The IAEA approach for the safe management of non-nuclear radioactive waste

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Content

• Non-nuclear waste:
  – Waste and sealed or unsealed radioactive sources from nuclear application
  – Waste from the decommissioning of such facilities
  – NORM waste (not covered by this presentation)

• NNW management

• Overview of relevant IAEA publication applicable to the safe management of non-nuclear waste
  – Safety Standards
  – Technical Series

• Other International Instruments and Standards

• Conclusions
Nuclear Applications

Medical applications
• In vitro radioassay
• In vivo use of radiopharmaceuticals
• Radiotherapy using sealed radioactive sources for brachytherapy or teletherapy
• Etc.

Application in research and education
• Calibration
• Development of radiolabelled compounds
• Study of metabolic, toxicological or environmental pathways
• Clinical processes and applications
• Basic research (physics, chemistry, engineering)
• Etc.

Industrial, agricultural and other applications
• Production and labelling of compounds
• Manufacture of radioactive sealed sources
• Use of radioactive material for scientific measurement/calibration
• Oil exploration and well logging
• Process and plant control
• Non-destructive testing and QC
• Water treatment
• Sterilization
• Food irradiation, etc.

Consumer products
• Smoke detectors
• Luminous devices
• Lightening rods
• Etc.
Categories of waste from nuclear applications

Solid waste can include:
- spent or disused sealed sources
- contaminated equipment, glassware, gloves and paper
- animal carcasses, excreta and other biological waste

Liquid waste can include:
- aqueous solutions and organic solutions resulting from research and production processes
- excreta
- liquids from the decontamination of laboratory equipment or facilities; and liquids from activity measurement systems (such as scintillation counting)

Gaseous waste is generated at a number of facilities from the production and radiolabeling of chemical compounds and organisms and from the treatment of solid and liquid waste.

The waste may contain radionuclides that are differentiated by activity (alpha, beta–gamma and neutron emitters) and half-life, and may further be differentiated by the physical, mechanical, chemical and biological properties of the waste matrix.
IAEA activities – Disused Sealed Radioactive Sources

Radioactive sources are used worldwide in medicine, industry and research. Once they fall out of use, the risk of them being unprotected or abandoned increases.

The IAEA’s Safety Standards provide the international requirements to control disused sources and helps Member States implement technologies to recover, condition, store and dispose them.
# Categorization of radioactive sources

## Categorization of radioactive sources used in common practices

<table>
<thead>
<tr>
<th>Category</th>
<th>Practice</th>
<th>Activity ratio A/D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RTG’s; Irradiators; Teletherapy; Gamma Knife</td>
<td>A/D ≥ 1000</td>
</tr>
<tr>
<td>2</td>
<td>Gamma radiography Brachytherapy (HDR/MDR)</td>
<td>1000 &gt; A/D ≥ 10</td>
</tr>
<tr>
<td>3</td>
<td>Fixed industrial gauges (High-activity sources) Well logging</td>
<td>10 &gt; A/D ≥ 1</td>
</tr>
<tr>
<td>4</td>
<td>Brachytherapy (LDR except eye plaques &amp; permanent implants) Gauges (not high activity); Static eliminators; Bone densitometers</td>
<td>1 &gt; A/D ≥ 0.01</td>
</tr>
<tr>
<td>5</td>
<td>Brachytherapy (eye plaques &amp; perm implants); XRF; ECD</td>
<td>0.01 ≥ A/D ≥ Exempt/D</td>
</tr>
</tbody>
</table>

### Increasing risk
The aim of non-nuclear radioactive waste management is to minimize waste generation and to produce a waste form that conforms to the requirements for subsequent handling, processing, transport and storage and meets the acceptance requirements for disposal.

The waste management option selected may also result in a waste or material that is suitable for return to a manufacturer or supplier of radioactive material, to be recycled, for authorized discharge as liquid or gas to the environment, or for removal from regulatory control.

In many instances no disposal facilities are available for non nuclear waste and storage may be necessary for considerable periods of time before disposal facilities become available.

Disposal of non-nuclear waste is the final step in their management.
The Basic Steps in RWM

Waste Characterisation (physical, chemical and radiological properties)

Pre-treatment (collection, segregation, chemical adjustment, decontamination)

Treatment (volume reduction, radionuclide removal, change in composition)

Conditioning (immobilisation, packaging)

Exempt waste and materials

Radioactive material for reuse or recycling

Storage

Disposal
IAEA Safety Standards - Predisposal

Predisposal Management of Radioactive Waste from the Use of Radioactive Material in Medicine, Industry, Agriculture, Research and Education

Draft Safety Guide
DS 454

will be replaced soon by DS 454 in publication process
1. INTRODUCTION

2. PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

3. ROLES AND RESPONSIBILITIES

4. STEPS IN THE PREDISPOSAL MANAGEMENT OF RADIOACTIVE WASTE

- Radioactive waste management and control, including minimization
- Characterization and classification of radioactive waste
- Processing of radioactive waste
  - Pretreatment
  - Treatment
  - Conditioning
  - Discharge of radioactive material to the environment
  - Clearance of material from regulatory control
  - Disused sealed radioactive sources
  - Orphan sources
  - Generation of radioactive waste from accidents
  - On-Site Handling
  - Off-Site Transport

- Storage of radioactive waste
  - Storage prior to discharge or removal of regulatory control
  - Storage prior to processing
  - Storage of radioactive waste prior to disposal

- Radioactive waste acceptance criteria
• 5. SAFETY CASE AND SAFETY ASSESSMENT

• 6. DEVELOPMENT AND OPERATION OF PREDISPOSAL RADIOACTIVE WASTE MANAGEMENT FACILITIES AND ACTIVITIES
  – LOCATION AND DESIGN OF FACILITIES
  – CONSTRUCTION AND COMMISSIONING OF THE FACILITIES
  – FACILITY OPERATION
  – SHUTDOWN AND DECOMMISSIONING OF FACILITIES
  – EXISTING FACILITIES

• 7. MANAGEMENT SYSTEMS
  – RECORD KEEPING AND REPORTING
  – SAFETY CULTURE
In facilities in which only small amounts of waste are generated, there may be limited knowledge among the staff about the safety of radioactive waste management.

The safety culture in the organization may not be particularly focused on radioactive waste management because of this limited knowledge and/or because insufficient importance is given to safety by senior management in the organization.
The government is responsible for establishing a national policy and corresponding strategies for the management of radioactive waste. The policy and strategy, and the legal framework, should cover all types and volumes of radioactive waste generated in the State, all waste processing and storage facilities located in the State, and waste imported or exported from it, with due account taken of the interdependences between the various stages of radioactive waste management, the time periods involved and the waste management options available.

In order to facilitate the establishment of a national policy and strategy, the government should establish a national inventory of the radioactive waste (both current waste and anticipated waste, including waste generated during the decommissioning and dismantling of facilities) and should update it at regular time intervals.
The safety case is of particular importance and benefits for large predisposal waste management facilities, such as centralized facilities for the processing and storage of radioactive waste in States that have a nuclear power program.

For smaller scale facilities, such as storage facilities for disused sealed sources, the components of the safety case are still relevant; however the level of detail and the complexity and depth of the safety assessment are required to be commensurate with the potential hazard (Graded Approach)
Biological Waste Management

1. Generation of biological radioactive waste
   - Waste minimization
   - Yes
   - Does the waste contain infectious matter?
     - No
     - Storage and decay
     - Yes
     - Are the clearance levels met?
       - No
       - Secondary waste
       - Treatment
       - Conditioning
       - Interim storage
       - Disposal in a repository
       - Disposal as non-radioactive waste
     - Yes
     - Is waste suitable for clearance?
       - Yes
       - Are the clearance levels met?
         - No
         - Secondary waste
         - Treatment
         - Conditioning
         - Interim storage
         - Disposal in a repository
         - Disposal as non-radioactive waste
       - Yes
Highlights from TRS No. 402

- The overall waste management scheme should be properly planned to consider collection and segregation of wastes, their volume reduction and appropriate conditioning into a form suitable for future handling, transportation, storage and disposal (interdependencies).

- The different waste types should be properly segregated during waste collection. Organic liquids should not be mixed with aqueous liquids, since this complicates further treatment for both.

- Suitable records should be maintained identifying the type of waste in each container, the radioisotopes present and their activity levels.

- If the processing facility is off-site it is preferable that the liquid waste be collected and stored in containers suitable for transport.

- Compliance with a QA program provides confidence that the objectives of waste management are being met.
Other International Instruments and Standards

The Joint Convention

INFORMATION CIRCULAR

International Atomic Energy Agency

INF CIRC/586
24 December 1997

GENERAL Dis.
Original: ARABIC, CHINESE, ENGLISH, FRENCH, RUSSIAN and SPANISH

JOINT CONVENTION ON THE SAFETY OF SPENT FUEL MANAGEMENT AND ON THE SAFETY OF RADIOACTIVE WASTE MANAGEMENT

Latest Status

1. The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management was adopted on 5 September 1997 by a Diplomatic Conference convened by the International Atomic Energy Agency at its headquarters from 1 to 5 September 1997. The Joint Convention was opened for signature at Vienna on 23 September 1997 during the forty-first session of the General Conference of the International Atomic Energy Agency and will remain open for signature until its entry into force.

2. Pursuant to article 40, the Joint Convention will enter into force on the ninetieth day after the date of deposit with the Depositary of the twenty-fifth instrument of ratification, acceptance or approval, including the instruments of fifteen States each having an operational nuclear power plant.

3. The text of the Convention, as adopted, is attached hereto for the information of Member States.
First legally binding agreement between Contracting Parties

Objectives of the JC:

- To achieve and maintain a high degree of safety worldwide in spent fuel and radioactive waste management,

- To ensure that there are effective defences against potential hazards so that individuals, society and the environment are protected now and in the future

- To prevent accidents and mitigate their consequences should they occur
Scope of Application

Includes

– Waste and spent fuel from the operation of nuclear reactors

– Waste from use of radionuclides in medicine and industry

– Spent sealed sources

– Discharges from regulated nuclear facilities

– Waste from mining and processing of uranium
Code of Conduct and Import / Export Guidance

• Set of Principles, Objectives and Guidance to ensure Safety and Security of sources

• Focuses on high activity sources (categorization safety guide RS-G 1.9)

• Approved by the Board and the General Conference in 2003 & 2011
Code Objectives

1. to achieve and maintain a high level of safety and security

2. to prevent loss of control & malicious use

3. to mitigate or minimize the radiological consequences of any accident or malicious act

Achieved through a system of regulatory control of radioactive sources, from the stage of initial production to their disposal
States should:

- Ensure safety and security of RS at the end of their useful lives
- Encourage reuse or recycling of RS
- Emphasize to … those managing DS their responsibilities for the safety and security of RS
- Ensure that the RB can attach conditions concerning DS regarding the return of DS to a supplier.
- Ensure that, where DS are stored for extended periods of time, the facilities in which they are stored are fit for that purpose.
- Ensure that arrangements, including financial arrangements, are made for the safe management and secure protection of DS
- Appropriate records of the transfer and disposal of the RS
- Allow for re-entry into its territory of DS destined for authorized manufacturers if such transfer allowed by national law
Conclusions

• The applications and characteristics of radionuclides used in medicine, industry and research are extremely diverse. Sources and the waste itself must be fully characterized in radiological, chemical, biological and physical terms as a precursor to effective waste management.

• Most radionuclides used in nuclear applications, and especially those used in medicine for diagnostic purposes, have relatively short half-lives (i.e. a few hours to a couple of months). Therefore full use of on-site decay methods should be utilized to allow disposal of waste as non-radioactive refuse after a suitable period of storage.

• Minimization of waste arising and adequate management of waste should be the primary focus of any waste management program.

• A national radioactive waste management infrastructure and regulatory framework is an important part of any radioactive waste management system.

• When developing a waste management strategy, consideration should be given to the entire sequence of waste management operations from the waste’s production to its disposal, and all related issues, including the various regulatory, sociopolitical and economic issues.
Thank you!
(a) Clearance from regulatory control (unrestricted disposal of waste, unrestricted reuse of useful materials);

(b) Authorized release (discharge to the environment of waste, authorised reuse of useful materials);

(c) Regulated disposal of waste, regulated transfer of useful materials.

Radioactive Materials Routing

Clearance (treat as normal refuse, effluent)

Authorised discharge (no further use foreseen)

Waste (can be used or recycled)

Useful materials

Clearance (unrestricted use, recycle)

Authorised use

Regulated disposal (to a dedicated repository)

Regulated transfer (to another practice)
(Many) safe & secure disposal solutions exist and/or have been extensively studied – for all classes of RW.

Adequate disposal solutions must provide for required long-term safety, through isolation & containment of RW.