Safety Reports Series
No. 45

Standard Format and Content for Safety Related Decommissioning Documents

IAEA
International Atomic Energy Agency

IAEA SAFETY RELATED PUBLICATIONS

IAEA SAFETY STANDARDS

Under the terms of Article III of its Statute, the IAEA is authorized to establish or adopt standards of safety for protection of health and minimization of danger to life and property, and to provide for the application of these standards.

The publications by means of which the IAEA establishes standards are issued in the **IAEA Safety Standards Series**. This series covers nuclear safety, radiation safety, transport safety and waste safety, and also general safety (i.e. all these areas of safety). The publication categories in the series are **Safety Fundamentals, Safety Requirements** and **Safety Guides**.

Safety standards are coded according to their coverage: nuclear safety (NS), radiation safety (RS), transport safety (TS), waste safety (WS) and general safety (GS).

Information on the IAEA's safety standards programme is available at the IAEA Internet site

http://www-ns.iaea.org/standards/

The site provides the texts in English of published and draft safety standards. The texts of safety standards issued in Arabic, Chinese, French, Russian and Spanish, the IAEA Safety Glossary and a status report for safety standards under development are also available. For further information, please contact the IAEA at P.O. Box 100, A-1400 Vienna, Austria.

All users of IAEA safety standards are invited to inform the IAEA of experience in their use (e.g. as a basis for national regulations, for safety reviews and for training courses) for the purpose of ensuring that they continue to meet users' needs. Information may be provided via the IAEA Internet site or by post, as above, or by e-mail to Official.Mail@iaea.org.

OTHER SAFETY RELATED PUBLICATIONS

The IAEA provides for the application of the standards and, under the terms of Articles III and VIII.C of its Statute, makes available and fosters the exchange of information relating to peaceful nuclear activities and serves as an intermediary among its Member States for this purpose.

Reports on safety and protection in nuclear activities are issued in other publications series, in particular the **Safety Reports Series**. Safety Reports provide practical examples and detailed methods that can be used in support of the safety standards. Other IAEA series of safety related publications are the **Provision for the Application of Safety Standards Series**, the **Radiological Assessment Reports Series** and the International Nuclear Safety Group's **INSAG Series**. The IAEA also issues reports on radiological accidents and other special publications.

Safety related publications are also issued in the **Technical Reports Series**, the **IAEA-TECDOC Series**, the **Training Course Series** and the **IAEA Services Series**, and as **Practical Radiation Safety Manuals** and **Practical Radiation Technical Manuals**. Security related publications are issued in the **IAEA Nuclear Security Series**.

STANDARD FORMAT
AND CONTENT
FOR SAFETY RELATED
DECOMMISSIONING DOCUMENTS

The following States are Members of the International Atomic Energy Agency:

AFGHANISTAN
ALBANIA
ALGERIA
ANGOLA
ARGENTINA
ARMENIA
AUSTRALIA
AUSTRIA
AZERBAIJAN
BANGLADESH
BELARUS
BELGIUM
BENIN
BOLIVIA
BOSNIA AND HERZEGOVINA
BOTSWANA
BRAZIL
BULGARIA
BURKINA FASO
CAMEROON
CANADA
CENTRAL AFRICAN REPUBLIC
CHILE
CHINA
COLOMBIA
COSTA RICA
CÔTE D'IVOIRE
CROATIA
CUBA
CYPRUS
CZECH REPUBLIC
DEMOCRATIC REPUBLIC OF THE CONGO
DENMARK
DOMINICAN REPUBLIC
ECUADOR
EGYPT
EL SALVADOR
ERITREA
ESTONIA
ETHIOPIA
FINLAND
FRANCE
GABON
GEORGIA
GERMANY
GHANA
GREECE
GUATEMALA
HAITI
HOLY SEE
HONDURAS
HUNGARY
ICELAND
INDIA
INDONESIA
IRAN, ISLAMIC REPUBLIC OF
IRAQ
IRELAND
ISRAEL
ITALY
JAMAICA
JAPAN
JORDAN
KAZAKHSTAN
KENYA
KOREA, REPUBLIC OF
KUWAIT
KYRGYZSTAN
LATVIA
LEBANON
LIBERIA
LIBYAN ARAB JAMAHIRIYA
LIECHTENSTEIN
LITHUANIA
LUXEMBOURG
MADAGASCAR
MALAYSIA
MALI
MALTA
MARSHALL ISLANDS
MAURITANIA
MAURITIUS
MEXICO
MONACO
MONGOLIA
MOROCCO
MYANMAR
NAMIBIA
NETHERLANDS
NEW ZEALAND
NICARAGUA
NIGER
NIGERIA
NORWAY
PAKISTAN
PANAMA
PARAGUAY
PERU
PHILIPPINES
POLAND
PORTUGAL
QATAR
REPUBLIC OF MOLDOVA
ROMANIA
RUSSIAN FEDERATION
SAUDI ARABIA
SENEGAL
SERBIA AND MONTENEGRO
SEYCHELLES
SIERRA LEONE
SINGAPORE
SLOVAKIA
SLOVENIA
SOUTH AFRICA
SPAIN
SRI LANKA
SUDAN
SWEDEN
SWITZERLAND
SYRIAN ARAB REPUBLIC
TAJIKISTAN
THAILAND
THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA
TUNISIA
TURKEY
UGANDA
UKRAINE
UNITED ARAB EMIRATES
UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND
UNITED REPUBLIC OF TANZANIA
UNITED STATES OF AMERICA
URUGUAY
UZBEKISTAN
VENEZUELA
VIETNAM
YEMEN
ZAMBIA
ZIMBABWE

The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

SAFETY REPORTS SERIES No. 45

STANDARD FORMAT AND CONTENT FOR SAFETY RELATED DECOMMISSIONING DOCUMENTS

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2005

COPYRIGHT NOTICE

Sales and Promotion Unit, Publishing Section
International Atomic Energy Agency
Wagramer Strasse 5
P.O. Box 100
A-1400 Vienna
Austria
fax: +43 1 2600 29302
tel.: +43 1 2600 22417
http://www.iaea.org/books

Printed by the IAEA in Austria
July 2005
STI/PUB/1214

IAEA Library Cataloguing in Publication Data

Standard format and content for safety related decommissioning documents. — Vienna : International Atomic Energy Agency, 2005.
p. ; 24 cm. — (Safety reports series, ISSN 1020–6450 ; no. 45)
STI/PUB/1214
ISBN 92–0–113204–2
Includes bibliographical references.

1. Nuclear power plants — Decommissioning. 2. Nuclear reactors — Decommissioning. 3. Nuclear reactors — Safety measures. I. International Atomic Energy Agency. II. Series.

IAEAL 05–00408

FOREWORD

The decommissioning of a nuclear facility involves activities that are different from those carried out during normal operation. New safety issues arise during the implementation of decommissioning activities. The regulatory body, which has the responsibility to ensure that workers, the public and the environment are protected during decommissioning activities, is required to ensure that the facility's operator has identified and resolved these safety issues. In connection with this, the principal document that provides the regulatory body with safety related information is the decommissioning plan, which is the cornerstone of a successful decommissioning project. The decommissioning plan brings together all the information on the proposed decommissioning activities and identifies relevant safety issues.

The present Safety Report provides information on the content and format for the decommissioning plan and supporting safety related documents. Its scope includes information that is relevant to all types of nuclear facilities, ranging from nuclear power plants and reprocessing facilities to university laboratories and manufacturing plants. By using a graded approach in the application of this Safety Report, the owner of a facility can provide the information necessary to allow the regulatory body to determine if the decommissioning activities have been properly evaluated with respect to safety.

The IAEA officer responsible for this publication was D.W. Reisenweaver of the Division of Radiation, Transport and Waste Safety.

EDITORIAL NOTE

Although great care has been taken to maintain the accuracy of information contained in this publication, neither the IAEA nor its Member States assume any responsibility for consequences which may arise from its use.

The mention of names of specific companies or products (whether or not indicated as registered) does not imply any intention to infringe proprietary rights, nor should it be construed as an endorsement or recommendation on the part of the IAEA.

An appendix, when included, is considered to form an integral part of the report and to have the same status as the main text. Annexes, footnotes and bibliographies, if included, are used to provide additional information or practical examples that might be helpful to the user.

CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

As with any industrial process, the end point of a facility's lifetime is planned and actions are taken to remove the facility from service when it is no longer needed. This is also the case with facilities that have used radioactive material except that they have been under regulatory control and have special needs that require addressing. The process of removing these facilities from regulatory control is called decommissioning.

Planning for decommissioning starts during the initial design of the facility and ends with the final release of the facility by the regulatory body. During this time a number of documents are prepared that help ensure that the decommissioning process is performed in a safe and efficient manner. These documents help focus planners and implementers on the important aspects of the decommissioning process and provide the information necessary for the regulatory body to make the required decisions.

The central document that is prepared is the decommissioning plan. With this as the base document, a number of other documents are prepared that support this plan. As the facility evolves through its design, operational life, preparation for termination of operations, shutdown and decommissioning, so do these supportive documents.

1.2. OBJECTIVE

The purpose of this Safety Report is to provide practical information to the regulatory body and the operator on the type of safety related documents that need to be prepared to support the decommissioning process and to elaborate on the contents of these documents.

1.3. SCOPE

The emphasis of this report is on the preparation of documents that help to ensure the safe decommissioning of a nuclear facility[1]. These documents are

[1] A nuclear facility is defined in this report as a facility and its associated land, building and equipment in which radioactive materials are produced, processed, used, handled or stored on such a scale that consideration of safety is required.

applicable to most nuclear facilities, but will vary in content and degree of detail depending on the type of facility involved and the type and quantity of material used or handled. These documents may also be developed for decommissioning of individual systems or components within a facility, even though the facility itself may not undergo complete decommissioning activities until some time later.

It is assumed that the management of spent fuel and operational waste is not part of decommissioning.

The information contained in this report does not necessarily apply to environmental remediation projects. Although some of the same documents are prepared for these types of projects, their content and emphasis may be very different.

1.4. STRUCTURE

Section 2 provides a discussion of the overall documentation preparation and approval process. Section 3 provides details of the format and content of a typical decommissioning plan. The format and content for other safety related documents that support the decommissioning process are provided in Section 4. There is one annex, which lists the entire suite of documents that might be used to support a large, complex decommissioning project.

2. DOCUMENT PREPARATION AND APPROVAL

2.1. GENERAL

The types of document that are required to be prepared to support the decommissioning effort are specified by the regulatory body. The single document that is required by IAEA publications is the decommissioning plan: "A decommissioning plan shall be developed for each nuclear facility, unless otherwise required by the regulatory body, to show that decommissioning can be accomplished safely" (para. 6.2 of Ref. [1]). Other IAEA publications provide guidance on the planning process for decommissioning [2, 3].

The initial versions of these documents are by necessity less detailed than the final documents. The amount of detail increases as the plans for the facility progress from the initial plan to the final one and uncertainties are reduced.

2.2. RESPONSIBILITIES

The responsibilities of the regulatory body have been described in the following way: "The regulatory body shall establish safety criteria for the decommissioning of nuclear facilities, including conditions on the end points of decommissioning" (para. 3.7 of Ref. [1]). This means that the regulatory body will define the types of document to be submitted by the operator to show that decommissioning will be performed safely. The regulatory body provides guidance on the type of information that is required for it to review the proposed activities and determine the overall safety of the concept.

Furthermore, para. 3.13 of Ref. [1] requires that: "The operator shall establish and maintain decommissioning plans which are commensurate with the type and status of the facility." This allocates to the operator the overall responsibility for the planning of decommissioning. The operator is responsible for the overall safety during the entire decommissioning process.

2.3. DECOMMISSIONING PLAN

The decommissioning plan is the key document in the entire decommissioning process. It contains the information on which the regulatory body will base its decision regarding the relative safety of the decommissioning concept as proposed by the operator. There is a range of support documentation that will probably be referenced and summarized briefly in the decommissioning plan. This is particularly likely for large, complex decommissioning projects (see the Annex). In some countries, and for smaller facilities, these support documents are integrated into the decommissioning plan itself.

2.3.1. General

Table 1 provides a list of the major topics contained in a decommissioning plan. Each of these topics is addressed in the decommissioning plan; however, the detail presented on each will vary greatly depending on the type of facility, quantity, type and chemical form of the radionuclides involved, and the stage in the life cycle of that facility.

Much of the information required in a decommissioning plan may already exist as complete documents in themselves, including the decommissioning environmental report, decommissioning safety assessment, radiation protection programme, health and safety programme, cost estimate, waste

TABLE 1. TYPICAL TABLE OF CONTENTS FOR A DECOMMISSIONING PLAN

1.	Introduction
2.	Facility Description
2.1.	Site location and description
2.2.	Building and system description
2.3.	Radiological status
2.3.1.	Contaminated structures
2.3.2.	Contaminated systems and equipment
2.3.3.	Surface soil contamination
2.3.4.	Subsurface soil contamination
2.3.5.	Surface water contamination
2.3.6.	Groundwater contamination
2.4.	Facility operating history
2.4.1.	Authorized activities
2.4.2.	Licence or authorization history
2.4.3.	Spills and occurrences affecting decommissioning
2.4.4.	Previous decommissioning activities
2.4.5.	Prior on-site burial
3.	Decommissioning Strategy
3.1.	Alternatives considered
3.2.	Rationale for chosen strategy
4.	Project Management
4.1.	Legal and regulatory requirements
4.2.	Project management approach
4.3.	Project management organization and responsibilities
4.4.	Task management organization and responsibilities
4.5.	Safety culture
4.6.	Training
4.7.	Contractor support
4.8.	Schedules

TABLE 1. TYPICAL TABLE OF CONTENTS FOR A DECOMMISSIONING PLAN (cont.)

5.	Decommissioning Activities
5.1.	Contaminated structures
5.2.	Contaminated systems and equipment
5.3.	Soil
5.4.	Surface and groundwater
5.5.	Decommissioning schedules
6.	Surveillance and Maintenance
6.1.	Equipment and systems requiring surveillance and maintenance
6.2.	Schedule for surveillance and maintenance
7.	Waste Management
7.1.	Identification of waste streams
7.2.	Solid radioactive waste
7.3.	Liquid radioactive waste
7.4.	Waste containing both radionuclides and other hazardous material
8.	Cost Estimate and Funding Mechanisms
8.1.	Cost estimate
8.2.	Funding mechanisms
9.	Safety Assessment
9.1.	Identification of relevant safety criteria
9.2.	Operational limits and conditions
9.3.	Hazard analysis of normal decommissioning activities
9.4.	Hazard analysis of abnormal events and incidents
9.5.	Assessment of potential consequences
9.6.	Preventive and mitigating measures
9.7.	Risk assessment
9.8.	Comparison of analysis results with relevant safety criteria
9.9.	Conclusions
10.	Environmental Assessment
10.1.	Background data
10.2.	Description of project

TABLE 1. TYPICAL TABLE OF CONTENTS FOR A DECOMMISSIONING PLAN (cont.)

10.3.	Environmental protection programme
10.4.	Effluent monitoring programme
10.5.	Effluent control programme
11.	Health and Safety
11.1.	Radiation protection plan
11.2.	Nuclear criticality safety
11.3.	Industrial health and safety plan
11.4.	Audits and inspections
11.5.	Record keeping programme
11.6.	Optimization analyses and programme
11.7.	Dose estimation and optimization for major tasks
11.8.	Clearance criteria
11.9.	Final release criteria
12.	Quality Assurance
12.1.	Organization
12.2.	Quality assurance programme
12.3.	Document control
12.4.	Control of measuring and test equipment
12.5.	Corrective actions
12.6.	Quality assurance records
12.7.	Audits and surveillance
12.8.	Lessons learned programme
13.	Emergency Planning
13.1.	Organization and responsibilities
13.2.	Emergency situations
13.3.	Records
14.	Physical Security and Safeguards
14.1.	Organization and responsibilities
14.2.	Physical security programme and measures
14.3.	Safeguards programme and measures
15.	Final Radiation Survey

management programme, quality assurance programme, emergency response plan, project surveillance and maintenance programme, project final radiological survey plan and final decommissioning report. In the decommissioning plan, these documents may be incorporated by giving references, with a brief summary provided in the plan. Each of these documents will be discussed later in this Safety Report.

2.3.2. Types of decommissioning plan

Decommissioning plans are developed in three stages during the life of the facility: an initial plan, updated plans and a final decommissioning plan.

The initial plan is prepared during the design stage of the facility. This plan is normally required before the regulatory body will provide an operating licence. A minimal amount of detail may be provided and many of the conclusions can be based on realistic assumptions. Some of the information identified in Table 1 may not be available and should be added later during the periodic review and revision of the initial plan. This initial decommissioning plan focuses on major pieces of equipment, facility structure, types and expected quantities of radionuclides to be used or handled, major processes, design drawings and process flow diagrams. The primary purpose of this version of the plan is to:

(a) Provide basic information on the complexity of the decommissioning process;
(b) Establish the decommissioning funding programme and collection mechanism;
(c) Document the assumptions for the decommissioning process;
(d) Establish procedures for the collection of relevant information during operation and maintenance.

This information is critical in developing the initial decommissioning cost estimate. A cost estimate is necessary to identify the funding mechanism for decommissioning. In addition to the cost estimate, the initial decommissioning plan includes the following information, some of which is based on logical assumptions:

(a) Site location and description;
(b) Building and system description;
(c) Identification of potentially activated and contaminated areas and equipment;
(d) Tentative decommissioning strategy;

(e) Assumed decommissioning activities;
(f) Initial estimate of waste by category;
(g) Record keeping requirements during operations;
(h) Experience from decommissioning projects of similar facilities.

The initial plan is updated periodically during the life of the facility. Each update includes information on changes of equipment or processes, unplanned events, changes in support capabilities including waste management and radiological monitoring, update of radiological conditions, changes in legislative requirements, changes in financial assumptions and improvements in decommissioning technology. This updated plan becomes more detailed as the end of the operating period draws near and missing information is added. The assumptions of the initial plan become validated, and conclusions can then be drawn concerning the proposed decommissioning strategy. The proposed decommissioning strategy relates to the decommissioning cost and, hence, can be used to confirm the funding mechanism.

The final decommissioning plan is normally prepared before the facility permanently ceases operation, except when the facility is to go into a deferred dismantling mode. If this is the case, the plan is finalized approximately three to five years before the safe enclosure phase ends. This final plan is detailed and will include the topics identified in Table 1. Approval by the regulatory body is normally needed before implementation of the final decommissioning strategy, i.e. decontamination and dismantling. This plan is the basis for the development of the detailed work instructions and procedures.

3. DECOMMISSIONING PLAN DETAILS

This section gives guidance on the specific details that are critical to the development of a final decommissioning plan suitable for submission to a regulatory body. Advice on plan contents is provided in the following subsections in accordance with Table 1. The information provided in the decommissioning plan and the level of detail are adapted to the size and scope of an individual project and the potential radiological risks anticipated, i.e. the concept of a graded approach can be applied. The IAEA has published a number of documents that can be used during the planning and implementation phases of decommissioning. These are provided in the Bibliography.

3.1. INTRODUCTION

The name and address of the facility and the licensee's or authorization holder's name and address are provided in this section. This section provides the mailing address and all contact numbers, including the email addresses of responsible parties. The identification of the licence or authorization that was held (i.e. identification number) is also provided. This section identifies who owns the facility and how the ownership is structured, i.e. regional or national government, private corporation or academic institution. If ownership has changed during the life of the facility, all previous owners are identified. If ownership or the licence has been or will be transferred to another party for the purposes of decommissioning, the new entity is also identified.

3.2. FACILITY DESCRIPTION

3.2.1. Site location and description

This subsection identifies the location of the facility, including the geographical location, with maps being provided that indicate the site location in relationship to the surrounding community. The size of the facility is provided in square metres. The type of facility, such as light water or gas cooled power reactor, research or demonstration reactor, radiopharmaceutical research laboratory or university laboratory, is identified.

A complete description of the site including its layout is provided, and the facilities, buildings and/or areas that will be included in the decommissioning project are identified. The boundaries of the decommissioning project are also identified on the site layout.

Other buildings or facilities on the site that are not part of the decommissioning effort, but which could be affected by decommissioning activities or be needed to support these activities, are identified and their uses discussed. Appropriate site drawings and building drawings are provided that allow the reader to understand the size and complexity of the facility.

3.2.2. Building and system description

A general description of the building(s), major facility systems and ancillary equipment is provided. This subsection also provides building drawings that indicate areas within the building(s) that will be included in the decommissioning project. Engineering schematics and system layout drawings sufficient to provide a general knowledge of the systems and major

components that will require removal or decontamination during decommissioning are provided.

The following detailed information is given:

(a) Building construction: the type of construction used (for example, steel, reinforced concrete or pre-engineered construction materials), description of roof, existence of basements, crawl spaces and building access; description of building layout, schematic diagrams of rooms and facility layout identifying large components; and description of contents and purpose of each room and area.
(b) Major components: the major equipment and components operated within the building, to include facility equipment layout; the equipment associated with the facility operation that will require decontamination, dismantling or release from control; and the construction material of the equipment or systems.
(c) Building service systems: all the building systems (for example, heating, cooling, ventilation, water, electricity, compressed air and cranes) that will be required to remain in operation for the dismantling of facility components. Those systems that can be removed immediately are identified.

Where only part of a facility is being decommissioned, that project is described in detail in relation to the facility remaining in operation, and the impact of decommissioning activities on activities in the rest of the facility is discussed.

3.2.3. Radiological status

Most of the material provided in this subsection is based on operating records and the characterization survey. The results of this survey may be summarized in this subsection, with reference made to the detailed characterization survey report.

3.2.3.1. Contaminated structures

This subsection identifies contaminated and activated building structures and provides detailed characterization data. It provides a list and description of each room or work area within each structure, and the locations of contamination (for example, walls, floors, wall–floor joints and ceilings) in each room or work area are identified. Any liquids that might be involved are identified. The contamination and dose rate levels are provided in summary form

(maximum and average) for each room or work area, and survey drawings are provided where appropriate. This subsection identifies the radionuclides that have been used at the facility and that remain at the end of the operating period. The chemical forms of the radionuclides that are currently used or have been used in the past are provided. The characteristics of the contamination (on the surface or that have penetrated into the surface of the material, loose or fixed) are described. Locations where radionuclides were used or stored (either currently or in the past) will be identified on a map or floor plan. The background levels that were used during the characterization survey are provided.

3.2.3.2. Contaminated systems and equipment

This subsection provides a list with the location of all systems or equipment at the facility that contain residual radioactive material in excess of site background levels. It provides a summary of the radionuclides present in each system or on the equipment at each location. The maximum and average radionuclide levels as well as the chemical forms of the radionuclides are given, and whether they are in the form of fixed or loose contamination. The maximum and average radiation levels in each room or work area are indicated. A scale drawing or map of the rooms or work areas that shows the locations of the contaminated systems and equipment is provided. If the activation activity was determined through modelling or calculations, details of how the calculations were made and validated are provided. If computer codes were used, the codes are identified, including revision number and how the results were validated. If core samples were taken (i.e. for a concrete biological shield), a clear representation of the activity levels using profiles is provided.

3.2.3.3. Surface soil contamination

A list of all locations at the facility where the surface soil contains residual radioactive material in excess of the site background levels is provided. Data on surface soil contamination, i.e. radiation and contamination survey data of the areas surrounding the building(s) and delineating the spread of contamination released during the operating period, are provided. Such information is obtained with surface surveys, for example in situ gamma spectrometric scanning or soil sampling. The results of surface surveys and the analysis of surface soil samples for isotopic identification are also provided. This subsection indicates the radionuclides present at each location, the maximum and average amount of activity (in Bq/g) and the chemical form of the contamination. It also provides the maximum and average radiation levels at

each location. Contaminated areas are identified on a site map. The background levels that were used during the characterization are provided, along with the procedures used to determine these levels.

3.2.3.4. Subsurface soil contamination

All areas where subsurface soil contains residual radioactive material above the site background levels are listed. Characterization data for deeper penetration of contaminants into the subsurface soil layer are provided. Such information requires soil core sampling and subsequent laboratory analysis. Isotopes of concern are identified and the stratification of the contamination is presented. The radioactivity levels are presented in Bq/g and the chemical form of each radionuclide is also described. Buried structures or components are identified, as well as contamination in and surrounding them. A drawing that shows the distribution of the contamination in the soil, type of soil and components is included. The background levels that were used during the characterization are indicated, and the procedure for determining these background levels is included. An estimate of the amount of soil that might require removal is provided. This subsection identifies all contaminated areas on a map of the site, as well as any underground components (e.g. building services) that will require removal or decontamination.

3.2.3.5. Surface water contamination

All surface water bodies at the facility that contain residual radioactive material in excess of site background levels are identified and indicated on a site map. Any drainage paths and discharge points are also identified. This subsection provides data from the analysis of surface water present on the facility site to include maximum and average activity levels and the identification of radionuclides present. It also includes silt and sediment analytical results. A map that shows sample points and the results of analysis is provided. A summary of the background levels used during the characterization is provided, along with the procedures used to determine these levels.

3.2.3.6. Groundwater contamination

This subsection identifies any aquifers at the facility that contain residual radioactive material in excess of the site background levels. Data on groundwater contamination, to include maximum and average activity levels, are provided along with an identification of the radionuclides present. These data are collected through sampling of shallow and deep groundwater

monitoring wells to collect water samples for analysis of radionuclide content. A map that shows the location of monitoring wells and groundwater strata is provided. Indications of which strata have elevated activity levels are also provided. A summary of the background levels used during the characterization is included, along with the procedures used to determine these levels.

3.2.4. Facility operating history

3.2.4.1. Authorized activities

This subsection provides a short operational history of the facility to include any significant events that may have occurred which might have an impact on decommissioning or site restoration. Events that could have had a significant impact on the physical form of the facility such as major modifications or renovations are identified. Experimental activities that might have been performed which could have had an impact on decommissioning are identified and discussed. The types and dates of specific operations are provided, and any particular chemical or radiological process that was used during the life of the facility is described. A description of the uses of the facility before radioactive material was used on the site or in the facility is included. A brief description of the operations being performed in surrounding buildings, both on- and off-site, is provided.

3.2.4.2. Licence or authorization history

Where there have been multiple owners, they are identified and a brief history of each owner is provided. A listing of all licences or authorizations that have been in force during the life of the facility is provided. The type, chemical form and amount of radioactive material that were authorized with each licence are indicated.

3.2.4.3. Spills and occurrences affecting decommissioning

Facility operating records are reviewed and any spills, incidents and non-standard operations that may have had an internal or external influence on the facility and associated systems and that require special consideration during decontamination and dismantling are identified. The types, forms, amounts and concentrations of radionuclides involved in the spill or uncontrolled release are provided for each incident. A scale drawing or map is provided that shows the location of the spills.

3.2.4.4. Previous decommissioning activities

Past decommissioning activity performed in the facility or remediation activities at the site are briefly described, including impacts on the overall facility and any remaining radioactivity and hazards that need to be mitigated as part of future decommissioning activities. This subsection provides a summary of the types, forms, amounts and concentrations of radioactivity that were present in previously decommissioned or remediated areas or sites. The activities that caused this contamination are described. The results of the radiological evaluation that was performed after these previous decommissioning or remediation activities are summarized, and a map or drawing that shows where these areas were located is provided.

3.2.4.5. Prior on-site burial

Previously buried waste associated with the facility that must be managed as part of the decommissioning programme is identified. Characterization data for this waste are provided. An estimate of the quantity of waste involved and the configuration of the waste (for example in drums or cardboard boxes) is also provided. If the burial site was licensed as a separate facility, the licence information is provided. The location of buried waste sites is shown on a map in relation to the proposed decommissioning activities.

3.3. DECOMMISSIONING STRATEGY

3.3.1. Alternatives considered

This subsection identifies the decommissioning strategies that have been considered: immediate decommissioning, deferred dismantling, entombment or variants thereof [1–4]. Each strategy is described in the form it would be applied to the facility. Any modifications to the strategies that have been considered (if different from the normal understanding of the strategy) are discussed.

3.3.2. Rationale for chosen strategy

The objective of the decommissioning programme in relation to the selected strategy is clearly stated. The rationale used and the relevant information considered to select this strategy are provided. If a deferred dismantling strategy is being used or planned, the length of the intended

storage period is provided with a rationale for the proposed time span. The final end point of the decommissioning is clearly described in terms of what the facility or site will look like when the activities are complete.

The basic principles and criteria that have been used for evaluation to select the decommissioning strategy are presented. This subsection will explain how the various factors (i.e. legislation, regulations, safety, technology, social impacts, availability of waste management facilities and cost) have been incorporated into the decision making process and how each factor was evaluated with respect to each alternative.

3.4. PROJECT MANAGEMENT

3.4.1. Legal and regulatory requirements

The international, national and local laws and regulations that will be observed for the decommissioning project are listed. Note that a number of regulations not relevant for the operation of the facility will enter into force for the decommissioning.

3.4.2. Project management approach

The administrative functions that will be in place during the decommissioning activities are described. The resources that are available or will be needed to plan, manage and implement the decommissioning activities are identified. The review and monitoring arrangements used to ensure that the decommissioning programme and activities are being performed as approved are described. A description of the schedule tracking system, cost tracking system and change control mechanisms used to manage the decommissioning project is provided, including a description of any software programs that will be used. A description of the record keeping system that will be implemented during the planning and implementation of decommissioning activities is provided, including an identification of which records and reports will be maintained.

3.4.3. Project management organization and responsibilities

The project management organizational structure, including an organization chart that indicates how the decommissioning organization relates to the rest of the owner–operator organization, is provided. This chart indicates all project units such as management, health and safety, operations, quality

assurance and administration. A clear definition of the roles and responsibilities of the implementing organization and the project organization is provided. The responsibilities, duties and authorities of each of the functional units within these organizations, and key personnel within each of these units, are defined. The minimum qualifications for the key positions within the functional units are discussed and the actual qualifications of the individuals filling the positions are provided. A description of the hierarchy within the decommissioning project and the interrelationships within the organization is provided. Any decommissioning or safety oversight committees are identified, and information concerning the membership, duties and responsibilities of each committee is discussed along with their authority.

3.4.4. Task management organization and responsibilities

The implementing organizational structure for carrying out individual tasks and work packages and the reporting requirements to the project manager are described. The procedures for managing the tasks, such as through the use of work packages or permits and written procedures, are discussed. The procedures for evaluating the decommissioning tasks and developing the work packages for each task are discussed. The review and approval procedure for the work packages and procedures is also discussed. A description of how the work packages and procedures are managed during the project (i.e. how they are issued, maintained, revised and terminated) is provided. This subsection describes how the workers performing the tasks are informed of the procedures in the work packages, including initial briefings and when changes occur. The procedure for ensuring that the correct version of the procedure is being used is discussed.

3.4.5. Safety culture

The actions that management will take in order to maintain or improve safety culture among staff after the transition from an operating organization to a decommissioning organization are described. A description of how management will monitor the state of the safety culture during the implementation of the decommissioning strategy is provided.

3.4.6. Training

The safety training programme (both radiological and industrial) that the licensee will provide to each employee is described, including employment, annual, periodic and specialized training. This subsection describes the daily

worker 'job site' training or briefing sessions that will be provided at the beginning of each workday or job task to familiarize workers with the procedures and safety requirements specific to particular jobs. A description of the documentation that will be maintained to demonstrate that training has been performed satisfactorily will be provided.

3.4.7. Contractor support

A listing of decommissioning tasks that will be performed by contractors is provided. The management interfaces that will be in place between the licensee's management and on-site supervisors and the contractor's management and on-site supervisors are well described. The boundary between the responsibility of the contractor and the responsibility of the licensee will be well defined. The contractor's project organizational structure is described and an organizational chart provided. A clear definition of the roles of the implementing organization and of the project management organization is provided. An explanation of the responsibilities and duties of each contractor organizational unit is provided and the key personnel within each of these units are identified. This subsection provides the minimum qualifications for the key positions and shows the actual qualifications of the contractor's individuals filling these positions. The oversight responsibilities and authority that the licensee will exercise over the contractor personnel are described. The training that will be provided by the licensee to the contractor personnel and the training that will be provided by the contractor to its employees are described.

3.4.8. Schedules

This subsection describes how the project schedules will be prepared, such as what software will be used if applicable. It also describes the procedures for evaluating the decommissioning tasks and developing the schedules for each task. The review and approval procedure for the schedules is presented. A description of how the schedules are managed during the project (i.e. how they are issued, maintained, revised and terminated) is provided.

3.5. DECOMMISSIONING ACTIVITIES

3.5.1. Contaminated structures

A description of the decommissioning tasks planned for each room or area in the order in which they will occur is provided. Those activities the licensee's staff will perform and those that will be performed by a contractor are identified. A description of the decontamination and dismantling techniques that will be used (for example, scabbling, hydrolysing, mechanical demolishing and vacuum blasting) is provided. A summary of the radiation protection methods (for example, protective clothing, step-off pads and exit monitoring) and control procedures (for example, local high energy particulate air (HEPA) ventilation, superfine water misting and portable containments) that will be used in each room or area is provided. A summary of the procedures already approved under the existing licence and those for which approval is being requested as part of the decommissioning plan (this normally does not include specific work procedures) is provided. A commitment that decommissioning activities will be conducted in accordance with written, approved procedures is stated. Any unique safety or decommissioning issues associated with the decommissioning of the rooms or areas are identified, noting that underground structures require particular attention.

3.5.2. Contaminated systems and equipment

A summary of the decommissioning tasks planned for each system or major piece of equipment in the order in which they will occur is provided. Activities the licensee's staff will be performing and those that will be performed by a contractor are identified. The techniques that will be used to decontaminate the systems or equipment (for example, scabbling, hydrolysing and vacuum blasting) are described. Those techniques that will be used to dismantle or remove the systems or equipment (for example, arc sawing, torch cutting and mechanical cutting) are also described. A summary of the radiation protection methods (for example, protective clothing, step-off pads and exit monitoring) and control methods (for example, local HEPA ventilation, superfine water misting and portable containments) that will be used during the decommissioning of each room or area are identified. This subsection provides a summary of the procedures already authorized under the existing licence and those for which approval is being requested as part of the decommissioning plan (this normally does not include specific work procedures). A commitment that decommissioning activities will be conducted in accordance with written, approved procedures is stated. Any unique safety

or decommissioning issues associated with the decommissioning of the systems or equipment are identified, particularly providing details of underground systems and equipment.

3.5.3. Soil

This subsection provides a summary of the remediation tasks planned for surface and subsurface soil at the site in the order in which they will occur and indicates which of these tasks will be performed by the licensee's staff and which will be performed by a contractor. The techniques that will be used to remediate the surface and subsurface soil are discussed. A summary of the radiation protection methods (for example, protective clothing, step-off pads and exit monitoring) is provided along with a description of the control procedures that will be used during the soil remediation process to prevent wind dispersion. This subsection provides a summary of the procedures already authorized under the existing licence and those for which approval is being requested as part of the decommissioning plan (this normally does not include specific work procedures). Any unique safety or remediation issues associated with the soil remediation activities are described.

3.5.4. Surface water and groundwater

A summary of the remediation tasks planned for surface water and groundwater at the site in the order in which they will occur is provided along with an identification of which organization will perform the tasks (i.e. the contractor's or the owner's organization). The techniques that will be used to remediate the surface water and groundwater are described. A summary of the radiation protection methods (for example, protective clothing, step-off pads and exit monitoring) is provided along with the control procedures that will be used during the water remediation process. A summary of the procedures already approved under the existing licence and those for which approval is being requested as part of the decommissioning plan (this normally does not include specific work procedures) is provided. Any unique safety or remediation issues associated with the water remediation activities are identified.

3.5.5. Decommissioning schedules

A Gantt or Pert chart that provides details of the proposed decommissioning and remediation tasks in the order in which they will occur is provided. This includes the amount of time needed to perform each task and the

initiation and completion dates for the activities. The dependencies between the tasks are shown. This subsection provides the workforce requirements for the tasks to include the total number of people by labour category.

3.6. SURVEILLANCE AND MAINTENANCE

If the facility is going to be placed into a deferred dismantling strategy, this section will require expansion to include all the activities that will be performed during this period. If immediate dismantling is the selected strategy, the surveillance and maintenance activities for the safety systems required during the dismantling will be discussed.

3.6.1. Equipment and systems requiring surveillance and maintenance

All major pieces of equipment and systems (fixed and non-fixed) that will be used during the implementation of the decommissioning strategy and will require scheduled maintenance are identified. A description of the use of each piece of equipment, its location, the recommended maintenance schedule, spare part numbers and spare part storage requirements is provided. Surveillance requirements for systems and buildings (i.e. building roof and containment structures) are described, including surveillance methods and frequencies, and specifications for acceptance. An estimate of expendable items that will be needed for each major piece of equipment is provided. Warehousing requirements to support decommissioning activities are determined. Areas that require monitoring for potential changes in condition are identified. The procedure that will be followed if conditions are outside the normal parameters during the surveillance activity is described and possible corrective actions identified.

3.6.2. Schedule for surveillance and maintenance

This subsection provides a schedule for surveillance and maintenance activities. It indicates the number of personnel (level of effort) required to perform each of the activities and the type of staff needed (i.e. electricians, instrumentation personnel and pipe fitters). A discussion is provided on how this schedule will be periodically reviewed and modified on the basis of periodic inspections.

3.7. WASTE MANAGEMENT

The waste management plan is normally a separate document that is referenced and summarized in the decommissioning plan, so there is some repetition of information, which would not be required if the waste management plan were directly incorporated in the decommissioning plan.

3.7.1. Identification of waste streams

All the possible waste streams that might be generated as a result of the decommissioning activities are identified. The types of waste streams are specified according to the hazard posed and the waste classification system adopted and include radioactive waste, hazardous waste, mixed waste[2], other types of non-hazardous waste, recyclable material and cleared material.

3.7.2. Solid radioactive waste

A summary of the types of solid radioactive waste that are expected to be generated during the decommissioning activities is provided, including soil, concrete, plastic items, contaminated piping and structural material such as steel, activated components and wood. An estimate is provided of the volumes and weights of each type of solid waste according to the waste stream (in cubic metres and tonnes), the amount of radioactivity by radionuclide and approximately when the waste will be generated. A description of the procedures for treating, conditioning, packaging and storing each type of solid waste on-site prior to shipment for disposal is provided. A description of the measures that will be taken to reduce the volume of waste that will be sent for disposal is included. If appropriate, a description of the handling and management of solid waste that is volumetrically contaminated is given. A description is provided of how contaminated soil or loose radioactive material will be handled to prevent redispersal after exhumation and collection. The name and location of the disposal facility for each waste stream for the solid waste are given. Waste streams for which no disposal route currently exists are identified and an explanation is provided concerning the management of these waste streams until a disposal route is established. The procedures for monitoring, assaying and characterizing the solid waste are discussed. The procedures that will be

[2] For the purposes of this report, mixed waste is defined as waste that contains both radioactive and other hazardous material.

implemented to generate the appropriate waste tracking system and quality assurance records are also discussed.

3.7.3. Liquid radioactive waste

This subsection provides a summary of the types of liquid radioactive waste that are expected to be generated during the decommissioning process. An estimate of the volume of each liquid waste type (in litres) and when it is expected to be generated is provided. A description of the procedures for treating, conditioning, packaging and storing each type of liquid waste on-site prior to processing or shipment for disposal is given. A description of the measures that will be taken to reduce the volume of residual waste that will be sent for disposal is provided. The name and location of the disposal facility for each waste stream for the liquid waste are included. Waste streams for which no disposal routes currently exist are identified and an explanation is provided concerning the management of these waste streams until a disposal route is established. The procedures for monitoring, assaying and characterizing the liquid waste are discussed. The procedures that will be implemented to generate the appropriate waste tracking system and quality assurance records are also discussed.

3.7.4. Waste containing both radionuclides and other hazardous material

A summary of the types of solid and liquid waste that contain both radionuclides and other hazardous material that are expected to be generated during the decommissioning process is provided. An estimated volume of each waste type (in either cubic metres or litres) and when it is expected to be generated is included. A description of the procedures for treating, conditioning, packaging and storing this waste on-site prior to processing or shipment for disposal is given. The procedures that will be used to reduce the volume of waste that will be sent for disposal are provided. The name and location of the disposal facility for each waste stream for waste containing both radionuclides and other hazardous material are identified. Waste streams for which no disposal routes currently exist are identified and an explanation provided as to how these waste streams will be managed until a disposal route is established. The procedures for monitoring, assaying and characterizing this waste are presented. The procedures that will be implemented to generate the appropriate waste tracking system and quality assurance records are described. The coordination with other regulatory agencies that have jurisdiction over hazardous components contained in the waste is discussed.

3.8. COST ESTIMATE AND FUNDING MECHANISMS

The cost estimate is a detailed document that relies on information provided in other sections of the decommissioning plan, such as the facility description, decommissioning activities and waste management. The cost estimate is used to assist in preparing the project schedule, workforce requirements and phased funding needs. The cost estimate is normally a separate document that is referenced and summarized in the decommissioning plan.

3.8.1. Cost estimate

The process that has been used to generate a cost estimate for the full implementation of the decommissioning plan and for decommissioning of the facility is discussed. The specific approach used (for example, unit cost factors, mean construction costs and specific software) is identified and briefly described.

A basic description of the overall facility and of what portions of the facility are included in the cost estimate is provided. All assumptions used in developing the cost estimate, including labour costs, disposal costs, working hours and distance to disposal site, are listed.

A detailed summary of the costs by phase or major task, man-hours by task and estimated waste volumes is provided. The uncertainties within the cost estimate are discussed. Any contingency allowance is identified.

Backup details about how the costs were estimated are provided. These are to be in sufficient detail to allow an independent review of the entire cost estimate process, including a quantitative development. These details of the cost estimate can be provided as an appendix to the decommissioning plan or as a separate document. In either case, a summary of the results of the cost estimate are provided here.

3.8.2. Funding mechanisms

The funding mechanisms are described that either are in place, or will be put in place, to ensure that adequate funds will be made available to enable completion of the decommissioning activities on a timescale commensurate with the decommissioning plan. A summary of the measures that will be employed to manage project risks and prevent or mitigate cost escalation is included.

3.9. SAFETY ASSESSMENT

A new safety assessment[3] is generally required when a facility moves from an operational to a decommissioning mode [5]. The safety assessment is an evaluation of the potential hazards[4] associated with the implementation of the decommissioning activities and their potential consequences. The assessment includes a risk assessment specific to the proposed activities. The safety assessment is usually incorporated into the decommissioning plan by reference. If this is the case, a short summary is provided in the decommissioning plan.

3.9.1. Identification of relevant safety criteria

The safety criteria to be applied to all decommissioning activities, which provide the basis against which the safety assessment is to be evaluated, are identified. The criteria are based on:

(a) Dose to workers;
(b) Dose to the public;
(c) Discharges to the environment;
(d) Exposure to chemical and other non-radiological hazards.

Reference to non-radiological criteria that will be applicable during decommissioning activities is included, if applicable.

3.9.2. Operational limits and conditions

The operational limits and conditions that applied to the operating facility are identified and a review of their applicability to the decommissioning phase is performed. A justification for the continued use of existing limits and conditions is provided and any new applicable criteria are defined. This subsection will indicate whether any project or task specific limits or objectives have been set in order to demonstrate that optimization has been achieved.

[3] A safety assessment is an assessment of all aspects of an authorized facility that are relevant to protection and safety. The safety assessment includes a safety analysis, which is a detailed scrutiny of the individual elements that affect the safety, a risk assessment and an analysis of preventive and mitigating measures.

[4] The term hazard denotes an intrinsic property of a facility, activity or process, with a potential for creating damage to human health and/or the environment.

Some of the operational limits and conditions relevant to operation, if kept, may become unnecessary impediments during decommissioning.

The routine dose limits and action levels that are to be applied are stated and justified in relation to the Basic Safety Standards [5] and national regulatory requirements. The discharge limits being applied for routine radioactive aerial and liquid effluent discharges are identified. Relevant limits and conditions concerning non-radioactive material are provided, if applicable.

3.9.3. Hazard analysis[5] of normal decommissioning activities

This subsection identifies and analyses the hazards (radiological and non-radiological) for individual decommissioning activities taking into account the decommissioning strategy, anticipated activities and the results of the characterization survey. Where applicable, standard external events and hazards specific to the decommissioning activities are included in the analysis.

The doses to the workforce and the other impacts on them and the environment from known radioactive sources in the components and facilities in question are estimated and assessed. Situations where the radioactivity content may turn out to be higher than expected are evaluated. Hazards that become relevant due to the fact that buildings and facilities are being demolished are also identified and evaluated.

3.9.4. Hazard analysis of abnormal events and incidents

This subsection identifies abnormal events and incidents, as well as the methods and assumptions that were used to identify and analyse these events and incidents, and presents the results of the analysis. A listing of all the hazards and fault/accident conditions that are applicable to the decommissioning activities is included and these may be grouped appropriately to reduce the number of scenarios that require risk analysis. Separate listings for radiological and non-radiological hazards are presented. The types of consequences arising as a result of each are identified and a list of preventive measures, both engineered and administrative, that either protect against the scenario occurring or mitigate its consequences is provided. An estimate of the likelihood of all the fault/accident conditions identified, in either probabilistic or qualitative terms, is given. Certain scenarios are selected for further analysis

[5] Hazard analysis is a detailed scrutiny of the individual hazards and an identification of scenarios that activate these. It is initiated by hazard identification, listing all hazards related to the facility, activity or process in question.

and the reasons for excluding some — if any — of the identified events from further analysis are explained.

3.9.5. Assessment of potential consequences

A description of the potential consequences to workers, the public and the environment from normal decommissioning activities is provided, as well as the potential consequences from the scenarios selected for abnormal situations. Radiation doses to workers from both normal decommissioning activities and selected scenarios for abnormal situations are calculated. Radiation doses to the public and the activity content in releases to the environment as a result of normal decommissioning activities, as well as for each of the selected scenarios for abnormal situations, are calculated. The procedures used for calculating these dose rates are provided.

The methods used for assessing non-radiological consequences are described and potential physical injuries to workers as a result of abnormal situations are identified.

Reference to any data sources applied is given. The assumptions that have been made in the assessment of consequences are clearly stated and justified.

3.9.6. Preventive and mitigating measures

From the schedule of radiological hazards and the consequence assessment, the structures, systems and components (SSCs) and the administrative preventive measures that are essential for safety are identified for both those that make a significant contribution and those that offer little or no additional benefit. Both passive and active SSCs as well as those that may also require a subsequent operator action to achieve their function are included. The safety function of each SSC and their performance requirements are defined and include, where appropriate, reference to the degree of redundancy, diversity and segregation for each SSC.

The specific actions that are necessary to achieve the required safety function of each administrative preventive measure are identified, including, where appropriate, reference to the level of checking and supervision necessary to ensure that the specific actions have been undertaken correctly. Details of how the performance requirements of the SSCs and the specific actions for the administrative preventive measures are substantiated by the design are provided. A description is also provided of how the requirements will continue to be met during the decommissioning phases.

The examination, maintenance, inspection and testing requirements for each SSC are identified, taking into account any national regulatory requirements and making certain that responsibilities for maintenance, inspection and testing of the SSCs as well as for the administrative preventive measures are clearly described in the quality assurance programme.

Actions that will be taken to mitigate the effects of identified hazards and reduce their impacts on workers, the public and the environment are identified.

3.9.7. Risk assessment

This subsection provides an appropriate risk assessment[6], commensurate with the degree of hazard potential, taking into account the likelihood and consequences of the selected scenarios, and demonstrates that the resulting risks have been minimized. The hierarchy of preventive and control measures employed, both engineered and administrative, is stated and it is shown that sufficient defence in depth exists. If at this stage this cannot be demonstrated, the preventive and mitigating measures (and possibly the planned decommissioning procedures) are reconsidered.

Appropriate analyses are undertaken, including a cost–benefit analysis, to ensure that the principle of optimization has been fully satisfied and that no further reasonably practicable measures are available to further reduce the risks.

The safe boundaries of the risk assessment are identified and any deductions that can be made from it are indicated. A list of any important assumptions that may require further justification is provided.

Specific emergency and contingency arrangements that will need to be addressed via the overall emergency planning arrangements (Section 3.13) are summarized.

3.9.8. Comparison of analysis results with relevant safety criteria

A comparison of the safety analysis results with the safety criteria identified in Section 3.9.1 is given. Areas needing additional attention to mitigate the impact of abnormal events and incidents are identified. A summary of the assessment of routine doses and discharges, and the risk assessments for radiological and non-radiological hazards from the decommissioning activities, is provided. It is shown that these doses and discharges meet

[6] A risk assessment is an assessment of the radiological risks associated with normal operations and possible accidents.

all the relevant operational limits and conditions and that they have been optimized.

The total radiological risks to both operators and members of the public are evaluated and a comparison of these risks with the relevant limits defined in Section 3.9.1 is provided.

The environmental impacts from the decommissioning activities are summarized and it is shown that these impacts have been optimized (Section 3.10).

3.9.9. Conclusions

The results of the safety assessment are summarized and a statement is made on the acceptability of the decommissioning plan from a safety and environmental impact point of view.

3.10. ENVIRONMENTAL ASSESSMENT

The environmental assessment is normally a separate document that is referenced and summarized in the decommissioning plan. The conclusions of the assessment are provided in the decommissioning plan. Since the environmental assessment is normally a separate document, some information is repeated, which would not be required if it were directly incorporated in the decommissioning plan.

3.10.1. Background data

The objective and scope of the decommissioning project are given. Any applicable environmental protection laws, regulations or other requirements that need to be met by the decommissioning project are also identified.

3.10.2. Description of project

The decommissioning tasks that will be performed which could result in an environmental release from the facility and which have an impact on the local environment are identified. The potential pathways that could be involved with these releases are described and the potential discharge for each task evaluated. The form (i.e. airborne, liquid, solid or gaseous) of the potential release with regard to radionuclide and chemical form is described.

3.10.3. Environmental protection programme

The monitoring programme that will be used to verify that the environmental protection programme is being properly implemented is described. A map or site plan that identifies the locations of both on-site and off-site monitoring stations and sampling locations is provided, which includes monitoring for all pathways. A description of the equipment that will be used at each location is provided, along with its capabilities and limits of detection. The frequency for performing the monitoring, i.e. replacement of filters, dosimeters and sample collections, is specified. The types of samples that will be collected are described and the analytical procedures for these samples provided. The procedures that are used to determine the background and baseline concentrations of radionuclides in environmental media are discussed. The average background values for the site or areas of the site and the surrounding area are provided.

3.10.4. Effluent monitoring programme

The known or expected radionuclides in the effluents that will be generated as a result of decommissioning are identified. A map, drawing or description of all the effluent discharge points is provided. The sample collection and analytical procedures for samples that are collected at the discharge points are described in sufficient detail to ensure that the samples are representative of what is being released. The minimum detectable activity for the equipment is provided. The effluent sample collection frequencies are also provided. The environmental monitoring recording and reporting procedures are described.

3.10.5. Effluent control programme

The controls that will be used to minimize releases of radioactive material to the environment during decommissioning activities are described. A summary of the action levels is provided, along with an explanation of the actions that will be taken if an action level is exceeded. The leak detection system for ponds, lagoons and tanks outside in the environment is described. The procedures that will ensure that discharges to sewer systems are controlled and maintained to meet appropriate requirements are provided. An estimate of doses to the public from expected effluents and a description of the method used to estimate the public dose are also provided.

3.11. HEALTH AND SAFETY

Health and safety is governed by two programmes: the radiation protection programme and the industrial health and safety programme. The programmes in place during the operating period form the basis for the continuing programmes required throughout the decommissioning period. This information may be included in the decommissioning plan or be summarized in the plan with reference made to other documents.

3.11.1. Radiation protection plan

The radiation protection plan addresses a number of topics to include, but not be limited to: workplace air sampling, respiratory protection, internal and external exposure monitoring, contamination control and instrumentation.

3.11.1.1. Workplace air sampling

An overview of the workplace air sampling programme is provided. The criterion used for selection of the placement of air samplers in work areas where there is a potential for airborne hazards is described. The criteria applied that will demonstrate that air samplers with appropriate sensitivities are being used and that samples are being collected at appropriate frequencies are discussed. The use of constant air monitors, general zone samplers and breathing zone samplers is explained and a description of their readouts, annunciators and alarm set points is included. The use of portable air sampling or 'grab' samples is discussed. The specific types of equipment used are identified. The calibration frequency for all air sampling equipment, including flow meters, is provided. The procedures for responding to action and alarm levels are described. An explanation is provided of how the minimum detectable activity (MDA) for each specific radionuclide that may be collected is determined for each analytical procedure.

3.11.1.2. Respiratory protection

An overview of the respiratory protection programme is provided. The process controls, engineering controls and procedures that will be used to control the concentrations of radioactive material in the air are described. The procedure that will be followed if and when it is not feasible to use engineering controls or procedures is provided. The use of respiratory protection equipment is the optimized solution. The assigned protection factor for each type of respiratory protection device is listed and an explanation provided as to

how the equipment will be selected on the basis of the specific task to be performed. The medical screening and fit testing procedures that will be used to ensure that personnel are capable of using the equipment is described. A list of the procedures that are maintained to address all elements of the respiratory protection programme is provided. The use, maintenance and storage procedures for the respiratory protection equipment are described. The users training programme for the equipment is discussed. The procedure that will be used to select the appropriate respiratory protection equipment, considering both radiological and non-radiological hazards, is described.

3.11.1.3. Internal exposure monitoring

The type of monitoring that will be performed to determine worker exposure during decommissioning activities is described. The procedures for determining worker intakes and doses using measurements of quantities of radionuclides excreted from or retained in the body are explained. The frequency and technical objectives for baseline, periodic, special and termination assays are provided. The action levels for bioassay samples and the actions taken if a level is exceeded are described. The procedure for converting airborne concentrations to worker intakes and doses is explained. The procedure for determining airborne concentrations of radioactive material in the workplace is also explained. The action levels for air samples based on chemical toxicity if soluble radionuclides are present in the work area are provided. The procedures for combining bioassay and air sample results to determine intakes and doses for adult workers and declared pregnant workers are discussed. The procedure for converting worker intake into committed effective dose equivalent (and organ specific committed dose equivalent), including how intakes of radioactivity by declared pregnant women will be converted into dose to the embryo or fetus, is explained.

3.11.1.4. External exposure monitoring

The individual monitoring devices that will be used to monitor external exposures of workers are identified and described. The sensitivity, range and accuracy of each type of monitoring device are discussed. The procedure for using extremity monitoring or other whole body monitoring when the external radiation field is non-uniform is explained. An explanation of when audible alarm dosimeters and pocket dosimeters will be used is provided, along with a description of their performance specifications. The procedure for determining the external dose from airborne radioactive material is discussed. The procedure for ensuring that the monitoring surveys necessary to supplement

personnel monitoring are performed when needed is discussed, and the frequency of standard or routine surveys is stated. Action levels and limits for external exposures of workers are identified and the technical basis for these levels is explained. The actions that are taken if these levels are exceeded are defined. The procedures used to calculate total organ dose equivalent and total effective dose equivalent to workers on the basis of internal and external monitoring results are discussed. The programme for the preparation, retention and reporting of records for occupational radiation exposure is described.

3.11.1.5. Contamination control programme

An overall description of the contamination control programme is provided. The procedures for controlling access to, and stay time in, contaminated areas are discussed. The surveys that will be performed to supplement personnel monitoring of workers during decommissioning activities are listed, including the type of survey, frequency and type of equipment that will be used. The procedure for establishing background levels and the amount of activity from natural sources in areas where decommissioning will be performed is described, including the amount in material that naturally contains this type of material (concrete, bricks and blocks). The standard contamination control equipment that will be used during decommissioning activities is listed and described. The protective clothing that will be available is identified, and its limitations and the procedures for controlling its use are described. This subsection provides contamination action levels when action needs to be taken to decontaminate a person, place or area, to restrict access or to modify the type or frequency of radiological monitoring. The procedures, including the frequency with which they are carried out, that will be used to assess the effectiveness of decontamination and the change to radiological status through the removal of systems and equipment are discussed. The procedures used to test sealed sources, including the frequency of survey and analysis of results, are discussed. The procedures for disseminating radiological hazard information to workers are explained and the procedures for ensuring this information is included in revised work procedures are discussed.

3.11.1.6. Instrumentation

A list of instruments, both field and laboratory, that will be used to support the radiation protection programme is provided in tabular form and includes the manufacture's name, model number, intended use, number of units available, range of each scale, counting mode, sensitivity and any alarm

set points. The procedures for storage, calibration and maintenance of the instruments are described and the location where these activities will be performed is recorded. The methods that will be used to determine the MDA or minimum detectable concentration (MDC) (at a 95% confidence level) for each type of radiation to be detected are described. The instrument calibration and quality assurance procedures are discussed. The methods used to estimate the uncertainty bounds for each type of instrument measurement are explained. The organization that will calibrate the instruments is identified.

3.11.2. Nuclear criticality safety

This section is applicable for facilities where criticality safety is a concern during the decommissioning phase, for example reprocessing plants. The section describes how the nuclear criticality safety programme is implemented. Management responsibilities and the technical qualifications for safety personnel are specified. The method for ensuring an awareness of procedures and ensuring that other items relied on for safety will be maintained throughout the decommissioning activities, especially during the system decontamination and dismantling process, is described. Any activities that require an additional nuclear criticality safety analysis are identified when considering all the situations and processes that may be encountered during the decommissioning process. The results of any new analysis are provided. A summary of generic nuclear criticality safety requirements that will be applied during general decommissioning, decontamination or dismantling operations, including those dealing with systems that may unexpectedly contain fissile material, is provided. The instrumentation used to monitor criticality levels is identified and technical specifications provided. The response to criticality alarms or other off-normal situations involving criticality concerns is described.

3.11.3. Industrial health and safety plan

The industrial health and safety plan addresses the following safety topics: hoisting and rigging, electrical work, elevated work, construction safety, fire safety, heat–cold stress, power and hand operated tools, motorized vehicles and equipment, work environment, material handling and storage, high pressure safety and laser safety.

This section describes the personnel protection measures and systems that will be provided, which may include personal protective clothing, occurrence reporting and accident investigation, warning signs and devices, training, lockout or tagout, chemical control programme, hazards communication, training and noise monitoring. It provides details of how the non-radiological

health and safety concerns will be factored into the work procedures. A work permit system or other similar system which provides a systematic approach to identifying hazards and ensuring that staff are properly qualified and equipped for the workplace is described.

3.11.4. Audits and inspections

A general description of the annual review of the radiation protection programme and the industrial health and safety programme conducted by executive management is provided. The types and frequency of surveys and audits performed by the Radiation Safety Officer and his/her staff are described. The records that are retained to support the audits and corrective actions are identified. The process that is used in evaluating and dealing with violations of regulatory requirements or licence commitments identified during the audit is explained.

3.11.5. Record keeping programme

The record keeping programme for the safety programme is described. The records that must be obtained are identified and their retention period and eventual disposition are discussed. The organizations responsible for the maintenance of the records are identified and the location where the records will be kept is also identified. The method for storing the records (for example, electronically on CD or paper copies) is described.

3.11.6. Optimization analyses and programme

The administrative system for evaluation of the work performed to determine that safety was optimized and that doses and occupational hazards have been minimized is discussed. The procedure for documenting significant findings is discussed and the procedure for communicating these findings through a lessons learned programme is explained.

3.11.7. Dose estimation and optimization for major tasks

If a specific job presents a significant dose commitment or radiological hazard, the procedures for performing a detailed dose estimate incorporating ALARA (as low as reasonably achievable) principles are explained. An estimate of the whole body and extremity radiation doses to decommissioning workers for all major tasks and from all potential exposure pathways is provided. The engineering and administrative controls that will be

implemented to limit the dose to personnel (for example, incorporation of shielding, limitation of stay times and rotation of personnel) are identified.

A comparison of the estimated doses with the relevant limits defined in Section 3.9.2 is provided.

3.11.8. Clearance criteria

The release criteria to be used for the release of material and equipment, and for the reuse of buildings during and after decommissioning is provided, including a reference to applicable regulatory requirements. The procedure that will be used to ensure that the clearance criteria have been met for material, equipment and buildings being released from regulatory control is explained.

3.11.9. Final release criteria

This section provides the final site radiological criteria to be achieved at the end point of the project. The procedure for verifying that these criteria have been met is explained. A discussion is included that explains how the optimization process was considered during the development of these criteria.

3.12. QUALITY ASSURANCE

The quality assurance (QA) programme to be applied during decommissioning may be described in a separate document referenced and summarized in the decommissioning plan. The document in place during the facility's operation is generally valid for the decommissioning activities, except for revisions to the organizational structure and other minor changes. The QA topics are described below.

3.12.1. Organization

The QA organization is described in relation to the decommissioning organization, and an organizational chart is provided. Special attention is given to explaining the relationship between the implementing and project management structures. A description of the duties, responsibilities and authorities of each unit within the QA organization is provided, and the procedures for managing the delegation of responsibilities within the decommissioning programme are explained. The procedures for evaluating work performance are described.

3.12.2. Quality assurance programme

A commitment is included which ensures that activities affecting the quality of site decommissioning will be subject to the applicable controls of the QA programme and that activities covered by the QA programme are identified in programme defining documents. A brief summary of the licensee's or contractor's corporate QA policies is provided. The provisions to ensure that the technical and quality assurance procedures required to implement the QA programme are consistent with regulatory, licensing and programme requirements, and that they are properly documented and controlled, are discussed. The management reviews that will be performed to ensure that quality is maintained during the decommissioning activities are described. The method for ensuring that the QA programme is applied to contractors is explained. The procedure for notifying the regulatory body of changes in the approved QA programme, decommissioning plan or key members of the organization is discussed. The procedure for regular assessment of the scope, status, adequacy and compliance with the QA programme by management is explained. A description of the training given to personnel who are responsible for performing activities affecting quality is provided, along with their qualifications. The self-assessment programme that is used to confirm that activities affecting quality comply with the QA programme is described. The organizational responsibilities for ensuring that activities affecting quality are prescribed by documented instructions, procedures and drawings, and that they are accomplished through implementation of these documents, are described. The procedures that will be used to ensure that instructions, procedures and drawings include quantitative and qualitative acceptance criteria for ensuring that important activities have been satisfactorily performed are discussed.

3.12.3. Document control

A summary of the types of document that are included in the programme is provided. The procedure for developing, issuing, revising and retiring documents is described.

3.12.4. Control of measuring and test equipment

A summary of the measurement and test equipment that will be used during the decommissioning activities is provided. The procedure for calibrating the equipment and the frequency with which calibration is carried out are provided. The procedure for performing daily calibration checks on each piece of equipment is discussed. The documentation that will be

maintained to demonstrate that only properly calibrated and maintained equipment will be used during decommissioning activities is described.

3.12.5. Corrective actions

This section describes the corrective action procedures for the project, including a description of how a corrective action is determined to be adequate. The documentation that is maintained for each corrective action and any follow-up activities by the QA organization after the corrective action has been implemented is described.

3.12.6. Quality assurance records

The procedures for managing QA records are discussed. The required QA records that need to be maintained during the implementation of the project are identified. The responsibilities of the QA organization, as well as those of other organizations involved in the decommissioning, implementation and maintenance of QA records, are described. The storage facility for the QA records is identified and the procedures for storing the records are discussed.

3.12.7. Audits and surveillance

The QA audit and surveillance programme is described, including the procedures for conducting audits and surveillance. The records and documentation that will be generated during the audits are identified and the procedures for managing these documents are explained. The follow-up activities associated with the audits and surveillance are described. The trend tracking procedures that will be performed based on the results of audits and surveillance are described.

3.12.8. Lessons learned programme

A description of the lessons learned programme is provided. The procedures for capturing and recording the lessons learned during the decommissioning activities are discussed. The method for making this information available to others within and outside the organization is described. The feedback mechanism for this information in the overall decommissioning activities is discussed.

3.13. EMERGENCY PLANNING

Site and facility specific emergency plans are a contingency measure designed to address an accident or malfunction scenario. The emergency plan that exists at the end of the operating period can be used as the basis for the emergency plan for the decommissioning period. This plan can be recorded in a separate document referenced and summarized in the decommissioning plan.

3.13.1. Organization and responsibilities

Details about the organization and responsibilities for emergency planning are provided. An organizational chart for the emergency planning and response organization is provided and the responsibilities of key personnel are defined. The arrangements for dealing with and reporting abnormal events, incidents and emergencies, including on- and off-site actions, are summarized. The hazards and events for which those arrangements are required are identified and details of the necessary responses and lines of communication are provided. Actions that may require the support of external parties (i.e. fire departments, medical personnel and utility companies) are identified and arrangements that are in place to provide this support are discussed.

The modifications in operational arrangements concerning emergency response due to specific decommissioning activities are described. These modifications and their justification are discussed; recognizing that, as decommissioning progresses, the hazard potential of the facility will decrease.

3.13.2. Emergency situations

This section describes the procedures for responding to emergency situations and how these procedures are maintained throughout the decommissioning period. The requirements for operator training, regular testing and equipment maintenance as well as the schedule for periodic training exercises are discussed. The equipment available to respond to emergencies is identified.

3.13.3. Records

The procedure for recording emergency events is described, including the reports to the regulatory body. The procedures are discussed for performing investigations and ensuring corrective actions will be implemented and verified.

3.14. PHYSICAL SECURITY AND SAFEGUARDS

A site specific security system is in place during the operation phase, and is described in the physical security plan existing at the end of operation. That plan will be adapted to meet the security needs of the decommissioning activities. The plan is normally a separate document and may have restricted distribution, and can then only be referred to in the decommissioning plan in general terms. (Note that in many cases the physical security plan may not be available for public distribution, and consideration must be given to whether this document can be referenced.)

3.14.1. Organization and responsibilities

An organizational chart for the physical security function is provided and the responsibilities of the key personnel are defined.

3.14.2. Physical security programme and measures

This section provides information about the general approach to physical security. Details may only be supplied in the physical security plan.

3.14.3. Safeguards programme and measures

The operational arrangements for the safeguarding of special nuclear material are summarized. Any changes to the arrangements that were in place during operations and changes that are necessary as a result of the decommissioning activities, or potentially new waste management arrangements (Section 3.7), are identified. The justification for these modifications, recognizing that as decommissioning progresses the hazard potential of the facility will decrease, is provided.

3.15. FINAL RADIATION SURVEY

This section provides a brief overview of the final survey design. A map or drawing of the site, area or building which indicates the areas that will be included in the survey is provided. The reference areas or material that will be used to determine the background conditions are described, and a justification for their use is provided. The procedures that will be used to perform the final survey are discussed. The types of field instruments that will be used are identified and the procedures for their use, calibration, operational checks,

coverage and sensitivity for each type of media and radionuclide are discussed. The laboratory analytical instruments for measuring samples are identified and the procedures for the calibration, sensitivity and methodology for evaluation are discussed. The procedure for demonstrating that the instruments have adequate sensitivity during their use is discussed. The procedures for the collection, control and handling of the samples that will be analysed in the laboratory are described. The methodology for evaluating the survey results to ensure they are statistically correct and accurate is explained. Acceptable residual activity levels and their derivation are provided. The presentation of data in the final survey report is described and the analytical procedures for comparing the results obtained with the acceptable residual activity levels are discussed. The records that will be maintained are identified and the procedures for maintaining these records described.

4. RELATED DOCUMENTS

These related documents support the decommissioning process. They will normally be found as stand-alone documents, but may be annexed to the decommissioning plan. In this section, a description of the contents of each of these documents is provided. In the development of a decommissioning plan, any information that is not found in the related document is generated and included in the decommissioning plan. Related documents include the following:

— Characterization plan;
— Characterization survey report;
— Final radiological survey plan;
— Final radiological survey report;
— Public relations plan;
— Site policies and procedures;
— Final decommissioning report.

Other documents referenced in the decommissioning plan are listed in the Annex to this report. These documents can be a part of the decommissioning plan and thus also of the licence application documents.

4.1. CHARACTERIZATION PLAN

Proper facility and site characterization activities are a critical aspect of the decommissioning process. An adequate amount of time and effort needs to be devoted to the characterization activity since it drives the planning process in decommissioning — planning of work schedules, required workforce loading, required funding, waste volumes, worker exposures and effort required to maintain safe work conditions. An insufficient amount of time spent focusing on characterization can have a major impact on the entire project. The IAEA has issued a technical report [6] that provides information on the planning and implementation of characterization surveys.

Typically, the characterization plan and survey reports are referenced in the decommissioning plan. This characterization process involves a three step process:

(1) Understanding the site history to determine where data or information gaps exist;
(2) Providing details of these in a characterization plan and performing the additional characterization;
(3) Documenting the results of the characterization process in a detailed characterization report.

4.1.1. General

The name and address of the facility and the licensee's or authorization holder's name and address are provided. The location of the facility, including the geographical location and address, is provided and identified on maps that indicate the site location in relation to the surrounding community. The size of the site or facility is provided in square metres. The type of facility, such as light water or gas cooled power reactor, research or demonstration reactor, radiopharmaceutical research laboratory or university laboratory, is stated. A description of the processes that were used and the activities performed at the facility are provided.

A complete site description is given, including a site layout identifying all the facilities and buildings that are located on the site and those that will be included in the characterization survey and the decommissioning project. The boundaries of the survey are clearly defined on the map. If only a portion of a facility is included in the survey, these areas are clearly identified.

Other buildings or facilities on the site that are not part of the decommissioning effort, but that could be affected by decommissioning activities or that are needed to support the activities, are identified and their use discussed.

Appropriate drawings of the site and buildings that allow the reader to understand the size and complexity of the facility are included.

A general description of all the building(s), major facility systems and ancillary equipment that will be included in the decommissioning project is provided. Schematic engineering and system layout drawings, sufficient to provide general information about the systems and major components that will require removal or decontamination during decommissioning, are provided.

4.1.2. Document and historical review

The historical documentation from the operational period of the facility that was used in the past to obtain information about the activities that were performed and the radiological conditions is identified. Other important documents that are used in developing the characterization plan, such as the site licence, licence conditions and amendment applications, inspection records, disposal records, site maps and drawings and process flow diagrams, are also identified. The results of the review of these documents provide the verification or detailing of material used at the site, the locations of different operations and possibly the total quantities authorized. Any spills, fires or other operational occurrences that took place which might have an impact on the decommissioning or require additional consideration during the characterization survey are identified and described.

Any records of reviews performed of previous radiological surveys that were used to classify the different radiological areas and clean areas are described, and the basis for the classification of the areas discussed. This section indicates how past waste disposal or waste processing operations on-site have been either verified or discounted as a concern during the decommissioning activities.

This section also describes how past site activities and the potential for residual contamination (beyond that which would reasonably be expected) have been identified from unofficial sources. Useful unofficial sources including senior or former employees at the facility, old photographs of construction or modifications and newspaper articles that have been used in the evaluation of the facility are identified. Areas where soil topography changes have occurred are identified.

4.1.3. Identification of potential contaminant sources and locations

The types and amounts of known or licensed radionuclides at the facility are provided. The type of operation at the facility and the potential for activation of material and/or contamination is evaluated to determine if

additional radionuclides may be present and, if so, if the quantities are reasonable. The areas of concern where radioactive material might have accumulated or issues about which there is little information concerning the radiological status are identified and described.

The period of time since the facility performed its intended operations is given. If material originally present has decayed to background levels and no further characterization activities are necessary, a justification is provided with the method for showing that the release criteria have been met.

The 'known' locations of radiological contamination at the site based upon review of the records, which might include areas where radioactive material was handled or processed, where waste was managed and where spills, fires or other operational incidents released or spread contamination, are identified and described. Areas where activation of material is possible are identified. Maps and tabular data of various work areas are presented to identify and/or display the radiological conditions at the facility as currently known.

4.1.4. Characterization surveys/background surveys

Note that some data may already be available which provide a data set equivalent to that which these activities would generate. This case is reviewed as part of the historical record.

The procedures that will be used to perform detailed measurements in the facility are described. The types of survey (for example, for surface gamma radiation, loose contamination, fixed contamination or airborne contamination) and the areas where they will be performed are identified. The instrumentation that will be used to perform these surveys is identified and its MDA, any conversion factors and characteristics are provided. The measurements that will be taken in each area of the facility in order to obtain a complete radiological 'snapshot' of the facility are discussed. If a grid system is being used during the survey and sampling process, the system is described and the rationale behind the design of the grid system is discussed. Maps, drawings or other visual representations of the areas and systems that will be surveyed or sampled are provided, and the survey and sample points identified on these representations.

A listing of the types of sample that will be collected, the numbers of each type of sample, the size and location of each sample, and the analyses that will be performed is provided. Areas not previously monitored during operations, but which will become accessible during the decommissioning process, are identified and included in the survey.

The process used to verify that there is not any buried material on-site or any areas of subsurface contamination is described. Any areas that were scanned using any type of non-intrusive device (i.e. penetrating radars or electromagnetic measuring devices) to accomplish this task are indicated and the results presented.

The proposed QA provisions for the work to be performed are discussed. The required training and qualifications of the personnel who will perform the survey work are indicated. Examples of survey and sample analysis forms are provided. The disposition of all smears, filters or samples that are generated during the characterization survey is discussed.

The procedures that will be used to record field data and analytical results are described. The process that will be used to track smears and samples from the time they are taken to their final disposition is defined.

The process used to establish the naturally occurring background levels in the facility to allow for background correction is described.

4.1.5. Health and safety provisions

Safety hazards and any special safety concerns that might be encountered during the survey and sampling activities are identified. The provisions to be taken by the survey teams to protect workers and the public during the characterization effort are described. The procedures that will be taken to prevent releases to the environment from these characterization activities are discussed. Any special precautions or training that will be required of the survey team members are described.

4.1.6. Data interpretation and results

The method for presenting the data in the characterization report is illustrated. The process that will be used to convert the collected field measurements into units comparable to those of the guideline values is described. The procedures for determining the average values for the survey units and the comparison with the guideline values are discussed.

The methodology that will be used to calculate the MDA of the instrument or analytical technique and the standard deviation is provided, along with the procedure for statistically validating the collected data against the desired confidence level objective. The method for annotating areas that have contamination above the release criteria in the report is described.

The procedure that will be used to validate the computer analysis used for, for example, activation analysis and special nuclear material hold-up (i.e. the amount of material that might remain in the systems after an initial cleanout), is explained.

The disposition of the records containing the raw data, once data interpretation is completed, is discussed and the storage requirements for the records are described.

4.1.7. Comparison with site guideline values

The process used to compare the collected data with the guideline values for releasing areas or to identify areas not requiring any further action is described. Any newly identified contaminants or locations of contaminants that were discovered during the characterization survey are identified.

4.1.8. Report

The contents of the characterization report that will be prepared after the characterization survey has been completed and the data have been analysed are briefly discussed.

4.2. CHARACTERIZATION SURVEY REPORT

The characterization survey report represents a summary of all the radiological data and information that were collected during the characterization survey. The information is used to provide a final status report about the facility before the implementation of the decommissioning strategy is started. The data are also used to finalize the decommissioning plan. This is a critical document and provides the basis for nearly all of the remaining planning work for implementation of the site decommissioning activity.

4.2.1. General

The name and address of the facility and the licensee's or authorization holder's name and address are provided. The location of the facility, including geographical location, state or local vicinity, is provided and identified on maps that indicate the site location in relation to the surrounding community. The size of the facility is provided in square metres with an indication by building and surrounding area. The type of facility, such as light water or gas cooled power reactor, research or demonstration reactor, radiopharmaceutical research laboratory or university laboratory, is stated. A description of the processes that were used and the activities performed at the facility is given.

A complete site description including a site layout is provided that identifies the buildings and areas that have been included in the characterization survey. The boundaries of the survey are clearly defined on the map. If only a portion of a facility was included in the survey, these areas need to be clearly identified.

Other buildings or facilities on the site that are not part of the decommissioning effort, but on which decommissioning activities could have an impact or that are needed to support those activities, are identified and their use discussed. Appropriate site drawings and building drawings that allow the reader to understand the size and complexity of the facility are included.

A general description of the building(s), major facility systems and ancillary equipment that will be included in the decommissioning project is provided. Schematic engineering and system layout drawings sufficient to provide a general knowledge of the systems and major components that will require removal or decontamination during decommissioning are included.

4.2.2. Review of historical documentation

The results of the historical documentation review from the operational period of the facility are presented. The documents that were included in the review are identified. Pertinent information obtained from these documents that was useful for the implementation of the characterization survey is presented. Any information concerning spills, fires or other operational occurrences that could have an impact on the decommissioning activities is provided.

The extent and results of the review of previous radiological surveys are discussed. Past on-site waste disposal or other activities that were found during the review of records and verified by the characterization survey are identified.

4.2.3. Identification of contaminant sources and locations

The type, amount, chemical composition and physical form of any radioactive contaminants at the facility are presented. Any significant ratios between radionuclides that can be used during decommissioning activities are described. If the radionuclides or the ratio of radionuclides vary between different locations of the facility, this is described and the location of these different mixtures identified on site and building maps and drawings.

4.2.4. Measurements made and analyses performed

The procedures that were used to perform detailed measurements in the facility are documented. The types of survey (for example, for surface gamma radiation, loose contamination, fixed contamination or airborne contamination) that were performed are recorded and their locations are identified on maps of the facility and site.

The survey results that were collected during the survey are summarized in the report and the detailed data provided in an appendix of the report (Section 4.2.7). Maps and drawings are used to portray this information and provide a clear overview of the radiological conditions at the facility.

The results of sampling that was performed during the survey are summarized in the report and the detailed data described in an appendix (Section 4.2.7). The location of the sample collection points are shown on a map or drawing of the facility or site.

Any buried structures, equipment or disposal remains that were found during the characterization are identified and described. The radiological status of these items is summarized.

The procedure used to determine general area background radiation is discussed and the results provided, recognizing that the background might change within large facilities. Background levels for materials (i.e. concrete) are also provided.

The QA provisions for the work that was performed are described. The disposition of all smears, filters or samples that were generated during the characterization survey is discussed. The process that was used to track smears and samples from the time they are taken to their final disposition is discussed.

4.2.5. Comparison with site guideline values

Maps and drawings which show areas that exceed the release criteria for the facility are provided, and general levels of the contamination or radiation are indicated. Systems and equipment that have activity levels greater than the clearance criteria are identified, and general levels of radiation and contamination within the components are indicated. All areas, systems and components that are believed to be free from radioactive material and that can be released from regulatory control are identified.

4.2.6. Conclusions and summary

The radiological and non-radiological contaminant situation at the facility is described as concisely as possible. Any areas, systems or components in

which special problems may be encountered during decontamination or dismantling activities are identified. Any areas, systems or components that were not surveyed due to physical or radiological constraints but that might contain radioactive material and will need additional attention are identified. As a summary, overview drawings and maps of areas that will require control and decommissioning are provided.

4.2.7. Appendices

Maps and drawings of all areas, systems, equipment and components that were surveyed are provided. If a grid system was used, the grids are overlaid on the maps and drawings. The locations of the survey and sample collection points are also indicated on the maps and drawings. The type of survey or the type of material that was collected at each point is indicated.

4.2.7.1. Detailed radiation and contamination data

The detailed radiation and contamination data are provided in tabular form. This information includes the survey point number and/or grid location, type of survey performed (for example, beta–gamma fixed contamination, gamma radiation or alpha loose contamination), gross counts per minute or dose rate, activity per unit area (for contamination), MDA and uncertainty value (based on a 95% confidence level). The project title, survey unit location, date when data were collected and the instrument used are also indicated. The individuals who collected the data and those who reviewed the data and calculations are recorded.

For each instrument and type of survey, the model number, type of probe used (if applicable), serial number of the meter and probe, efficiency and MDA are provided. The procedure for determining the MDA is discussed. A correlation between the instrument used to collect the data and the survey point is included. If automatic counting systems were used for smears, the above information is also provided.

4.2.7.2. Sample data

The detailed sample data are provided in tabular form. For each sample the sample collection location, sample number, type of material sampled, size of sample, depth of collection (for soil and concrete), gross counts per minute, radionuclide (if identified), activity per unit weight (in Bq/g), MDA or MDC, and uncertainty value are provided. For air samples, the flow rate of the air sampler and the collection time are also indicated. The project title, collection

location, sample collection date and type of analysis performed are provided. The individual who collected and prepared the sample and the individual who reviewed the data and calculations are indicated.

For each instrument and type of sample, the model and serial number of the instrument, efficiency and MDA or MDC are provided. The procedure for determining the MDA or MDC is discussed. The procedure for preparing the samples for analysis is also described.

4.3. FINAL RADIOLOGICAL SURVEY PLAN

The final radiological survey plan provides details of the measurements to be made, the samples to be collected, analyses to be performed and final data evaluation to be performed on all the data collected from the final survey process. All of this information ensures that the release criteria have been met.

4.3.1. General

The name and address of the facility and the licensee's or authorization holder's name and address are provided. The location of the facility, including the geographical location, is provided and the facility is identified on maps that indicate the site location in relation to the surrounding community. The type of facility, such as light water or gas cooled power reactor, research or demonstration reactor, radiopharmaceutical research laboratory or university laboratory, is indicated. A description of the processes that were used and the activities performed at the facility when operating is given.

A complete site description including a site layout is provided that identifies any remaining facilities, buildings and areas that will be included in the final survey. The locations of any former facilities that were removed during decommissioning are also identified. Areas within the building(s) that will be included in the final survey are indicated on the maps and drawings. The boundaries of the survey are clearly defined on the map. If only a portion of a facility is included in the survey, these areas need to be clearly identified.

Other buildings or facilities on the site that are not part of the decommissioning effort, but on which decommissioning activities could have had an impact or that were needed to support the activities, are identified and their use discussed. Appropriate site and building drawings are provided that allow the reader to understand the size and complexity of the former facility and what will be included in the final survey.

A general description of the building(s), major facility systems and ancillary equipment that still remain is provided, including schematic engineering system layout drawings, as appropriate.

4.3.2. Documentation and historical review

The historical documentation from the operational period of the facility or from the decommissioning activities that was used to obtain past information about the radiological conditions is identified. Other important documents that are used in developing the final plan, such as site licence, licence conditions and amendment applications, inspection records, disposal records, site maps and drawings, and initial characterization survey, are also identified. The results of the review of these documents are presented. Any spills, fires or other operational occurrences or activities that occurred during the implementation of the decommissioning strategy which might have affected the remaining radioactivity are described.

4.3.3. Identification of potential contaminant sources and locations

The types of radionuclides that were found at the facility during the characterization survey and during the decommissioning activities are identified. The areas where radioactive material was found during the decommissioning activities are identified and the type of material found at the location discussed. Areas where activation of material was found to have occurred are also identified. Maps and tabular data of various work areas are provided to identify and display the radiological conditions at the facility as currently known through surveys that were performed during decommissioning.

4.3.4. Surveys

The procedures that will be used to perform the detailed measurements in the facility are described. The types of surveys (for example, for surface gamma radiation, loose contamination, fixed contamination or airborne contamination) that will be performed are discussed and the areas where these surveys will be performed identified. The types of instrumentation that will be used to perform these surveys are identified and their MDA, as well as any conversion factors and their characteristics, are provided. The measurements that will be taken in each area of the facility are described. The grid system that will be used during the survey is described and the rationale used to select this system is discussed. Maps, drawings or other visual representations of the areas

and systems that will be surveyed or sampled are provided and the locations of the survey and sample points are indicated on these representations. A listing of the types of samples that will be collected, the numbers of each type of sample, the size and location of each sample, and the analyses that will be performed, is provided.

The areas that have not been decontaminated to the release criteria standard are identified and an explanation is provided as to why they remain.

The process used to verify that there is not any buried material on-site nor any areas of subsurface contamination is described. If any areas were scanned using any type of non-intrusive system (for example, penetrating radar or electromagnetic measuring devices) to accomplish this task, the techniques used are described and the results presented.

The process used to establish the naturally occurring background levels in the facility to allow for background correction is described.

The proposed QA provisions for the work to be performed are described. The required training of the personnel who will perform the survey work is described. Examples of survey and sample analysis forms are given. The disposition of all smears, filters or samples that are generated during the final survey is discussed.

The procedures that will be used to record field data and analytical results are described. The process that will be used to track smears and samples from the time they are taken to their final disposition is explained.

4.3.5. Health and safety provisions

The provisions that will be taken by the survey teams to protect workers and the public during the final survey effort are described. Safety hazards or special safety concerns that might be encountered during the survey and sampling activities are identified. A description of any special precautions or training that will be required is also provided.

4.3.6. Data interpretation and results

The presentation format in the final survey report for the collected data is described. The process that will be used to convert the collected field measurements into units comparable to the guideline values is discussed. The procedures for determining the average values for the survey units are described.

The methodology that will be used to calculate the MDA of the instrument or analytical technique and the standard deviation is discussed. The

procedures that will be used to show that the collected values are statistically validated against the desired confidence level objective are discussed.

The disposition of the records once data interpretation is completed is discussed along with the procedures for storing the collected data.

4.3.7. Comparison with site guideline values

The process used to compare the collected data with the guideline values for releasing areas or to identify areas not requiring any further action is described. Any areas that were not decommissioned to these levels are identified and the reason for this given. The method for annotating areas that are above the release criteria in the report is described.

4.3.8. Report

The contents of the final radiological survey report that will be prepared after the survey has been completed and the data have been analysed are briefly discussed.

4.4. FINAL RADIOLOGICAL SURVEY REPORT

The final radiological survey report presents the final conditions at the facility and the site at the conclusion of the physical decommissioning activities. All of the data generated in this process are collected and reported to the regulatory body to verify and document that the release criteria have been met and the site is ready for licence termination.

4.4.1. General

The name and address of the facility and the licensee's or authorization holder's name and address are provided. The location of the facility, including geographical location, state or local vicinity, is identified on maps that indicate the site location in relation to the surrounding community. The type of facility, such as light water or gas cooled power reactor, research or demonstration reactor, radiopharmaceutical research laboratory or university laboratory, is stated. A description of the processes that were used and the activities performed at the facility during operation is provided.

A complete site description including a site layout is provided. The facilities and buildings that have been included in the final survey are identified on the site layout. Areas within the building(s) that were included

in the survey are also identified. The boundaries of the survey are clearly identified. If only a portion of a facility was surveyed, these areas also need to be clearly identified.

Other buildings or facilities on the site that were not part of the decommissioning effort, but on which the decommissioning activities could have had an impact or that were needed to support these activities, are identified and their uses discussed. This section includes appropriate site drawings and building drawings that allow the reader to understand the size and complexity of the facility that was surveyed.

A general description of the building(s), major facility systems and ancillary equipment that still remain is provided, including schematic engineering and system layout drawings sufficient to provide a general knowledge of the systems, as appropriate.

4.4.2. Identification of contaminant sources and locations

The radioactive contaminants that were identified at the facility during the decommissioning activities are identified and their chemical composition and physical form are described. Significant ratios between radionuclides that were used during the final survey are discussed. If the radionuclides or ratios of radionuclides varied between different locations of the facility, there is an indication of where these different mixtures occurred on the site and building maps and drawings.

4.4.3. Measurements made and analyses performed

The procedures that were used to perform the detailed measurements in the facility are described. The types of surveys (for example, for surface gamma radiation, loose contamination, fixed contamination or airborne contamination) that were performed are identified and the locations where they were performed indicated on maps and drawings. The instrumentation that was used to perform these surveys is identified.

The survey results provided in the appendix of the final radiological survey report (Section 4.4.6) are summarized using maps and drawings to portray this information to provide a clear overview of the final radiological conditions at the facility.

The results of sampling that was performed as described in this appendix (Section 4.4.6) are summarized and the location of the sample collection sites shown.

Any buried structures, equipment or disposal remains that were found during the characterization and decommissioning activities are identified and

described. The radiological status of these items after decontamination or dismantling activities is discussed.

The procedures for determining general area background is explained and the results are provided, recognizing that it might change within large facilities. Background levels for various materials (for example concrete) are also provided.

The QA provisions for the work that was performed are described. The disposition of all smears, filters or samples that were generated during the characterization survey is discussed. The process that was used to track smears and samples from the time they are taken to their final disposition is also discussed.

4.4.4. Comparison with site guideline values

Maps and drawings are provided that show areas that exceed the release criteria for the facility after the final survey has been performed. Systems and equipment that have activity levels greater than the clearance criteria are identified, and general levels of radiation and contamination are indicated for these items. All areas, systems and components that can be released for unrestricted use are identified. Any institutional controls that will be required for any areas that have not been released are discussed.

4.4.5. Conclusions and summary

The final radiological situation at the facility is described as concisely as possible. Any areas that were not surveyed due to physical constraints but that might contain radioactive material and will need additional attention or require institutional controls are identified. As a summary, overview drawings and maps of areas that will require institutional controls are provided.

4.4.6. Appendices

Maps and drawings are provided of all areas, systems, equipment and components that were surveyed. The grid system that was used is described and maps and drawings provided that show the location of the survey and sample collection points. These maps and drawings also indicate the type of survey that was performed or the type of material that was collected at each point.

4.4.6.1. Detailed radiation and contamination data

In tabular form, the survey point number and/or grid location, type of survey performed (for example, beta–gamma fixed contamination, gamma

radiation and alpha loose contamination), gross counts per minute or dose rate, activity per unit area (for contamination), MDA and uncertainty value (on the basis of a 95% confidence level) are provided. The project title, survey unit location, data collection date and instrument used are also indicated. The individuals who collected and reviewed the data and calculations are recorded.

For each instrument and type of survey, the model number, type of probe used (if applicable), serial number of the meter and probe, efficiency and MDA are recorded, along with an explanation of the method used to calculate the MDA. A correlation between the instrument used to collect the data and the survey point is included. If automatic counting systems were used for smears, the above information is also provided.

4.4.6.2. Sample data

In tabular form, the sample collection location, sample number, type of material sampled, size of sample, depth of collection (for soil and concrete), gross counts per minute, radionuclide (if identified), activity per unit weight (in Bq/g), MDA or MDC and uncertainty value are provided. For air samples, the flow rate of the air sampler and the collection time are also included. The project title, collection location, sample collection date and type of analysis performed are indicated. The individuals who collected and prepared the sample and those who reviewed the results and calculations are identified.

For each instrument and type of sample, the model number, equipment serial number, efficiency and MDA or MDC are provided and the procedure for calculating the MDA or MDC is discussed. The procedures used to prepare the samples for analysis are described.

4.5. PUBLIC RELATIONS PLAN

The various elements of the public relations plan are described. The stakeholders in the decommissioning project, including regulators, technical organizations, the public and non-governmental organizations, are identified. The department within the decommissioning organization that is responsible for this aspect of the project is identified along with the specific person who will be the point of contact with stakeholders, including their phone numbers, fax numbers, email addresses and conventional mailing addresses. The location where stakeholder groups can gain access to the detailed information from the project decommissioning plan, typically referred to as a public reading room, is identified.

A listing of the types of information that will be routinely distributed (for example, an annual progress report on the project) and other items such as examples of material that might be available on an irregular and unscheduled basis are described. The methods of communication that are used to provide information to each group of stakeholders are described. Any methods of independent verification that can be used by stakeholders for appropriate evaluations and updates are identified. Web sites that are available with information for use by interested stakeholders on the status of the project are identified. The procedure for issuing press releases on significant accomplishments or upcoming activities is discussed.

Plans for public meetings and updates on the project that are envisioned to be held routinely are described. Additional items such as any regular project status newsletters to be issued, open houses to be held or other opportunities to tour the facility or site are identified. The procedure for requesting speakers from the project to talk with any of the local stakeholders about various aspects of the work is discussed. Plans for, or the activities of, any environmental monitoring programmes that may already be ongoing or are to be implemented during the decommissioning are described.

The procedures for relaying emergency information to the public if required are described.

4.6. SITE POLICIES AND PROCEDURES

Existing policies and procedures that are applicable during decommissioning activities are identified. A list of all policies and procedures that are obsolete or have been superseded is provided.

New procedures and policies that will be required to support the decommissioning activities are identified. The procedure for preparing and approving new procedures will be discussed. Organizations that must review and/or approve the new policies and procedures or changes to them are identified. The process to be used to ensure that each party (including workers) in the process understands their role in the implementation of these procedures (i.e. worker briefings) is described. The process to be used in the formulation of updates to these procedures and how these updates will be distributed to ensure that everyone has the latest copy of the authorized procedures is described. The organization responsible for maintaining the master copy of the policies and procedures and their maintenance is identified.

4.7. FINAL DECOMMISSIONING REPORT

The final decommissioning report is submitted to the regulatory body as evidence that the decommissioning project has been completed in accordance with licence and other legal requirements. The report also documents the activities that were performed during the decommissioning project. The report is archived in accordance with local requirements so that it can be referenced in the future.

4.7.1. Facility description

The name and address of the facility and the licensee's or authorization holder's name and address are provided. The location of the facility, including the geographical location, is identified on maps that indicate the site location in relation to the surrounding area. The type of facility that was decommissioned, including a brief history of the facility and/or site, is provided. Appropriate site drawings, figures and other building and site drawings are provided that allow the reader to understand the size and complexity of the facility or site.

A complete site description, including a site layout, is provided that includes the identification of the buildings and areas that were included in the decommissioning project. The boundaries of the decommissioning project facility are clearly defined on the map. Buildings and areas that were completely removed, those that remain or those outside the scope of the project but on the site are identified. Buildings or areas that remain, but have restrictions placed on their future use, are identified. An inventory of materials, equipment and premises released/cleared from regulatory control is provided.

4.7.2. Decommissioning objectives

The objective of the decommissioning project is described. The strategy that was selected for implementation is identified. Any parts of the original objective that could not be met are discussed and an explanation provided as to why they could not be achieved.

4.7.3. Release criteria

The radionuclides and non-radiological contaminants that were encountered during the decommissioning are listed. The radiological criteria that were used as the basis for the release of the equipment, buildings or areas from regulatory controls are provided.

4.7.4. Decommissioning activities

The major decommissioning activities that were performed are briefly described. This description needs to be in sufficient detail to allow someone at a future date to understand precisely what activities were performed. A Gannt chart that indicates the period during which major activities were initiated and when they were completed is provided. The budgeted cost versus the actual cost to perform the project work is also given, broken down according to major activities.

4.7.5. Remaining entities

Any remaining equipment, buildings or areas that were originally part of the decommissioning project but that were not completely released from regulatory control are identified and the reason for this retention under control discussed. Any institutional controls that will remain in place at the facility are discussed.

4.7.6. Final radiological status

A summary of the final radiological condition of any remaining equipment, structures or areas is provided. Reference is made to the final radiological survey report prepared from this activity. Any areas remaining above the release criteria are identified and existing activity levels presented.

4.7.7. Site release

A list of structures, areas or equipment designated for restricted use (if any) is provided, including any requirements for further monitoring of areas.

4.7.8. Waste volumes

A comparison of the planned versus actual volumes of all types of waste generated during decommissioning activities is provided. Radioactive waste, cleared materials and other special wastes, such as chemical or other regulated waste materials, are considered. The waste documentation package prepared for the waste items is described. Any unexpected volumes of waste material generated above the volume originally planned are identified and the reason for the difference between these values is explained. The disposal or storage sites for all of these different types of waste or material that were removed from the site are identified. If material was buried on the site, information

concerning its type, radiological status and amount is provided, along with the location of the site and the authorization or licence number.

Information about airborne or liquid waste emissions during the decommissioning activities, even if authorized under a permit, is provided.

4.7.9. Personnel doses

A summary of the radiological doses received by workers during the decommissioning activities is provided. The actual doses received are compared with the initial estimates and major differences are discussed.

4.7.10. Abnormal occurrences and incidents

A summary of any abnormal events or incidents that have occurred during the decommissioning process is provided. The root cause of each one is identified and a discussion provided as to how recurrence was mitigated.

4.7.11. Lessons learned

The lessons learned during the decommissioning process are listed and discussed. Work activities that might be approached and planned differently if the project were to be done again are identified. This section describes what worked well and identifies the key areas for the success of the project.

4.7.12. References

The project documentation prepared to support the decommissioning activity is listed, including supporting documentation (for example, the characterization report, health and safety plan and quality assurance plan) used to justify and build the case for other actions such as clearance of items and conduct of final status surveys.

4.7.13. Appendices

Details of information too extensive to be included in other sections are included here for the reader to review. These can be used in the final report as the writer wishes.

REFERENCES

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Predisposal Management of Radioactive Waste, Including Decommissioning, IAEA Safety Standards Series No. WS-R-2, IAEA, Vienna (2000).

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

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

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Decommissioning of Nuclear Fuel Cycle Facilities, IAEA Safety Standards Series No. WS-G-2.4, IAEA, Vienna (2001).

[5] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANISATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996).

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

BIBLIOGRAPHY

INTERNATIONAL ATOMIC ENERGY AGENCY, Safe Enclosure of Shut Down Nuclear Installations, Technical Reports Series No. 375, IAEA, Vienna (1995).

— The Principles of Radioactive Waste Management, Safety Series No. 111-F, IAEA, Vienna (1995).

— Quality Assurance for Safety in Nuclear Power Plants and Other Nuclear Installations, IAEA Safety Standards Series No. 50-C/SG-Q, IAEA, Vienna (1996).

— Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, IAEA Safety Standards Series No. GS-R-1, IAEA, Vienna (2000).

— Organization and Management for Decommissioning of Large Nuclear Facilities, Technical Reports Series No. 399, IAEA, Vienna (2000).

— Regulatory Control of Radioactive Discharges to the Environment, IAEA Safety Standards Series No. WS-G-2.3, IAEA, Vienna (2000).

— Methods for the Minimization of Radioactive Waste from Decontamination and Decommissioning of Nuclear Facilities, Technical Reports Series No. 401, IAEA, Vienna (2001).

— Record Keeping for the Decommissioning of Nuclear Facilities: Guidelines and Experience, Technical Reports Series No. 411, IAEA, Vienna (2002).

— Safe Enclosure of Nuclear Facilities during Deferred Dismantling, Safety Reports Series No. 26, IAEA, Vienna (2002).

— Decommissioning of Small Medical, Industrial and Research Facilities, Technical Reports Series No. 414, IAEA, Vienna (2003).

— Predisposal Management of Low and Intermediate Level Radioactive Waste, IAEA Safety Standards Series No. WS-G-2.5, IAEA, Vienna (2003).

— Predisposal Management of High Level Radioactive Waste, IAEA Safety Standards Series No. WS-G-2.6, IAEA, Vienna (2003).

— Remediation of Areas Contaminated by Past Activities and Accidents, IAEA Safety Standards Series No. WS-R-3, IAEA, Vienna (2003).

— Safety Considerations in the Transition from Operation to Decommissioning of Nuclear Facilities, Safety Reports Series No. 36, IAEA, Vienna (2004).

INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR OFFICE, Occupational Radiation Protection, IAEA Safety Standards Series No. RS-G-1.1, IAEA, Vienna (1999).

INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR OFFICE, Assessment of Occupational Exposure due to Intakes of Radionuclides, IAEA Safety Standards Series No. RS-G-1.2, IAEA, Vienna (1999).

UNITED STATES DEPARTMENT OF ENERGY, The DOE Corporate Lessons Learned Program, Rep. DOE-STD-7501-99, USDOE, Washington, DC (1999).

Annex

SUPPORTING DOCUMENTS

Documents prepared separately but included or referenced in the decommissioning plan [A–1] are as follows:

Characterization survey plan;

Characterization survey report;

Safety assessment;

Cost estimate;

Financial assurance plan;

Environmental impact assessment;

Environmental protection plan;

Radiation protection programme;

Quality assurance plan;

Waste management plan;

Emergency plan;

Physical security plan;

Safe enclosure plan;

Site preparation plan;

Surveillance and maintenance plan;

Final survey plan;

Health and safety plan.

REFERENCE TO ANNEX

[A–1] INTERNATIONAL ATOMIC ENERGY AGENCY, Predisposal Management of Radioactive Waste, Including Decommissioning, IAEA Safety Standards Series, No. WS-R-2, IAEA, Vienna (2000).

CONTRIBUTORS TO DRAFTING AND REVIEW

Boing, L.E.	Argonne National Laboratory, United States of America
Draper, D.	Shaw Group, United States of America
Hazley, G.	RWE NUKEM, United Kingdom
Helbrecht, R.	Private consultant, Canada
Laraia, M.	International Atomic Energy Agency
Lauridsen, K.	Danish Decommissioning, Denmark
Reisenweaver, D.	International Atomic Energy Agency
Sterner, H.	Energiewerke Nord GmbH, Germany

The purpose of this report is to provide practical information on the type of safety related documents that need to be prepared to support the decommissioning process and on the contents of these documents. The scope of this report includes all types of nuclear facilities, ranging from nuclear power plants and reprocessing facilities to university laboratories and manufacturing plants. It will be of interest to decommissioning engineers, project managers and operations managers.

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA
ISBN 92–0–113204–2
ISSN 1020–6450