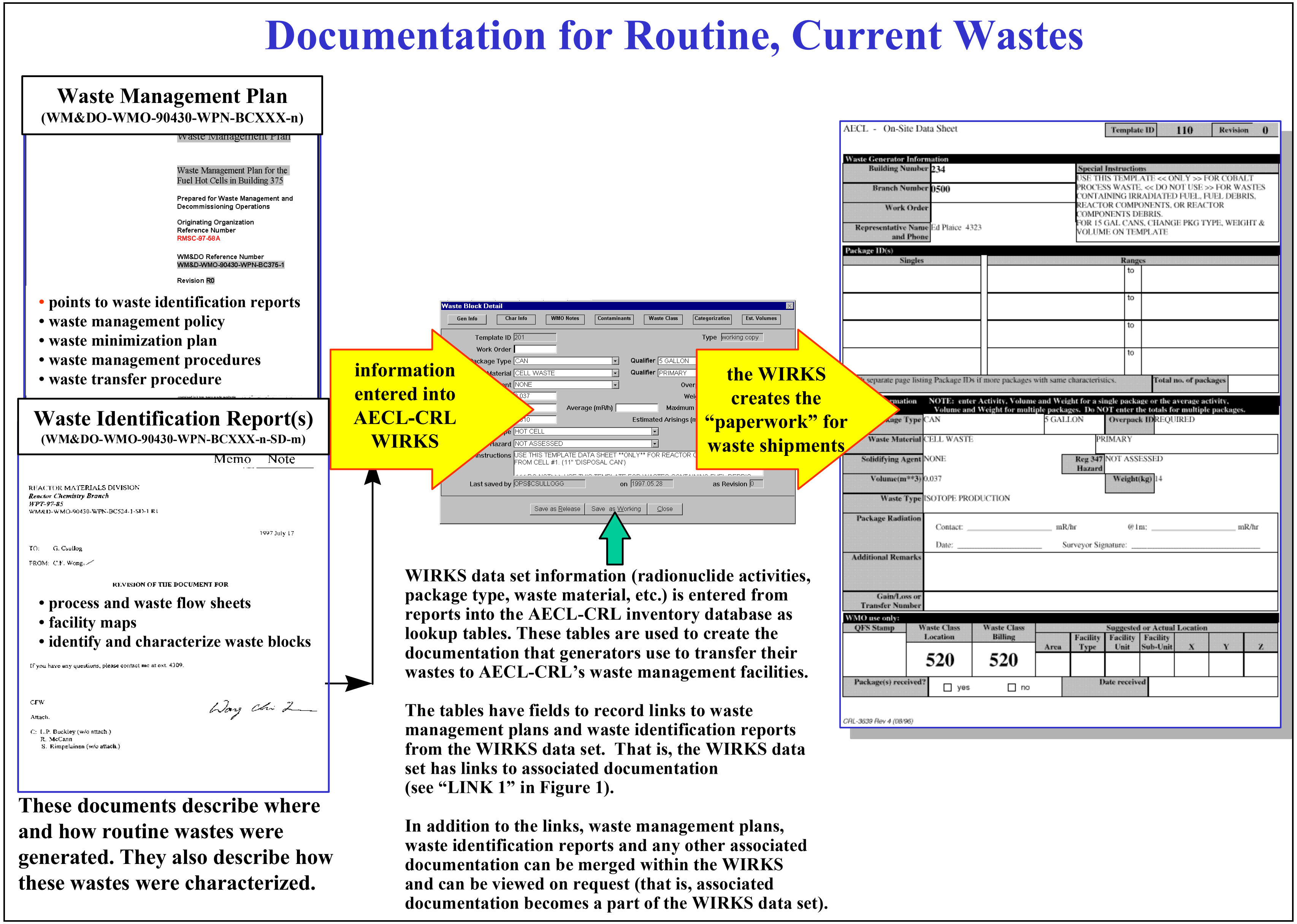


FIG. 6. Documentation for current, routine wastes at AECL-CRL.

Documentation for Non-Routine, Current Wastes

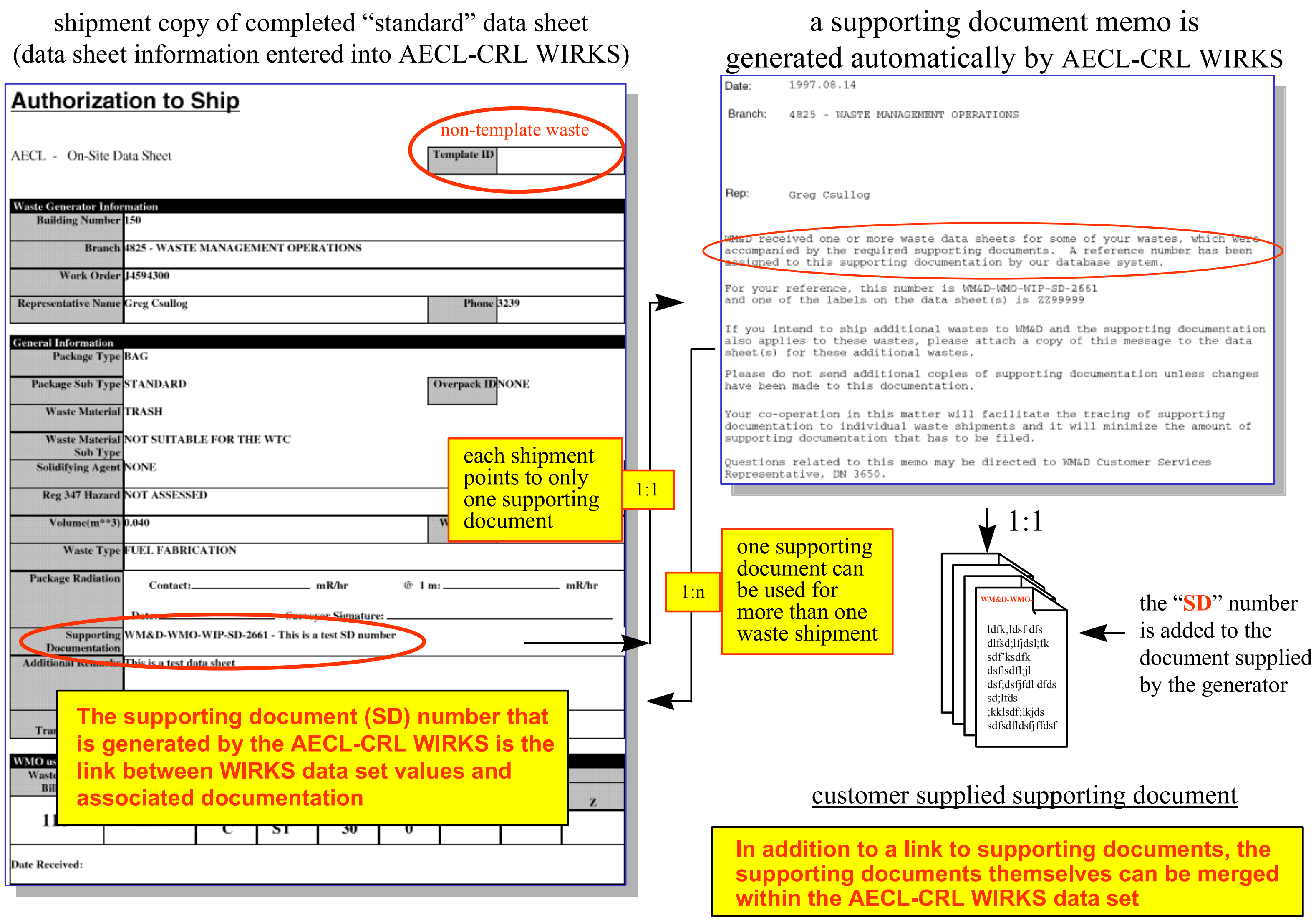


FIG. 7. Documentation for current, non-routine wastes at AECL-CRL.

AECL: Off-Site Data Sheet

See reverse side for instructions

Waste Generator Information

Company Name		Department	
Street Address			
City	Province	Postal Code	_ _ _ _ _ _ _
Representative's Name		Phone-voice fax	(___)___-____x____ (___)___-____x____

Package ID(s)

Singles	Ranges		
		to	
		to	
		to	
		to	

Please attach a separate page listing additional Package IDs if there is insufficient room above to attach all the required tear-off, mini-labels for all waste packages. — **Total No. of packages**

General Information — **NOTE: Enter Activity, Volume and Weight for a single package or the average Activity, Volume and Weight for multiple packages. Do NOT enter the totals for multiple packages.**

Package Type		Overpack ID	
Waste Material			
Solidifying Agent		Ontario Regulation 347 Hazard Type	
Volume (m^3)		Weight (kg)	
Waste Type			
Package Radiation	Contact: _____ mR/hr; @ 1 m: _____ mR/hr Date: _____ Signature: _____		
Supporting Doc No.		WM&D-WMO-WIP-SD-	
Additional Remarks			

WMO use only:

Transfer Number

QFS stamp	Waste Class	Suggested or Actual Location						
		Area	Facility Type	Facility Unit	Facility Sub-Unit	X	Y	Z

Package(s) received? ❑ yes ❑ no — Date received (yyyy.mm.dd):

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Please note: When completing the other side of this data sheet, Package Type, Waste Material, Solidifying Agent, Regulation 347 Hazard Type, and Waste Type ***MUST*** be selected from Waste Management and Decommissioning's (WM&D) list of accepted terms. If you have any questions, please contact the WM&D Customer Service Representative at CRL local 3650.

Please complete the following table to list **all** the contaminants in the wastes covered by this data sheet. For non-routine wastes, supporting documentation must be provided to describe (1) where and how the wastes were generated and collected, (2) details of the packaging if the package is not one of the ones routinely accepted by Waste Management and Decommissioning (WM&D), (3) details of the process or activity that gave rise to the wastes, and (4) details of how the contaminants in the waste were identified and quantified.

If the other side of this data sheet or the following table are not completed **legibly and in full**, your wastes may not be accepted by WM&D. If you have any questions, please contact the WM&D Customer Service Representative at 3650.

Contaminant Type (see list of contaminant types below)	Contaminant Name	Quantity in Each Package	Measure Unit (see list of unit types below)	Check this Box for Suspect Contaminants

Contaminant Types
alpha
beta
gamma
long lived nuclide (LLN)
short lived nuclide (SLN)
toxic substance (TS)
chelating agent (CA)
pressurized gas (PG)
aqueous solution (AS)
organic liquid (OL)
solid

Measure Units
Bq or g for nuclides
g for all non-radioactive contaminants except gases
kPa for gases

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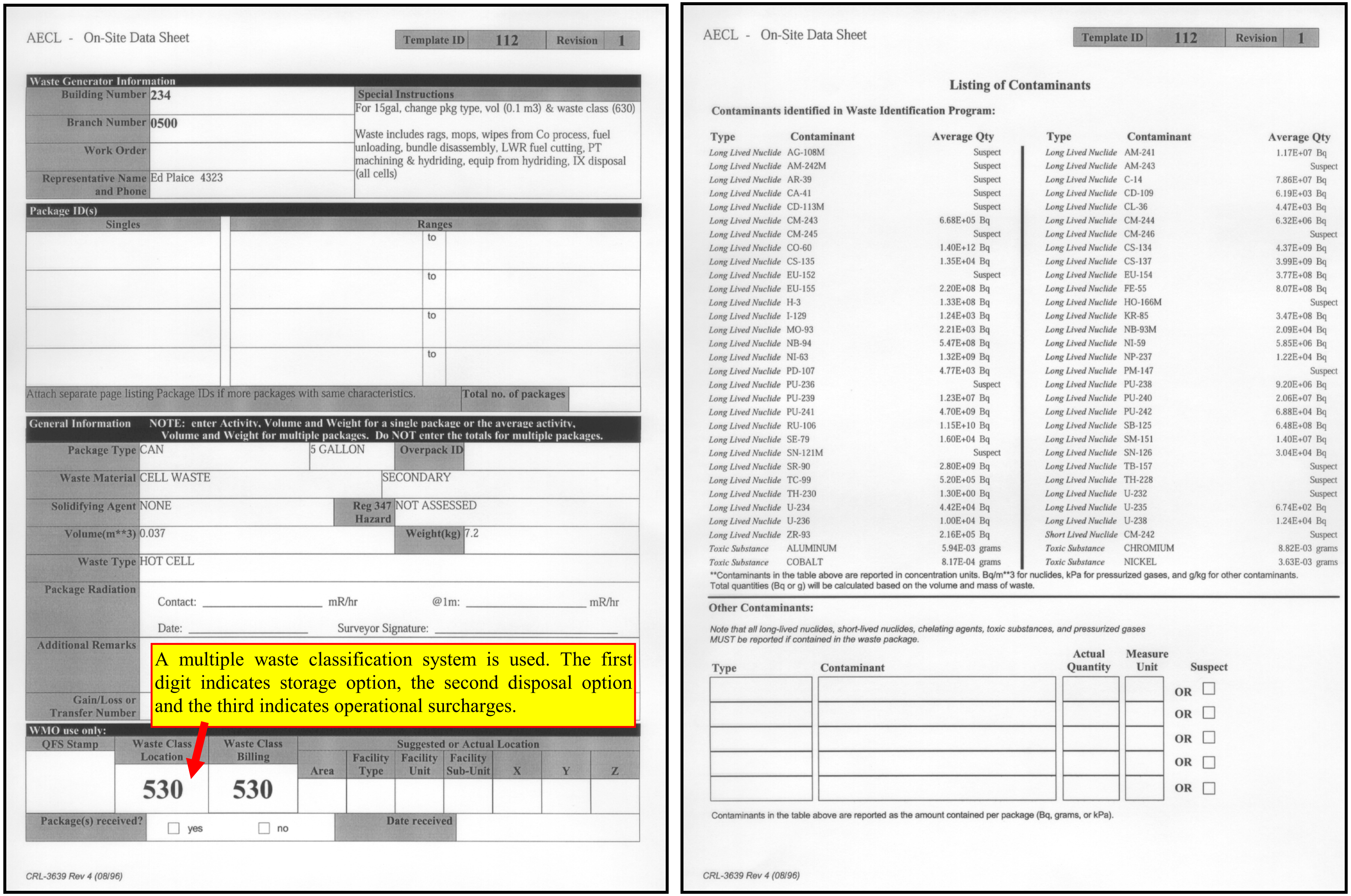
FIG. 8. Standard AECL-CRL data sheet to be completed for non-routine wastes.



AECL - On-Site Data Sheet

Template ID	112	Revision	1

Waste Generator Information

Building Number	234	**Special Instructions** For 15gal, change pkg type, vol (0.1 m3) & waste class (630)
Branch Number	0500	Waste includes rags, mops, wipes from Co process, fuel unloading, bundle disassembly, LWR fuel cutting, PT machining & hydriding, equip from hydriding, IX disposal (all cells)
Work Order		
Representative Name and Phone	Ed Plaice 4323	

Package ID(s)

Singles	Ranges		
		to	
		to	
		to	
		to	

Attach separate page listing Package IDs if more packages with same characteristics. **Total no. of packages**

General Information NOTE: enter Activity, Volume and Weight for a single package or the average activity, Volume and Weight for multiple packages. Do NOT enter the totals for multiple packages.

Package Type	CAN 5 GALLON	Overpack ID	
Waste Material	CELL WASTE		SECONDARY
Solidifying Agent	NONE	Reg 347 Hazard	NOT ASSESSED
Volume(m**3)	0.037	Weight(kg)	7.2
Waste Type	HOT CELL		
Package Radiation	Contact: ______ mR/hr @1m: ______ mR/hr Date: ______ Surveyor Signature: ______		
Additional Remarks			
Gain/Loss or Transfer Number			

A multiple waste classification system is used. The first digit indicates storage option, the second disposal option and the third indicates operational surcharges.

WMO use only:

QFS Stamp	Waste Class Location	Waste Class Billing	Suggested or Actual Location: Area	Facility Type	Facility Unit	Facility Sub-Unit	X	Y	Z
	530	530							

Package(s) received? ☐ yes ☐ no **Date received**

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AECL - On-Site Data Sheet

Template ID	112	Revision	1

Listing of Contaminants

Contaminants identified in Waste Identification Program:

Type	Contaminant	Average Qty	Type	Contaminant	Average Qty
Long Lived Nuclide	AG-108M	Suspect	*Long Lived Nuclide*	AM-241	1.17E+07 Bq
Long Lived Nuclide	AM-242M	Suspect	*Long Lived Nuclide*	AM-243	Suspect
Long Lived Nuclide	AR-39	Suspect	*Long Lived Nuclide*	C-14	7.86E+07 Bq
Long Lived Nuclide	CA-41	Suspect	*Long Lived Nuclide*	CD-109	6.19E+03 Bq
Long Lived Nuclide	CD-113M	Suspect	*Long Lived Nuclide*	CL-36	4.47E+03 Bq
Long Lived Nuclide	CM-243	6.68E+05 Bq	*Long Lived Nuclide*	CM-244	6.32E+06 Bq
Long Lived Nuclide	CM-245	Suspect	*Long Lived Nuclide*	CM-246	Suspect
Long Lived Nuclide	CO-60	1.40E+12 Bq	*Long Lived Nuclide*	CS-134	4.37E+09 Bq
Long Lived Nuclide	CS-135	1.35E+04 Bq	*Long Lived Nuclide*	CS-137	3.99E+09 Bq
Long Lived Nuclide	EU-152	Suspect	*Long Lived Nuclide*	EU-154	3.77E+08 Bq
Long Lived Nuclide	EU-155	2.20E+08 Bq	*Long Lived Nuclide*	FE-55	8.07E+08 Bq
Long Lived Nuclide	H-3	1.33E+08 Bq	*Long Lived Nuclide*	HO-166M	Suspect
Long Lived Nuclide	I-129	1.24E+03 Bq	*Long Lived Nuclide*	KR-85	3.47E+08 Bq
Long Lived Nuclide	MO-93	2.21E+03 Bq	*Long Lived Nuclide*	NB-93M	2.09E+04 Bq
Long Lived Nuclide	NB-94	5.47E+08 Bq	*Long Lived Nuclide*	NI-59	5.85E+06 Bq
Long Lived Nuclide	NI-63	1.32E+09 Bq	*Long Lived Nuclide*	NP-237	1.22E+04 Bq
Long Lived Nuclide	PD-107	4.77E+03 Bq	*Long Lived Nuclide*	PM-147	Suspect
Long Lived Nuclide	PU-236	Suspect	*Long Lived Nuclide*	PU-238	9.20E+06 Bq
Long Lived Nuclide	PU-239	1.23E+07 Bq	*Long Lived Nuclide*	PU-240	2.06E+07 Bq
Long Lived Nuclide	PU-241	4.70E+09 Bq	*Long Lived Nuclide*	PU-242	6.88E+04 Bq
Long Lived Nuclide	RU-106	1.15E+10 Bq	*Long Lived Nuclide*	SB-125	6.48E+08 Bq
Long Lived Nuclide	SE-79	1.60E+04 Bq	*Long Lived Nuclide*	SM-151	1.40E+07 Bq
Long Lived Nuclide	SN-121M	Suspect	*Long Lived Nuclide*	SN-126	3.04E+04 Bq
Long Lived Nuclide	SR-90	2.80E+09 Bq	*Long Lived Nuclide*	TB-157	Suspect
Long Lived Nuclide	TC-99	5.20E+05 Bq	*Long Lived Nuclide*	TH-228	Suspect
Long Lived Nuclide	TH-230	1.30E+00 Bq	*Long Lived Nuclide*	U-232	Suspect
Long Lived Nuclide	U-234	4.42E+04 Bq	*Long Lived Nuclide*	U-235	6.74E+02 Bq
Long Lived Nuclide	U-236	1.00E+04 Bq	*Long Lived Nuclide*	U-238	1.24E+04 Bq
Long Lived Nuclide	ZR-93	2.16E+05 Bq	*Short Lived Nuclide*	CM-242	Suspect
Toxic Substance	ALUMINUM	5.94E-03 grams	*Toxic Substance*	CHROMIUM	8.82E-03 grams
Toxic Substance	COBALT	8.17E-04 grams	*Toxic Substance*	NICKEL	3.63E-03 grams

Contaminants in the table above are reported in concentration units. Bq/m3 for nuclides, kPa for pressurized gases, and g/kg for other contaminants. Total quantities (Bq or g) will be calculated based on the volume and mass of waste.

Other Contaminants:

Note that all long-lived nuclides, short-lived nuclides, chelating agents, toxic substances, and pressurized gases MUST be reported if contained in the waste package.

Type	Contaminant	Actual Quantity	Measure Unit		Suspect
				OR	☐
				OR	☐
				OR	☐
				OR	☐
				OR	☐

Contaminants in the table above are reported as the amount contained per package (Bq, grams, or kPa).

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FIG. 9. Template (partially pre-filled) AECL-CRL data sheet to be completed for routine wastes.

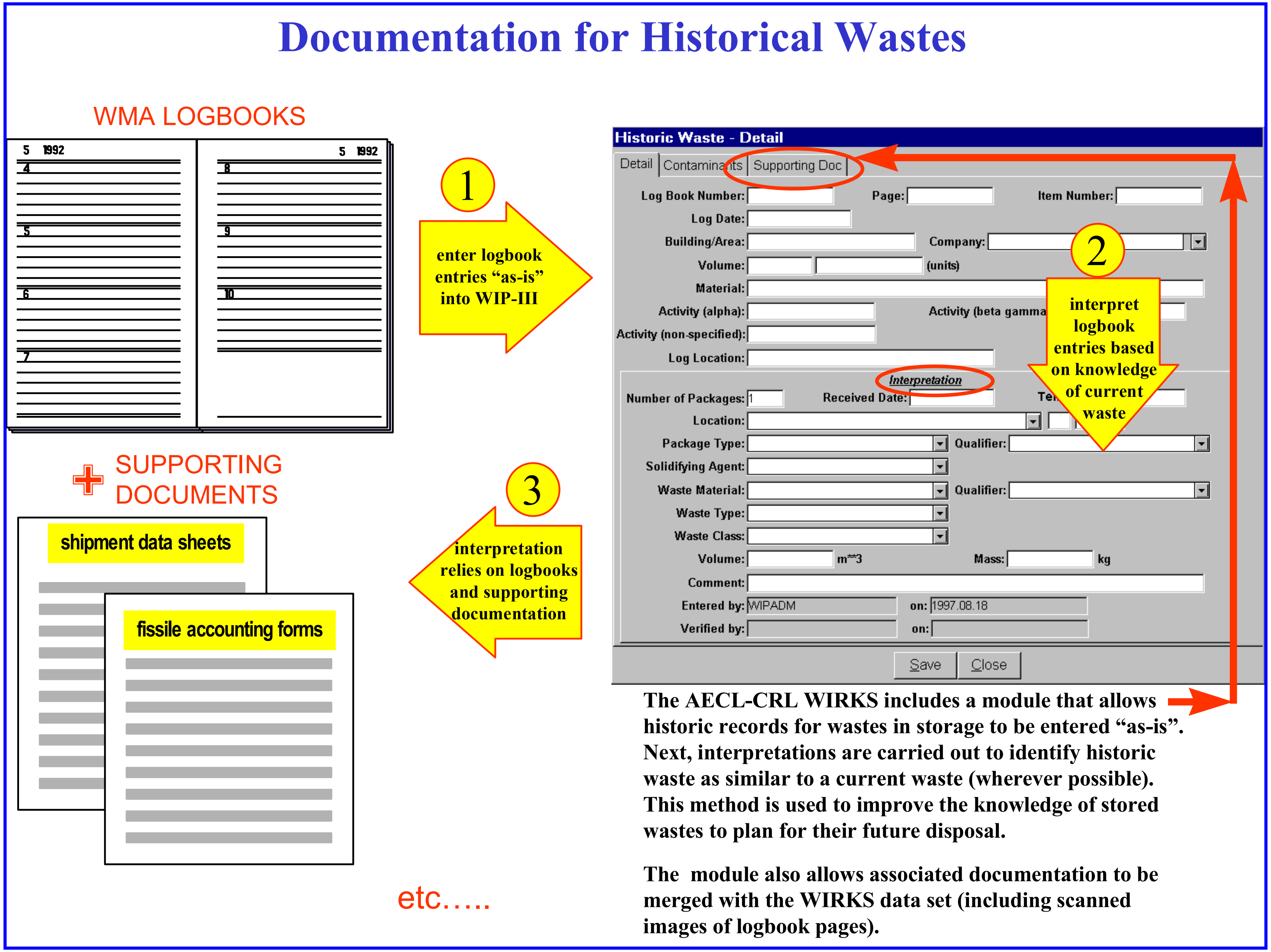


FIG. 10. Documentation for historical wastes at AECL-CRL.

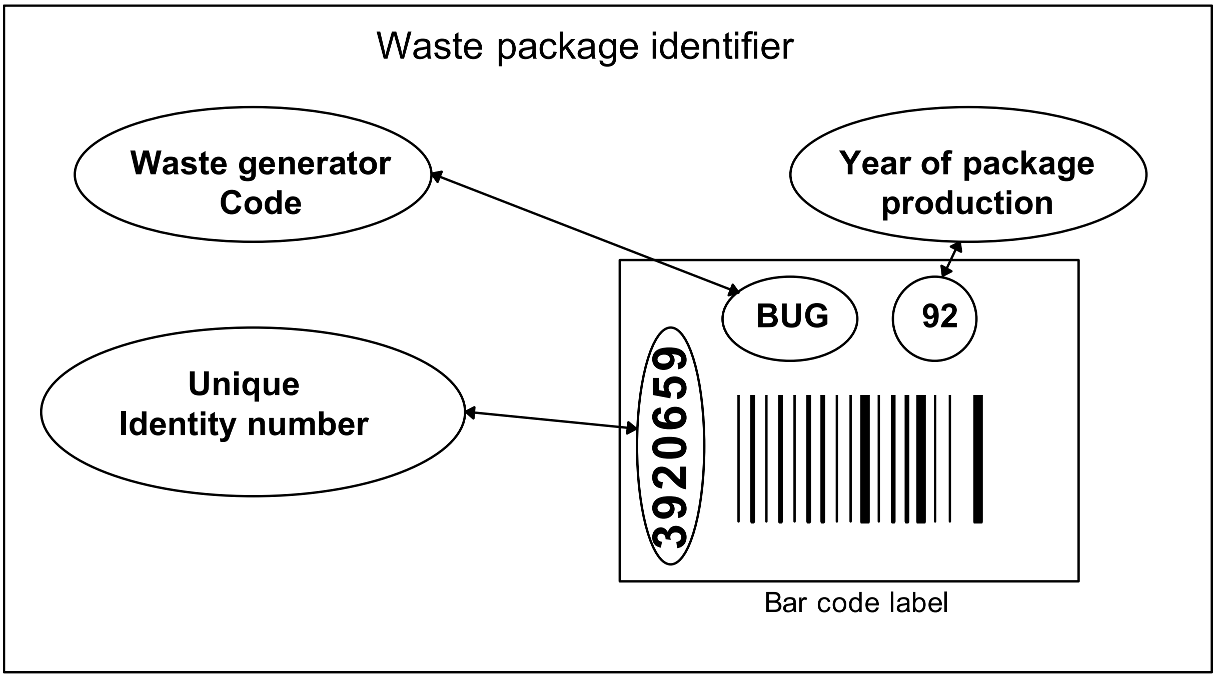
7.2. Member State experience with WIRKS – France

The waste package database for Andra's Centre de l'Aube disposal facility is used either to keep information on waste package characteristics or to verify that waste packages meet acceptance criteria (verification of the conformance of waste to the characteristics indicated by the generator).

The waste package data consist of:

- Package identification number and type code
- Waste generator registration number
- Date of creation of waste package
- Description of the waste (physical and chemical form)
- Description of waste container
- Weight of waste package
- Type and weight of internal/external shieldings
- Waste package external dose rate
- Waste package location (X, Y, Z co-ordinates in a disposal vault)
- Radionuclides inventory and activities

A unique identifier is used to link data to waste packages:



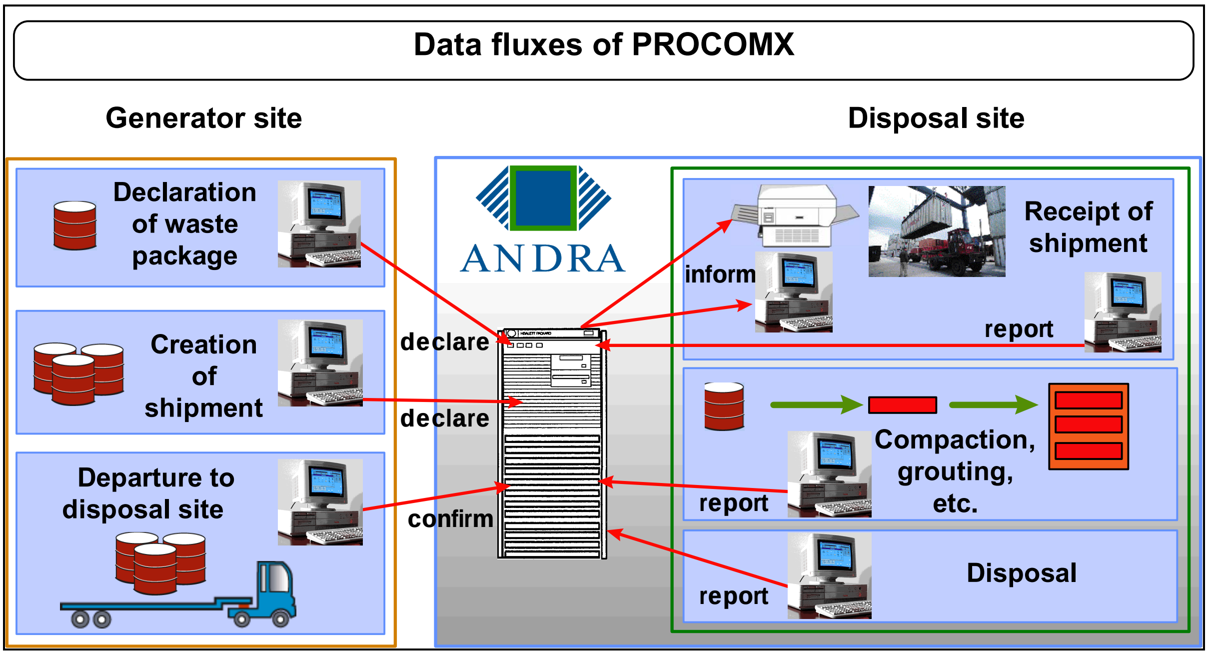
Elements such as data sheets, shipping records and disposal records are included in the waste package database.

Most supporting documentation is included in the acceptance specifications, which are managed in a separate the document management system. The link between the waste package database and the acceptance specification document system is a code describing the generator and the waste package type.

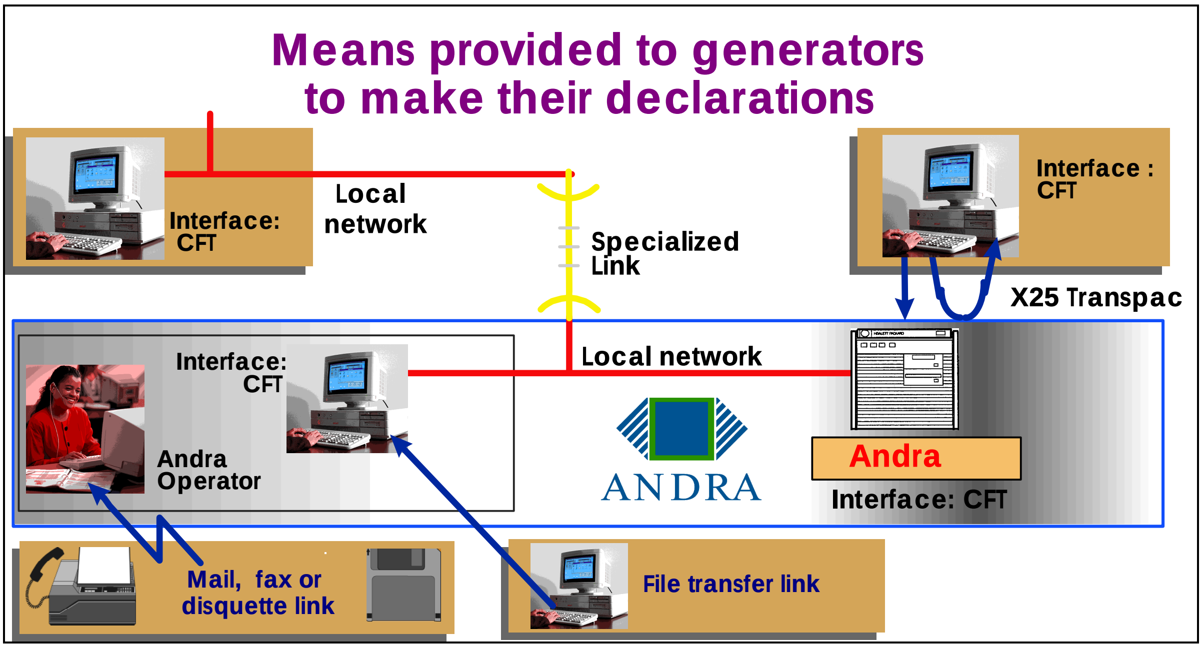
Part of the reference documentation is also included in the waste package database, for instance radionuclide half-lives.

Supplemental documentation is managed in a separate document management system. Plans call for including digitized technical drawings in an electronic document management system (EDMS).

The following figure provides a representation of the data stream from the generator site to the disposal site. With the main generators, the system allows the electronic exchange of data without the need for hard copy documents. Only small waste generators use hard copy documents such as data sheets or shipping documents.



The following figure provides a representation of the technical means used to transfer the package description data.



The following shows the data sheets that are used.

The first data sheet is used to declare the information related to packages. Most of the data are codes. The second data sheet is used to declare the information related to the packages' radiological constituents.

ANDRA	**Data sheet n° 2** **DESCRIPTION OF** **WASTE PACKAGE**	Waste generator's identification R S C	Written by : Check by :	Data sheet n° 2 Transmission 1 0 0 5 1 9 9 7

WP year of production	WP unique identity number	Quantity of waste packages	Packaging code & Activity code	Immobili-zation code	Origin code & Physical form	Waste package type code	Spectrum reference	Date of activity measurement	Activity (GBq)
9 8	5 4 0 2 5 4 1	0 0 1	1 2 2 0	2 2	2 A B	1 I		1 0 0 6 1 9 9 7	2 3 5 1 - 0 9

Weight of waste package (kg)	Dose rate (µGy/h)	Internal shielding code	Internal shielding Weight of schielding (kg)	Raw waste generator code	Waste generator's identification	Reference for βγ activity measurement method	Reference for α activity measurement method	Reference for ^3H activity measurement method	Contaminated shielding code
0 0 1 2 1	2 0 - 0			0 1	R S C	B 9 5 0 0 1	A 9 5 0 0 1	H 9 5 0 0 1	

WP year of production	WP unique identity number	Quantity of waste packages	Packaging code & Activity code	Immobili-zation code	Origin code & Physical form	Waste package type code	Spectrum reference	Date of activity measurement	Activity (GBq)

Weight of waste package (kg)	Dose rate (µGy/h)	Internal shielding code	Internal shielding Weight of schielding (kg)	Raw waste generator code	Waste generator's identification	Reference for βγ activity measurement method	Reference for α activity measurement method	Reference for ^3H activity measurement method	Contaminated shielding code

ANDRA	**FICHE 4** **Nuclide composition** **(Activity in GBq)**	Waste generator's identification R S C	Written by : Check by :	Data sheet n° 2 Transmission 1 0 0 5 1 9 9 7

1 WP year of production	1 WP unique identity number	3 Nuclide code	4 Activity (GBq)	5 Nuclide code	6 Activity (GBq)	7 Nuclide code	8 Activity (GBq)
2 Spectrum reference							
9 8	5 4 0 2 5 4 1	C O 6 0	2 5 1 0 - 0 7	U 2 3 6	1 2 0 1 - 0 8		
		C O 5 8	5 0 2 0 - 0 7				
		U 2 3 5	1 2 0 1 - 0 8				

7.3. Member State experience with WIRKS – Germany

An overall inventory is required to demonstrate the safety of a final repository for radioactive waste during operation and in the post closure phase and to distribute the expenses for the erection of federal facilities for disposal of radioactive waste among the waste producers in proportion to the amount of radioactive waste produced.

The Federal Office for Radiation Protection (Bundesamt für Strahlenschutz, BfS) is responsible for maintaining this inventory based on the following:

(a) Act on the Peaceful Utilization of Atomic Energy and the Protection against its Hazards (Atomic Energy Act, Atomgesetz - AtG)

– § 9a
(3) ... the Federation shall establish installations for the safekeeping and disposal of radioactive waste.
– § 9b
(1) The erection and operation of the federal installations referred to in § 9a (3) as well as any major alteration of such installations or their operation shall be subject to a planning approval procedure.
(4) ... It (the planning approval notice) shall not be issued if
1. the erection or operation of the proposed installation suggest that the common welfare will be impaired and that such impairment can not be prevented by restrictions and obligations ...
– § 23
(1) The Federal Office for Radiation Protection shall be responsible for
2. the erection and operation of federal installations for the safekeeping and disposal of radioactive waste.

(b) Ordinance Concerning Prepayments for the Erection of Federal Facilities for the Long-Term Engineered Storage and Disposal of Radioactive Waste (Endlagervorausleistungs-verordnung - Endlager-VlV)

– § 6 Distribution of expenses
...

(3) Among the waste producers according to para. 1 Nos. 1 to 3, the expenses shall be distributed in proportion to the capacities of the respective facilities. Among the waste producers according to para. 1 No. 4, the expenses shall be distributed in proportion to the amount of radioactive waste produced on the average during the last 3 years prior to the levying of the prepayments, and which should be delivered to federal facilities according to § 9a para. 3 of the Atomic Energy Act.

(4) If federal facilities according to § 9a para. 3 of the Atomic Energy Act are only erected for radioactive waste of certain waste producers, the expenses are solely distributed under those waste producers. The distribution is performed in proportion to the amount of radioactive waste to be assigned to the individual waste producers, if those are already known at the time when the prepayments are levied. Otherwise, para. 3 shall apply correspondingly.

Example of Repository Inventory Management

The waste acceptance requirements for the Morsleben repository define activity limits for long lived radionuclides based on long term safety assessments. These limits may be exceeded for single waste packages with special permission by BfS. The BfS has to make sure that the overall limits for the repository are met. For every nuclide limited by the long term safety assessment, the mean concentration of all waste packages deposited so far has to be calculated and compared to the limit. The exhaustion of the activity limits from the long term safety assessment for 22 320.37 m³ radioactive waste deposed of between 1994 and 1998 in the Morsleben repository is shown in the Table IV, which follows:

Table IV. Exhaustion of activity limits from the long term safety assessment

Limit Bq/m³	Nuclide	Activity Bq	Concentration Bq/m³	Exhaustion
9.6E+07	C-14	3.3E+11	1.5E+07	16 %
6.1E+07	Cl-36	2.4E+09	1.1E+05	0 %
1.7E+07	Ca-41	5.6E+07	2.5E+03	0 %
3.8E+08	Ni-59	1.1E+11	5.1E+06	1 %
1.4E+11	Ni-63	9.7E+12	4.4E+08	0 %
1.4E+06	Se-79	1.1E+08	4.7E+03	0 %
4.2E+06	Rb-87	2.0E+07	8.8E+02	0 %
9.2E+06	Zr-93	7.0E+09	3.1E+05	3 %
2.5E+08	Nb-94	2.0E+10	9.1E+05	0 %
5.8E+07	Mo-93	1.9E+08	8.6E+03	0 %
1.1E+08	Tc-99	5.4E+10	2.4E+06	2 %
3.3E+08	Pd-107	5.7E+07	2.6E+03	0 %
6.2E+05	Sn-126	1.9E+08	8.4E+03	1 %
1.6E+06	I-129	1.8E+08	7.9E+03	0 %
7.1E+06	Cs-135	2.1E+08	9.6E+03	0 %
1.4E+10	Sm-151	2.9E+11	1.3E+07	0 %
1.6E+06	Ra-226	6.1E+07	2.7E+03	0 %
2.2E+04	Th-229	3.0E+05	1.4E+01	0 %
1.0E+04	Th-230	1.6E+06	7.3E+01	1 %
7.3E+04	Th-232	5.9E+06	2.6E+02	0 %
6.3E+04	Pa-231	1.7E+06	7.6E+01	0 %
5.0E+04	U-233	4.9E+06	2.2E+02	0 %
2.3E+05	U-234	4.8E+08	2.2E+04	10 %
1.8E+05	U-235	3.3E+07	1.5E+03	1 %
1.2E+06	U-236	4.8E+07	2.2E+03	0 %
3.1E+05	U-238	1.8E+08	8.0E+03	3 %
1.0E+05	Np-237	8.1E+07	3.6E+03	4 %
2.2E+06	Pu-239	7.0E+09	3.2E+05	15 %
3.7E+07	Pu-240	8.1E+09	3.6E+05	1 %
1.8E+10	Pu-241	8.1E+11	3.6E+07	0 %
9.2E+04	Pu-242	1.2E+08	5.2E+03	6 %
4.3E+04	Pu-244	2.1E+04	0.0E+00	0 %
1.0E+08	Am-241	3.7E+10	1.7E+06	2 %
1.0E+05	Am-243	9.5E+07	4.3E+03	4 %
4.0E+08	Cm-244	9.5E+09	4.3E+05	0 %
3.8E+05	Cm-245	2.3E+06	1.0E+02	0 %
3.8E+05	Cm-246	2.7E+06	1.2E+02	0 %
5.2E+03	Cm-247	2.6E+04	1.0E+00	0 %
8.4E+04	Cm-248	2.2E+07	1.0E+03	1 %

The delivery of waste to Federal Facilities is regulated in the Ordinance on the Protection against Damage and Injuries Caused by Ionizing Radiation (Radiation Protection Ordinance, Strahlenschutzverordnung - StrlSchV) § 81, 82 and 83.

§ 81 Delivery to Federal Facilities

(1) Radioactive waste shall be delivered to a federal facility for the safekeeping and final disposal of radioactive waste if the waste originated

1. during the governmental custody of nuclear fuel under § 5 of the Atomic Energy Act,

2. during storage under § 6 of the Atomic Energy Act,

3. at the installations requiring a license under § 7 of the Atomic Energy Act,

4. during work as specified in § 9 of the Atomic Energy Act.

(2) Para. (1) shall also apply to radioactive waste which originated during handling under § 3, para. (1) provided such handling occurred in connection with either of the practices under para. (1) or if a license granted pursuant to the Atomic Energy Act under § 3, para. (2), also covers handling under § 3, para. (1).

(3) Other radioactive waste may only be delivered to a federal facility for the safekeeping and final disposal of radioactive waste if the competent authority has allowed such delivery.

§ 82 Delivery to State Collecting Facilities

(1) Radioactive substances other than those specified in § 81, paras. (1) and (2) shall be delivered to a state collecting facility.

(2) The radioactive waste specified in § 81, paras. (1) and (2) may only be delivered to a state collecting facility if the competent authority has allowed such delivery.

(3) Basically, the state collecting facility shall deliver the radioactive waste which it keeps in interim storage to a federal facility for the safekeeping and final disposal of radioactive waste.

§ 83 Exceptions and Exemptions from Compulsory Delivery

(1) Compulsory delivery under § 81 or § 82 does not refer to radioactive waste inasfar as

1. their disposal does not require a license under § 4, para. (4), first sentence, No. 2 (e),

2. their discharge is acceptable under §§ 45 or 46, or

3. their other disposal or delivery has been prescribed or permitted.

Compulsory delivery shall be suspended for as long as some other intermediate storage of the radioactive waste has been prescribed or permitted.

(2) Compulsory delivery under § 81 shall be deemed to have been complied with by delivery to a state collecting facility if delivery to such a facility is allowed under § 82, para. (2). Compulsory delivery under § 82 shall be deemed to have been complied with by delivery to a federal facility if delivery to such facility is allowed under § 81, para. (3).

Waste generators delivering waste to a Federal Repository are listed in Table V.

Table V. List of code letters for waste producers

Code Letters	Waste Producer	Code Letters	
BAM	Bundesanstalt für Materialforschung und -prüfung	LRP	Landessammelstelle Rheinland-Pfalz
EIT	Europäisches Institut für Transurane	LSA	Landessammelstelle Saarland
FZK*	Forschungszentrum Karlsruhe Technik und Umwelt GmbH	LSH	Landessammelstelle Schleswig-Holstein
GKS	Forschungszentrum Geesthacht GmbH	LSN	Landessammelstelle Sachsen
GSF	Forschungszentrum für Umwelt und Gesundheit GmbH	LST**	Landessammelstelle Sachsen-Anhalt
HMI	Hahn-Meitner-Institut Berlin GmbH	LTH**	Landessammelstelle Thüringen
KFA	Forschungszentrum Jülich GmbH	ABQ	Gamma-Service-GmbH
MHH	Medizinische Hochschule Hannover	ANF	Advanced Nuclear Fuels GmbH
VKT	Verein für Kernverfahrenstechnik und Analytik Rossendorf e.V.	ASB	Amersham Buchler GmbH & Co KG
ZFI	Zentralinstitut für Isotopen- und Strahlenforschung i.A.	GNS	Gesellschaft für Nuklear-Service mbH
BBG	Kernkraftwerk Biblis, Blöcke A/B	NUK	Nukem GmbH
GKN	Kernkraftwerk Neckarwestheim, Blöcke 1/2	SBW	Siemens AG - Brennelementewerk Hanau
KBR	Kernkraftwerk Brokdorf	SGR	Siempelkamp Gesellschaft für Guß- und Reaktortechnik mbH
KGG	Kernkraftwerk Gundremmingen, Blöcke B/C	STO	Stoller Ingenieurtechnik GmbH
KI1	Kernkraftwerk Isar 1	SUK	Siemens AG - Unternehmensbereich Kraftwerk Union
KI2	Kernkraftwerk Isar 2	URA	Uranit GmbH
KKB	Kernkraftwerk Brunsbüttel	URE	Urenco GmbH
KKE	Kernkraftwerk Emsland	AVR	Versuchsatomkraftwerk Jülich
KKG	Kernkraftwerk Grafenrheinfeld	FJ1	Forschungsreaktor 1 Jülich
KKK	Kernkraftwerk Krümmel	FJ2	Forschungsreaktor 2 Jülich
KKP	Kernkraftwerk Philippsburg, Blöcke 1/2	FRB	Forschungs- und Meßreaktor Braunschweig
KKS	Kernkraftwerk Stade	FR2	Forschungsreaktor 2 Karlsruhe
KKU	Kernkraftwerk Unterweser	HDR	Heißdampfreaktor Großwelzheim
KWG	Kernkraftwerk Grohnde	KGA	Kernkraftwerk Gundremmingen, Block A***
KWO	Kernkraftwerk Obrigheim	KGR	Kernkraftwerk Greifswald
KWW	Kernkraftwerk Würgassen	KKN	Kernkraftwerk Niederaichbach
MKA	Kernkraftwerk Mülheim-Kärlich	KKR	Kernkraftwerk Rheinsberg
COG	Wiederaufarbeitungsanlage La Hague	KWL	Kernkraftwerk Lingen
BNF	Wiederaufarbeitungsanlage Sellafield	OHA	Nuklearschiff "Otto Hahn"
LBA	Landessammelstelle Bayern	THT	Kernkraftwerk Hamm-Uentrop
LBB	Landessammelstelle Brandenburg	VAK	Versuchsatomkraftwerk Kahl
LBE	Landessammelstelle Berlin	WAK	Wiederaufarbeitungsanlage Karlsruhe
LBW	Landessammelstelle Baden-Württemberg	BUW	Bundeswehr
LHE	Landessammelstelle Hessen	HOE	Hoechst AG
LMV	Landessammelstelle Mecklenburg-Vorpommern	BLG	Brennelementlager Gorleben GmbH
LNI	Landessammelstelle Niedersachsen	BZA	Brennelement-Zwischenlager Ahaus GmbH
LNW	Landessammelstelle Nordrhein-Westfalen	DBE	Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH

* Former combination of code letters: KFK.

** In case there is no state collecting facility established yet, the assignment of the serial number must be regulated separately.

*** Common processing of liquid wastes with KGG.

Quality Control Procedure and Documentation

The waste producer/conditioner has to demonstrate fulfilment of waste acceptance requirements within the quality control procedure, which can be demonstrated by:

— qualification of conditioning processes with subsequent inspections and
— random checks on existing waste packages.

The quality control procedure for radioactive waste packages as agreed between the federation and the Federal States is shown in Figure 11.

For every waste package disposed of in the Morsleben repository the data contained in the waste-data-sheet (see Figure 12) is documented. Additional data (e.g. results of measurements, analyses, calculations) are collected by the waste producer and verified by the authorized expert on behalf of the BfS. These additional data are not part of the documentation of the final repository.

After emplacement, the date and emplacement field (for the period between 1994 and 1998 there have been five emplacement fields) are added to the documentation. It is not intended to use a more detailed system (e. g. X-Y-Z co-ordinates) for the planned Konrad repository.

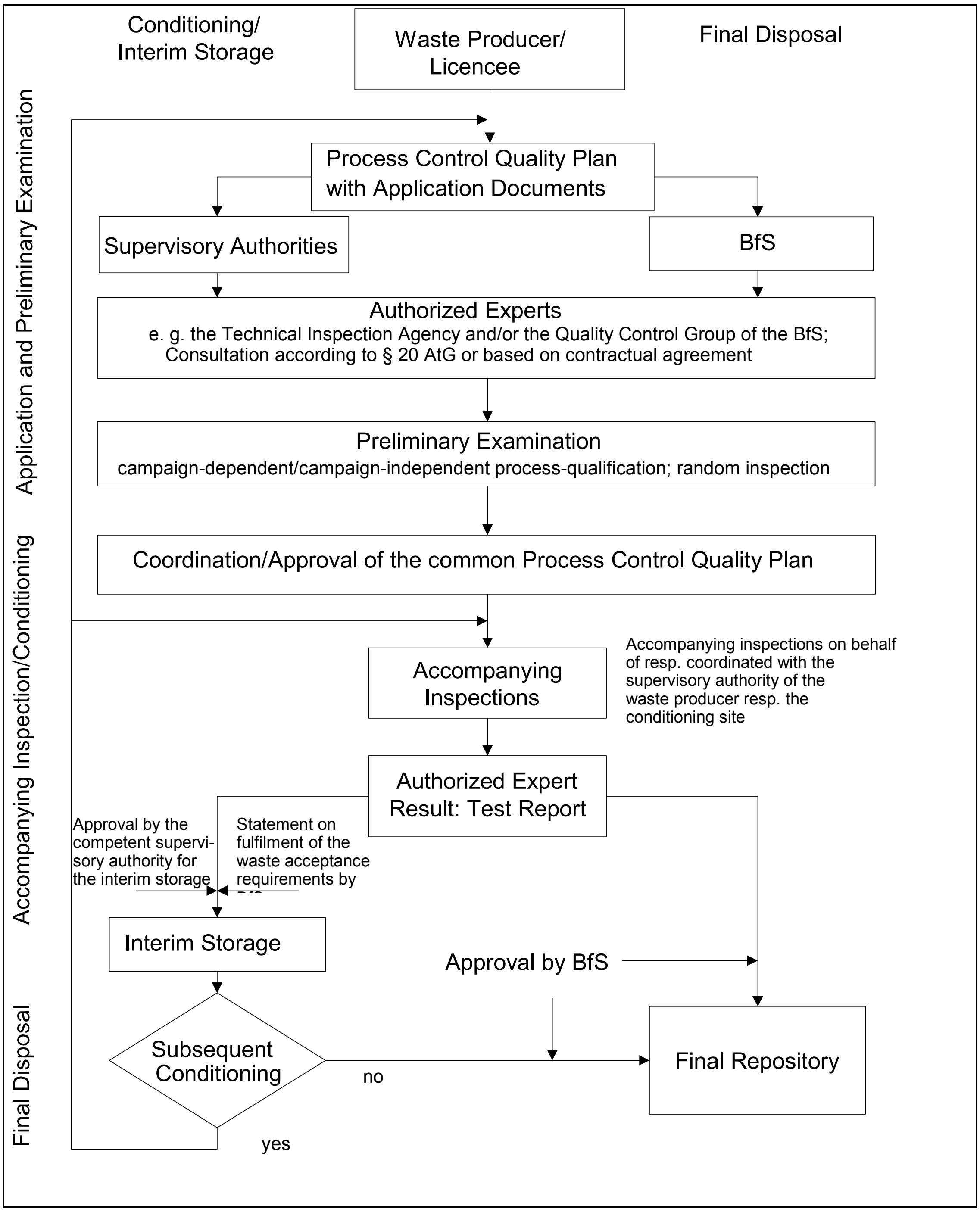


FIG. 11. Quality control procedure for radioactive waste.

Example Datasheet

Einzeldatenblatt-Nr.:	E1DBE000123-0001	1	Kennzeichnung:	DBE0000011

Einzeldatenblatt für radioaktive Abfälle, Abfallart A1 (feste Abfälle), Blatt 1

2 Ablieferer:	DBE	3 Konditionierer:	DBE
Anschrift:	Postfach 12 34 56 98765 Musterstadt	Anschrift:	Postfach 12 34 56 98765 Musterstadt
Ansprechpartner:	Herr Mustermann	Ansprechpartner:	Herr Mustermann
Telefon:	012345/67-0	Telefon:	012345/67-0
Fax:	012345/67-100	Fax:	012345/67-100

9	Konditionierung:	308	5	Konditionierungsdatum:	29.01.1998
6	Strahlenschutzgruppe:	S2	8	Abfallart:	A1
7	Behältertyp:	280 l-Fass	10	Qualitätsmerkmal:	QM1
7	Bezugsvolumen:	0,28 m³	11	Innenbehälter:	Nein
20	Dosisleistung 0,1 m:	0,600 mSv/h	21	Kontam. Beta/Gamma:	< 0,400 Bq/cm²
20	Dosisleistung 1 m:	0,040 mSv/h	21	Kontam. Alpha:	< 0,040 Bq/cm²
22	Gebindemasse:	406,50 kg	22	Masse der Einheit:	406,50 kg

25 Die Anforderungen an endzulagernde radioaktive Abfälle für die Abfallart A1 (feste Abfälle) gemäß den ‘Anforderungen an endzulagernde radioaktive Abfälle - Endlager Morsleben (ERAM) -‘ werden eingehalten. Wir versichern, dass die angegebenen Abfalldaten korrekt und vollständig sind.

		06.02.1998
Abfallablieferer/ Konditionierer	Ort	Datum, Unterschrift Konditionierer

26 Die Angaben wurden entsprechend den im Prüfbericht (AZ:) aufgeführten Anforderungen überprüft. Das o. g. Gebinde genügt entsprechend den Festlegungen im Prüfbericht den Anforderungen für endzulagernde Abfallgebinde - Endlager Morsleben (ERAM) -

		19.02.1998
Produktkontrolle	Ort	Datum, Unterschrift

27 Prüfung ERAM:

	11.03.1998
(Bestätigung der Annahmebereitschaft)	Datum, Unterschrift

28 Freigabe BfS:

19.03.1998
Datum, Unterschrift

ERAM:

Ostfeld 2	25.03.1998
Einlagerungsort	Datum, Unterschrift

Ausdruck: 04.02.1998 Stand: 21.11.1996

FIG. 12. ERAM-single datasheet.

Einzeldatenblatt-Nr.:	E1DBE000123-0001	1	Kennzeichnung:	DBE0000011

Einzeldatenblatt für radioaktive Abfälle, Abfallart A1 (feste Abfälle), Blatt 2

12	Gesamtaktivität β/γ:	1,6E+09 Bq	12	Gesamtaktivität α:	1,6E+05 Bq	
14	Aktivitätskonzentration β/γ:	4,9E+09 Bq/m³	13	Aktivitätskonzentration α:	5,6E+05 Bq/m³	
19	Störfallsummenwert:	0,080				
15	Nuklidaktivität im Abfallgebinde		18	Bezugsdatum der Aktivitäten:		06.02.1998

Beta-/Gamma-Strahler				Alpha-Strahler			
H-3UN	1,0E+07 Bq	Cs-135	1,1E+03 Bq	Ra-224	4,6E+01 Bq	Cm-250	**
H-3HTO	**	Cs-137	1,7E+08 Bq	Ra-226U	**	Cf-249	2,0E+00 Bq
H-3MF	**	Sm-151	2,5E+05 Bq	Ra-226F	**	Cf-251	**
C-14UN	1,2E+07 Bq	Eu-152	2,4E+03 Bq	Th-228	4,6E+01 Bq	Cf-252	2,0E+00 Bq
C-14VDK	**	Ho-166m	**	Th-229	**	Cf-254	**
Na-22	5,7E+01 Bq	Pb-210	**	Th-230	**		
Al-26	**	Ra-228	**	Th-232	**		
Cl-36	3,4E+03 Bq	Ac-227	**	Pa-231	**		
K-40	**	Ac-228	**	U-232	4,9E+01 Bq		
Ca-41	2,0E+01 Bq	Np-236	**	U-233	**		
Co-60	4,7E+08 Bq	Pu-241	3,8E+06 Bq	U-234	1,9E+03 Bq		
Ni-59	4,1E+06 Bq	Am-242m	8,5E+02 Bq	U-235	3,0E+01 Bq		
Ni-63	6,9E+08 Bq			U-236	4,4E+02 Bq		
Se-79	6,5E+02 Bq			U-238	8,0E+02 Bq		
Rb-87	**			Np-237	7,4E+02 Bq		
Sr-90	3,8E+06 Bq			Pu-239	9,7E+03 Bq		
Zr-93	4,4E+01 Bq			Pu-240	2,1E+04 Bq		
Nb-94	4,6E+05 Bq			Pu-242	1,6E+02 Bq		
Mo-93	3,4E+02 Bq			Pu-244	**		
Tc-99	3,3E+06 Bq			Am-241	7,0E+04 Bq		
Pd-107	2,0E+01 Bq			Am-243	1,1E+02 Bq		
Ag-108m	1,4E+05 Bq			Cm-244	1,5E+04 Bq		
Cd-113m	4,3E+05 Bq			Cm-245	4,0E+00 Bq		
Sn-126	4,0E+03 Bq			Cm-246	**		
I-125	**			Cm-247	**		
I-129	6,3E+01 Bq			Cm-248	**		

16	Nicht deklarationspflichtige Nuklide:		keine Angabe		
17	Rest Beta/Gamma	2,3E+08 Bq		Rest Alpha	3,7E+04 Bq
23	Qualifizierte Verpackung:	Ja	23	Feuerfeste Verpackung:	Ja
24	Brennbarkeit Abfallstoffe:	Ja	24	Thermisch stabil:	Nein
24	Dispergierbar:	> 1 %			

Bemerkungen:

Insbesondere Angaben über im Abfall enthaltene Materialien (nach Möglichkeit quantitative Angaben)

Presslinge

Ausdruck: 04.02.1998 Stand: 21.11.1996

FIG. 12. (cont.)

7.4. Member State experience with WIRKS – Hungary

Hungarian legislation requires that all licensed users of radioactive materials — including radioactive waste storage and disposal facilities – maintain a local registry of all radioactive substances in their possession. The nation wide Central Registry of Radioactive Materials, supervised by the Hungarian Atomic Energy Authority (HAEA), should keep records of all sealed sources and disposed bulk waste. Operators of radioactive waste repositories are required to work out and operate waste record keeping systems, which must be approved by the HAEA. A new ministerial decree — in preparation — on establishing and licensing radioactive waste storage and repository facilities is more specific regarding this issue. It would require that the operators have a system that provides up-to-date information about the total quantity of the waste at the site as well as the origin, date and location of disposal, physical and chemical characteristics, and radionuclide inventory of all individual waste packages. But the general approach does not change: the authority should decide on a one-by one basis whether a particular implementation of the WIRKS meets the requirements or not. Therefore the officials of the responsible authority as well as the personnel of the repository operator should have a sound understanding of the basic purposes and goals, and general implementation possibilities of WIRKS.

Hungary has only one LILW repository in operation at Püspökszilágy. The repository was commissioned in 1976 and is almost full — only about 100 m^3 out of the 5000 m^3 total capacity are free. Originally all radioactive wastes generated in Hungary — at the Paks Nuclear Power Plant as well as at small-scale institutional producers — were disposed of here. For the last couple of years the repository received only institutional waste. Annual arisings of these waste are in the range of 10–20 m^3, so the available space is expected to be sufficient for the next 5 years. At the same time a national project to build a new LILW repository is under way. Until the opening of the new facility, NPP waste is stored on the power plant site.

At the Püspökszilágy repository, bulk waste is collected in steel drums, which are disposed of in concrete pools. Annual volumes and the corresponding radionuclide inventories are reported once a year to the Central Registry of Radioactive Materials. Spent sealed radioactive sources are disposed of in bore holes and the relevant information is cross-checked with the database of the Central Registry. Since measurement capabilities at the repository site are limited, radioactivity and nuclide information is based mostly on the producer's declaration.

In line with the current legislative requirements, the Püspökszilágy radioactive waste repository maintains a waste record keeping system. In the early days of operation the system was implemented in the form of paper documents. Since the early '90s the record keeping has been computerized, featuring a dBase IV database application running on PC/DOS platform. The structure and contents of the database reflects the limited capabilities of the personal computers and database handling programs of the late '80s.

Recently the repository operator decided to perform a major upgrade of its record keeping system. MS Access '97 on a Windows NT 4.0 platform was selected to support the database. At the time the project was started, the preparation of this TECDOC was already under way. This fortunate coincidence, in combination with the opportunity for a Hungarian expert to participate on drafting this TECDOC, lead to a very fruitful information exchange between the two projects. The ideas discussed at WIRKS drafting meetings and the experiences learned from the practice of participants representing other Member States were used in outlining the basic requirements for the new Püspökszilágy WIRKS. In addition, all information was directly channelled to the software developers. As well, problems encountered during the progress of the Hungarian project was fed back to the WIRKS drafting team. This is clearly reflected in the structure, scope, level of detail, and practical usability of this TECDOC.

As a result of the above process, the new WIRKS at the Püspőkszilágy radioactive waste repository conforms with the guidance in the current TECDOC. The system provides for most data fields and all functions described in Section 2. A dual record structure for packages, like that shown in Figure 4, was implemented, which reflects the practice of waste collection and packaging in Hungary where several waste producers may contribute to a single waste package which is disposed of at the repository. The new Hungarian database also overcomes earlier limitations, where only general information about package locations (borehole or pool) was stored and the nuclide inventory listing was limited to ten radionuclides per package. Even the concept of waste streams is implemented, in spite of the fact that it is not likely to be of much use due to the near saturation status of the repository. However, the experience gained with the new WIRKS at the Püspökszilágy site is expected to be used at the planned new facility.

At the time when the final draft of this TECDOC was under preparation, the new Püspökszilágy WIRKS was already completed, old data have been migrated to the new database and the system was under exhaustive testing. After the successful completion of the testing phase, the operator – as legislation requires – will submit the WIRKS for approval to the HAEA. Since the regulations do not provide a detailed description of requirements, the most recent draft of this TECDOC available at the time of the approval procedure would be used by the authority as a guide.

It is obvious from the Hungarian example that this TECDOC — from its very early drafting stages till the elaboration of the final document — has already proven to be very helpful for both the repository operators and the regulatory authority. Based on his own personal experience, the Hungarian member of the WIRKS drafting team is convinced that this TECDOC could serve as a good starting point and basic guideline for many other cases in the future.

7.5. Member State experience with WIRKS – United Kingdom

This section describes the principles of the UK Radioactive Waste Inventory, the need for the data, and how the information is compiled and presented to meet the needs of the users.

The Inventory is intended to meet the needs of all users including: waste producers, regulatory authorities, nuclear organisations, R&D teams, consultants, designers and other interested parties including the public. In particular it is used in developing the national long-term strategy for managing radioactive wastes and by Nirex for the development of safe and environmentally sound options for dealing with radioactive waste generated by the Nation's commercial, medical, research and defence activities.

Although the Inventory is primarily a compilation of data provided by waste producers, who continually strive to provide improved data e.g. revised data following operational experience of the new nuclear facilities such as THORP at Sellafield and the Sizewell "B" PWR, improvements have been made by Nirex. In particular the data on the radionuclide chlorine-36 and improved data manipulation capabilities by development of a new database system.

In the future the information will provide the single authoritative input to the strategic decision makers. In addition the database may be further developed to assist waste producers with the day-to-day management of their wastes, both when generated and when packaged for safe long term management.

Principles

The UK Radioactive Waste Inventory is jointly funded by the Department of the Environment, Transport and the Regions (DETR) and UK Nirex Ltd (Nirex). Its aim is to provide full and accurate information on the status of radioactive waste stocks and forecasts of arisings in the UK. Its publication is one facet of the commitment of the UK nuclear industry and the Government to openness in matters relating to the management of radioactive wastes.

The Inventory is intended to meet the need for comprehensive data on radioactive wastes in the UK. It is intended to provide a single definitive source of information to key strategic decision makers. Users include the DETR, Nirex, the waste producers, regulatory authorities, nuclear organisations, R&D teams, consultants, designers, and other interested parties including the public. It is considered important by DETR and Nirex that there is only a single UK Inventory, available to all.

The Inventory contains information on high level waste (HLW), intermediate-level waste (ILW) and low level wastes (LLW) only. Gaseous and liquid effluents that are discharged to the environment in accordance with Government policy and very low level wastes (VLLW) that are routinely disposed are excluded from the Inventory. Radioactive materials which are not classed as waste are not currently included in the Inventory. The absence of data in this area has been identified in the House of Lords Select Committee Report in March 1999 which recommended that decisions are needed soon on which materials are to be declared a waste.

The information in the Inventory will be used in developing the national strategy for managing solid radioactive waste; and more specifically, in planning, developing, designing waste management facilities and in the preparation of associated safety cases for the long term safe management. The Inventory therefore, has to include detailed information on all radioactive wastes arising in the UK: their sources, quantities, nature and radionuclide content, physical and chemical properties, the conditions in which they are stored and the envisaged methods to be used in preparing the wastes for disposal.

As radioactive wastes arise from a diversity of sources and in a large number of different forms, a number of conventions have been adopted by DETR and Nirex in order to collate information on the wastes and assist in its clear presentation. One fundamental convention used is that of the waste stream, which is an arising of waste material or waste items at a particular site from particular processes or operations and can be described on a single data sheet.

Other fundamental conventions include:

- the form of the waste: either as stored, or conditioned for long term safe management;
- whether the waste arising is committed (i.e. arising from plants which exist or for which there is a firm commitment to build or operate in the future) or uncommitted (i.e. arising from plants based on potential future programmes);
- the origin of the waste: from plant or facility operations or from decommissioning.

The waste producers supply all the information on which the Inventory is based. The information changes with time, for a number of reasons. These include: ongoing programmes of waste characterisation, which lead to improvements and refinements of the data; and developments of methods for conditioning the waste for long term safe management. Projections of future arisings are revised according to the perceived prospects of the nuclear industry. For these reasons, the Inventory needs to be routinely updated. However, the increasing maturity and stability of much of the data means that the Inventory needs to be updated less frequently than in its earlier years.

At the stock date for the 1998 Inventory there were seven major producers of radioactive waste in the UK:

(1) Urenco (Capenhurst) Ltd operates uranium enrichment plants,

(2) British Nuclear Fuels plc (BNFL) is engaged in uranium processing and fuel fabrication, uranium enrichment and fuel reprocessing. The company also operates a number of Magnox reactors as well as decommissioning Magnox reactors at Berkeley, Hunterston and Trawsfynydd,

(3) Nuclear Electric Ltd (NE) operates Advanced Gas Cooled (AGR) reactors at five sites in England and the pressurised water reactor at Sizewell,

(4) Scottish Nuclear Limited (SNL) operates AGR's at two sites in Scotland,

(5) the United Kingdom Atomic Energy Authority (UKAEA) operates a number of nuclear facilities where it is responsible for the decommissioning and waste management liabilities remaining from its research programme,

(6) the Ministry of Defence (MoD) own a number of sites that generate radioactive wastes,

(7) Nycomed Amersham (NA) a leading health science company.

In addition many other medical, industrial, educational and research establishments produce smaller quantities of radioactive wastes.

The needs of users

The information presented in the Inventory is designed to meet the needs of the users. Examples of how the users apply the data are discussed below.

Nirex

UK Nirex Ltd (Nirex) has been responsible for developing safe and environmentally sound options for the disposal of intermediate and some low level radioactive waste generated by the Nation's commercial, medical, research and defence activities.

To achieve this Nirex needs various information on the wastes, much of which can be derived from the Inventory. This includes:

· Volumes of wastes

To allow planning for the overall size of the facilities and the associated transport system information is required on the volume of waste, when it will arise, when and how it will be conditioned and where it is located.

· Radionuclide characteristics and content

To allow development of safety cases information on the radionuclide characteristics and content is required. As examples operational safety needs information on gamma emitting radionuclides and distribution within packages since external dose rate is a key parameter. The post-closure safety case will require information on long-lived radionuclides.

· Information on physical and chemical characteristics of the unpackaged waste

To allow assessment of proposals for pre-treatment or encapsulation process, information on chemical reactivity, gas generation mechanisms and quantities of conventional toxic or hazardous materials are necessary. Some of this data will be necessary to meet conventional disposal authorisation parameters associated with safety and regulatory purposes. Other key parameters include materials, which may affect solubility of key radionuclides, or gas generation, such as organics or metallic waste components.

Department of the Environment Transport and the Regions

As the lead Government department responsible for authorising radioactive waste disposals, DETR needs information for the purposes of waste minimisation studies, waste classification studies, identification of waste disposal options, development of policy on radioactive waste management, and provision of data to European and other international bodies such as the IAEA or the Joint Convention for comparative purposes.

The DETR needs information from the Inventory on:

— total waste volumes;
— total radionuclide content;
— how the waste is currently stored;
— plans for immobilisation and disposal for all wastes;
— waste disposed of to the Drigg and Dounreay facilities for LLW;
— the volume and activity of waste generated per unit of electricity;
— HLW.

BNFL

As well as being a waste producer, BNFL operates the Drigg facility for disposal of LLW. BNFL needs the following information on LLW likely to arise for disposal at Drigg:

— volumes of waste;
— when the waste may arise;
— radionuclide composition;
— physical and chemical composition, e.g. toxic and hazardous materials.

Compilation of the Inventory

It is recognised that collation of data is a time consuming and costly exercise which can incur significant dose uptake to workers, therefore each piece of data needs to be justified and supplied to meet a defined need.

Thus regular reviews with Inventory users and waste producers identifies and justifies the need for changes to data. Modifications and changes are only made after agreement with all parties prior to the data collection. Prior to each Inventory exercise a revised questionnaire and guidance document is prepared, discussed and agreed with waste producers and efforts are made to identify priority areas for improvements.

The information presented in the 1998 Inventory was gathered from seven major waste producers by means of a questionnaire document for each waste stream – currently there are approximately 1,000 separate streams.

As agreed with waste producers and in order to minimise the work performed, questionnaires for existing waste streams are issued containing the data previously published, so that only changes to the data need to be made.

When each questionnaire is returned the data are independently checked and reviewed for completeness, accuracy and consistency. The data are then entered onto the database from which individual datasheets, one for each waste stream, are generated and returned to waste producers for agreement. The data are eventually compiled into a series of reports:

(1) The main Inventory report which contains information on volumes, (e.g. times of arising), radionuclides, (e.g. total alpha and beta activities), and physical and chemical nature of the waste, (e.g. weight and materials present).

(2) Companion reports giving detailed information on the nature and quantity of each individual waste stream including volume, when arising, radionuclide and material content, density, conditioning factor, proposed waste processing/treatment plans.

(3) A summary report giving overview information on radioactive wastes and their management as well as presenting summary information on the quantities and characteristics of stocks and arisings.

(4) A waste processes producing report which provides a summary of the processes which give rise to radioactive wastes in the UK.

These reports are sent to waste producers for technical review, and again finally for formal agreement of all the data before being placed in the public domain.

Examples of Inventory Improvements in the 1998 Inventory

· Chlorine-36

It was recognised in the 1991 Inventory that the data on chlorine-36 was variable whereas this radionuclide was shown to be a key contributor to the post-closure risk for a deep waste repository based on current safety assessments. Nirex therefore initiated a programme of work on chlorine-36.

Chlorine-36 is a radionuclide with a half-life of 300,000 years. The principle route for production is neutron activation of chlorine-35 which is the principle isotope of stable chlorine. Although chlorine is a common trace contaminant in a broad range of reactor materials, the data on chlorine-36 was found to be lacking primarily as shorter lived radionuclides such as cobalt-60 dominate operational dose consideration. However, in the longer term i.e. the disposal environment, chlorine-36 was identified as a radionuclide which could dominate the post-closure risk assessments.

A programme of work was therefore placed with the objective of producing a realistic and defensible estimate.

This involved:

- theoretical studies to reduce uncertainties in neutron flux, reactor load factor and the masses of materials exposed,
- measurements of the stable precursors of chlorine-36 (notably chlorine-35 and potassium-39) in all reactor materials,
- calculations of the amounts of chlorine-36 produced,
- chlorine routing into radioactive wastes including looking into graphite.

The major challenges in the research programme included the acquisition of sufficient specimens of reactor materials from the entire lifetime of the UK nuclear industry, performing measurements on materials where the precursor concentrations were low, and development of measurement techniques.

The results of the work were supplied to waste producers for them to agree and were included in individual waste stream Inventory data.

· Inventory Database system

The database system in place in the early 1990's, although reliable, was old and not user friendly and made publication of the data difficult.

The database system on which the UK Inventory data is stored was updated and improved. The new system runs on modern software and hardware, has an improved speed of response, is compatible with most modern software packages and will improve the potential for data transfers. The system allow better presentation in the reports and allow the inventory database system to be transferred in entirety i.e. software and data to compatible hardware. The 1994 and 1998 Inventories have been provided on CD-ROM in addition to paper reports, allowing waste producers to import and manipulate their own data easily.

Future Developments

One identified user requirement is that of BNFL, the operator of the disposal facility at Drigg. These requirements are to up-date their post-closure safety case using wherever possible data in the public domain. Therefore it is intended to use the information from the next planned Inventory, which is planned to have a stock date of 1 April 2001, for a qualitative update of the Drigg post closure safety case. The 2001 data will be improved in a number of areas. These include:

- additional data on the chemical form of iodine and thorium,
- data on Pa-232,
- a revision to the limit for reporting the presence of complexing agents.

This is just one example of the intention of Nirex, the DETR and the waste producers to continually improve the accuracy of the Inventory. Examples of other future changes to the Inventory data may include:

- new waste streams arising from new clean up technologies introduced to meet the requirements from OSPAR,
- revised data based on continued operating experiences and improvements to waste packaging plants.

Conclusion

This section has explained the principles on which the UK Radioactive Inventory of Radioactive Wastes is based, including the need for the data and the Inventory cycle. The commitment for improving the quality and presentation of the data in the light of developments in technology has been illustrated.

7.6. Member State experience with WIRKS – United States of America

Background

Radioactive waste is disposed in the USA by both commercial entities and the Federal government. Requirements for record keeping are promulgated in Federal and State regulations that apply to the specific waste management facility. Due to the fact that waste management functions are performed in the USA by both governmental and private entities and that regulatory authority resides with the Federal government and States depending on the waste class and location, the waste inventory reporting systems are generally unique to the facility. Disposal facility WIRKS must be able to maintain the paper trail from generation through disposal. In the USA this trail may fall solely in the government or the private sector or may in some instances cross between both sectors as government wastes may be disposed in commercial low level waste facilities and commercial spent nuclear fuel will be disposed in the government's high level waste repository.

Low level radioactive wastes[2] from non-government sources, e.g., commercial power reactors, universities, and medical treatment facilities, have been and currently are disposed in near-surface disposal facilities operated by private companies and regulated by the US Nuclear Regulatory Commission (USNRC) or the State in which they are located (Agreement State). There are currently 3 operating commercial low level waste disposal facilities in the USA, all of which are licensed by Agreement States: Chem-Nuclear Systems Barnwell Facility in South Carolina; US Ecology Richland Disposal Facility in Washington; and Envirocare of Utah in Clive, Utah. There are also 4 closed commercial low level waste disposal facilities at: Beatty, Nevada; Maxey Flats, Kentucky: Sheffield, Illinois: and the former West Valley fuel reprocessing plant in New York. Additional facilities could be sited and licensed in the future under USNRC or Agreement State regulations.

The USNRC regulations governing licensing requirements for land disposal of radioactive waste are found in Title 10, Code of Federal Regulations, Part 61. Agreement States develop their own regulations, which have to be compatible and at least as stringent as the USNRC regulations. Specific requirements for maintenance of records, reports, and transfers in USNRC regulations are found in §61.80. Upon receipt and acceptance of a waste shipment, licensees are required to record: the date, location in the disposal site, quantity of radioactive waste contained in the disposal site, condition of the waste packages as received with any discrepancies between the materials listed on the manifest and those received, any evidence of leaking and damaged packages or radiation levels in excess of limits specified in US Department of Transportation and USNRC regulations, description of any repackaging operations, and any other information required by the license. The licensee retains these records through license termination, when certain records are transferred to State, local, and Federal governmental agencies. Operators of commercial disposal sites have latitude to design their record keeping systems to meet their license requirements.

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[2] The definition of low level waste in the United States is not identical to the proposed IAEA definition of the low and intermediate level [LILW] waste class. In the United States, low level waste is waste that is not high level waste, transuranic waste (applies to USDOE waste), spent nuclear fuel, byproduct material (as defined in §11e.(2) of the *Atomic Energy act of 1954*, as amended, or naturally occurring radioactive material (The definition is adapted from the *Nuclear Waste Policy Act of 1982*, as amended). The IAEA LILW waste class has characteristics above clearance levels and thermal power below about 2 kW/m^3.

The USNRC is also the licensing agency for the deep geological disposal facility for high level waste[3] and spent nuclear fuel, which the US Department of Energy (USDOE) plans to construct and operate. The Yucca Mountain site in Nevada is currently being investigated by USDOE as a candidate geological repository location. The geological repository is currently planned to dispose of high level waste and spent nuclear fuel from private (commercial nuclear power plants) and Federal government sources (nuclear materials production, research and development, and naval propulsion). The USNRC regulations (§60.71 of Title 10, Code of Federal Regulations, Part 60) require DOE to maintain records and reports as specified by the license, once it is issued. These records will cover the receipt, handling, and disposition of high level waste and spent nuclear fuel at the geological repository, providing a complete history of the movement of waste from the shipper through all phases of storage and disposal. Records must be maintained for use by future generations.

The USDOE owns and operates a deep geological disposal facility for its defense-related transuranic waste[4], the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico. The US Environmental Protection Agency (USEPA) certified in May 1998 the ability of WIPP to protect the environment and human health. The USEPA certification criteria for WIPP are promulgated in Title 40, Code of Federal Regulations, Part 194. Record keeping systems are part of the system of controls, described in §194.24, which confirms that waste disposed is within certified limits.

The USDOE owns and operates shallow land disposal facilities for its low level waste at: Hanford Site, Idaho National Engineering and Environmental Laboratory, Los Alamos National Laboratory, Nevada Test Site, Oak Ridge National Laboratory, and Savannah River Site. These facilities are operated under authority of the Atomic Energy Act of 1954, as amended, and are subject to USDOE self-regulation through a series of Orders.

The USDOE Order 435.1, *Radioactive Waste Management*, provides assurance that all radioactive waste is managed in a manner that is protective of worker and public health and safety, and the environment. The implementation manual and guidance document for USDOE Order 435.1 require that all radioactive waste management facilities, operations, and activities have and maintain a record-keeping system. This requirement applies to WIPP and the USDOE low level waste disposal sites described above. This system must maintain records for radioactive waste generated, treated, stored, transported, and disposed in compliance with USDOE Order 200.1, *Information Management Program*, and USDOE Order 414.1, *Quality Assurance.* Records are required to be kept throughout the entire life cycle of the waste,

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[3] The definition of high level waste in the United States is similar to, but different than, the proposed IAEA high level waste definition. In the United States high level waste is defined as: the highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations (definition adapted from the *Nuclear Waste Policy Act of 1982*, as amended). Spent nuclear fuel is not high level waste. This definition is a source-based definition and is not dependent upon waste characteristics such as thermal power or radionuclide concentrations and half-lives found in the IAEA proposed high level waste class definition.

[4] The definition of transuranic waste is similar, but not identical, to the IAEA proposed low and intermediate level waste — long-lived waste (LILW-LL) class. The US definition of transuranic waste applies only to wastes generated by the USDOE. Commercial wastes with similar characteristics are defined in USNRC regulations as low level waste (Greater than Class C). Transuranic waste is radioactive waste containing more than 3,700 Bq/g. of alpha emitting transuranic isotopes, with half-lives of greater than 20 years, except for high level waste. In addition there are special provisions to include or exclude waste by exception (definition adapted from the *WIPP Land Withdrawal Act of 1992*, as amended). The IAEA LILW-LL class has waste characteristics exceeding 4,000 Bq/g. with thermal power below about 2 kW/m^3.

including after it is disposed. Specific requirements for record keeping are provided for waste certification, waste transfer, high level waste disposal, low level waste storage, and radioactive waste management basis. Additional record keeping requirements may apply for "mixed" radioactive waste to comply with Federal and/or State hazardous waste regulations. The WIPP is an example of a waste disposal facility that complies with Federal and State hazardous waste regulations for disposal of mixed transuranic waste.

Examples of WIRKS

Several examples of WIRKS for currently operating radioactive waste disposal facilities[5] are described below:

Integrated Waste Tracking System (IWTS)[6]. The IWTS was developed by the USDOE's Idaho National Engineering and Environmental Laboratory to track waste throughout the life cycle from waste declaration to disposal. One of the facilities using the IWTS is the INEEL Radioactive Waste Management Complex, which includes their low level waste disposal facility. This tracking system employs state-of-the-art web-based technology, replacing former labor intensive, paper and ink tracking systems. The IWTS is designed around 3 fundamental building blocks: waste characterization, container characterization, and waste movement/processing. Three-tiered facility models (i.e., facility, unit, and location grid x-y-z) are used to represent the appropriate waste management facilities. Waste profiles describe waste streams in terms of physical, chemical, and radiological attributes. Waste projections are part of the profiles. Actual waste characterization data are captured in IWTS for specific waste containers falling within the profiles. Data include detailed physical, chemical, and radiological attributes and are subject to data validation checks, during certification, review, and approval steps. The information on containers may be entered directly at remote field locations by waste management staff, including bar-code scanning for identification and location purposes, using handheld, wireless, scanning devices. Real-time remote inventory analysis and verification is performed. The IWTS models various shipments, processes (e.g., repackaging, incineration, or compaction), and disposal. Each container profile provides a history and graphical genealogy of the respective container, so that one can trace combination of various containers into a single container or vice versa. The system generates transportation and hazardous waste manifest through its web-based reporting system.

Solid Waste Information Tracking System (SWITS). The USDOE uses the SWITS for solid radioactive waste management at its Hanford Site. This WIRKS pertains to low level waste and transuranic waste management - only low level waste is disposed at Hanford. As part of the Hanford Site solid waste acceptance program, waste profile sheets are developed for each waste stream to ensure that the stream can be managed in compliance with treatment, storage, and disposal facility safety, regulatory, and operational requirements. This is consistent with the IWTS profiles discussed earlier. The profile provides a picture of the radiological, chemical, and physical characteristics, packaging methods, and regulatory classification for the waste stream. For each container of waste generated under the profile, waste generators provide data such as: the source facility, the waste type, the container physical properties, transportation information, waste and filler material physical properties, waste characteristics

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[5] Since the high level waste repository program in the United States is still in the investigative phase, the WIRKS for waste and spent nuclear fuel disposal for that facility has not yet been designed or built.

[6] The IWTS system has been successfully implemented at several USDOE facilities. The system is portable and easily adaptable to specific facility needs. Member States can obtain more information by contacting the Idaho National Engineering and Environmental Laboratory, Waste Generation Services.

— both radiological and hazardous and mixed waste assay information, dose rates, shielding, and applicable dates, e.g., accumulation and container closure. The system then tracks waste through subsequent operations and disposal or shipment to another site. More information on the Hanford Site solid waste acceptance program and SWITS can be found on the web at:

http://www.hanford.gov/wastemgt/wac/tools.htm.

Waste Isolation Pilot Plant Waste Information System (WWIS). The WWIS is a computerized database management system used by USDOE to gather, store, and process information pertaining to USDOE transuranic waste destined for or disposed of in the WIPP geological repository. Information spans characterization, certification, shipment, and emplacement at WIPP. Waste generators must prepare waste stream profile forms for each waste stream sent to WIPP. The WWIS accepts the container-specific data that is the basis for the summary information included on the waste stream profiles. Some data elements are: waste assay and characterization methods, sampling data, hazardous constituents, radionuclide mass, fissile gram equivalent, decay heat power, container packaging characteristics (layers and liner type), gas generation, shipping and packaging data (date, shipper, mode of shipment), packaging identification codes, decay heat power, external dose rates at various locations, surface payload weight, and emplacement data (receiving date, emplacement date and location). The WWIS provides a system which tracks the waste through approval steps, including characterization data approval, certification data approval, and shipment data approval. The WWIS automatically sends electronic mail messages to the shipper/generator each time a container or shipment record is reviewed and accepted or rejected. A user's manual for shippers and generators is available on the web at:

http://www.wipp.carlsbad.nm.us/library/caolib.htm.

Additional information on WWIS can be obtained directly from the USDOE Carlsbad Area Office, National Transuranic Waste Program.

Manifest Information Management System (MIMS). Similar to USDOE facilities, operating commercial low level waste disposal sites in the USA maintain their own WIRKS to meet the regulatory requirements in their operating licenses. Information on waste shipped to each of the 3 operating sites is documented in Uniform Manifests. Waste generators and waste containers must meet specific certification and waste acceptance requirements. Although not formally a WIRKS, MIMS contains WIRKS information supplied by the 3 operating commercial low level waste disposal sites and the closed commercial disposal site at Beatty, Nevada. The MIMS was built and is maintained by USDOE, which obtains the information from the commercial disposal entities. The MIMS is accessible to the public at http://mims.inel.gov/ where a variety of reports are offered. Information is available on the waste generator including an identification code, State of origin, and generator type (academic, government, industry, medical, and utility). Waste information includes waste class, volume, isotopes and activity, date received, manifest number, and number of shipments. Waste generators, States, USNRC, and the public recognize the MIMS system as the consolidated source for commercial low level waste disposal information for the USA.

Other Information Management Systems

To facilitate the need to compile data from the United States government's multiple disposal sites similar to MIMS, there is an information management system (not a WIRKS) which makes certain WIRKS information available for management and public information purposes. The *Integrated Planning, Accountability, and Budgeting System – Information System (IPABS-IS)* is an internal management tool used by the USDOE Environmental Management Program. Of the many functions which IPABS-IS serves, one key function is to compile waste generation projection data and information concerning radioactive waste management facilities, operations, and activities within the USDOE waste management complex (government sector). Life-cycle information on waste from generation to disposal is available, but is much more "rolled-up" or aggregated than found in operating facilities' WIRKS. The IPABS-IS data includes: annual quantities of waste by waste type (e.g., high level, transuranic, and low level), waste characteristics (e.g., isotopes, activity, and hazardous constituents), number of shipments, types of packages, and facility information, which are entered from numerous data sources or WIRKS at the individual waste management facilities. The IPABS-IS satisfies a requirement to establish a waste management data system in the USDOE Order 435.1, *Radioactive Waste Management*. This waste management information is made publicly available as part the USDOE *Central Internet Database (CID*) located at http://cid.em.doe.gov.

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