Establishing Reference Levels in Remediation of Legacy Sites

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Outline

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• Reference levels for existing exposure situations
• How to establish acceptable criteria for remediation
• Exposure scenarios for dose calculations
• Stakeholder participation
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Historical Uranium production

• Globally, the distribution of uranium ore deposits is widespread on all continents with the largest deposits found in Australia, Kazakhstan and Canada.

• The top five producers during the period 1946-1992 period were the USA, Canada, East Germany, South Africa and former Czechoslovakia.

• Many of these uranium operations were closed in the 1980’s and 1990’s resulting in numerous legacy uranium mine sites that require remediation.
Introduction

Definition of a legacy site

“A former uranium mining/processing site developed without appropriate regulatory oversight for which the party or parties responsible cannot be found, or are financially unable to carry out the required management, remediation or mitigation measures within an acceptable time frame.”
Introduction

Legacy sites – Sources of risk

Legacy sites generally pose three types of on-site risk, which are in some ways associated with each other:

1. Radiological risks from radioactive materials at or near the surface, or accessible through mine openings

2. Physical risks such as openings, derelict buildings, contaminated debris, unstable ground

3. Chemical risks which may contaminate surface and/or ground water

This presentation focuses on the radiological risks of legacy sites.
Introduction

Legacy sites – Sources of risk

Legacy sites may also pose *off-site* radiological (and conventional) risks if contaminants can migrate from the site. These will be similar to the on-site risks.

All risks associated with the site should be identified and reduced or eliminated.
Introduction

Legacy sites – Sources of risk

Sources of exposure at or near the surface:

- Uranium ore
- Uranium ore tailings
- Waste rock
- Core samples and cuttings from exploration
- Refined U (yellowcake)
- Aqueous concentrates
- Radon gas
- Contaminated equipment, building material, soil, water, plants
# Reference levels for existing exposure situations

<table>
<thead>
<tr>
<th>Type of situation</th>
<th>Occupational</th>
<th>Public</th>
</tr>
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<tbody>
<tr>
<td>Planned exposure</td>
<td>Dose limit</td>
<td>Dose limit</td>
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<tr>
<td></td>
<td>Dose constraint</td>
<td>Dose constraint</td>
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<tr>
<td>Existing exposure</td>
<td>Reference level</td>
<td>Reference level</td>
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Reference levels for existing exposure situations

• Used for optimization of protection and safety in existing exposure situations;

• Serves as a boundary condition in defining the range of options for the purposes of optimization in implementing protective actions

• Represents the level of dose or the level of risk above which it is judged to be inappropriate to plan to allow exposures to occur, and below which the optimization of protection and safety is implemented
Reference levels for existing exposure situations

BSS Requirement 47: Responsibilities of the government specific to existing exposure situations:

“The government shall ensure that existing exposure situations that have been identified are evaluated to determine which occupational exposures and public exposures are of concern from the point of view of radiation protection”

§ 5.2: “The government shall ensure that, when an existing exposure situation is identified, responsibilities for protection and safety are assigned and appropriate reference levels are established”
Reference levels for existing exposure situations

BSS Requirement 47: Responsibilities of the government specific to existing exposure situations:

So reference levels are:

- Specified by the relevant authority
- For legacy sites normally in the range 1—20 mSv/y, or other corresponding quantity, the actual value depending on the feasibility of controlling the situation and on experience in managing similar situations in the past (BSS § 5.8)

The challenge in the implementation of the BSS is how to determine the actual value
How to establish acceptable criteria for remediation

BSS Requirement 48: Justification for protective actions and optimization of protection and safety:

“The government and the regulatory body or other relevant authority shall ensure that remedial actions and protective actions are justified and that protection and safety is optimized.”

This means that the government shall:

• Establish a programme to identify existing exposure situations and to determine which exposures are of concern for radiation protection.

• Establish a strategy for controlling those existing exposure situations of concern for radiation protection.
How to establish acceptable criteria for remediation

Strategy requirements

• The nature and extent of remedial or protective actions shall be commensurate with the risks associated with the existing exposure
• The remedial or protective actions shall be justified in the sense that they do more good than harm
  • i.e. the actions yield sufficient benefit to outweigh the radiation risks and other detriments associated with taking them
How to establish acceptable criteria for remediation

Strategy requirements

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• The remedial or protective actions shall be justified in the sense that they do more good than harm
  • i.e. the actions yield sufficient benefit to outweigh the radiation risks and other detriments associated with taking them

• The form, scale and duration of the remedial or protective actions shall be optimized so as to produce the maximum net benefit
  • understood in a broad sense, under the prevailing social and economic circumstance
How to establish acceptable criteria for remediation

Strategy requirements

• The goal of the remedial actions shall be the **timely and progressive reduction of the hazard** and eventually, if possible, the **removal without restrictions of regulatory control** from the area

• In cases where the removal of control cannot practicably be achieved, at least the unacceptable risks to human health and the environment shall be removed and any restrictions on access to or use of the area and any other restrictions shall be established on the basis of an optimization process
How to establish acceptable criteria for remediation

Strategy requirements

• The remediation shall be justified by means of a decision aiding process requiring a positive balance of all relevant attributes relating to the contamination

• In addition to the avertable annual doses, both individual and collective, other relevant attributes shall be assessed
  • Health detriments
  • Expected reduction in anxiety caused by the situation
  • Benefits, social costs, disruption and environmental effects
How to establish acceptable criteria for remediation

Strategy requirements

- The optimum nature, scale and duration of the remedial actions shall be selected from a set of justified options for remediation.

- In some cases, the need for protective action in the form of restricted use of human habitats may be the outcome of the optimization process for remediation.

- The results of such a decision aiding process for justification and optimization shall be used as an input to a decision making process which may encompass other considerations (such as residual doses).
How to establish acceptable criteria for remediation

The decision making process

To be effective the decision making process must fulfil the following basic criteria:

- Be an approved process agreed by government
- Be organised and documented
- Be logical and realistic
- Be transparent
- Take account of the views of all stakeholders
- Take account of all factors affecting the decision making process
- Give balanced consideration to all possible options for action
- Provide unambiguous advice
How to establish acceptable criteria for remediation

Prioritization of legacy sites

• To implement the requirement for a national remediation strategy, legacy sites should be prioritized in accordance with the level of risk to human health and the environment.

• An inventory of contaminated areas should be prepared, which would include their locations, the types and properties of the contaminants, the size and environmental characteristics of the areas, the populations actually or potentially exposed and any other relevant factors.
Prioritization of legacy sites

Other factors may also have a strong influence in determining the priorities for remediation, such as:

- Socioeconomic impacts
- Availability of funds
- Availability of remediation techniques
- Availability of scientific data
- Potential effects on neighbouring states
Prioritization of legacy sites

- To assist in determining priorities, the regulatory body should use reference levels on the basis of an a priori assessment of situations that could occur.

- The priorities may also be established by comparison with other similar areas where exposures or activity concentrations are considered to be acceptable.
Exposure scenarios for dose calculations

Pathways from radioactive contaminants to the public

• Where members of the public have access to a legacy site, exposures inside the site can arise directly from the residues.

• Exposure of the public outside the legacy site may be caused by the spread of radioactive materials into the surrounding environment by wind and water erosion and dispersion.

• Additional pathways of public exposure include the construction of dwellings on or near to tailings heaps and the use of legacy residues and wastes in roads and buildings.

• As a result, elevated levels of these radionuclides can occur in local water supplies, soils and the food chain resulting in additional exposure of the public above the prevailing local natural background levels.
Exposure scenarios for dose calculations

Dose calculations

• A key parameter in any decision making process for selecting the appropriate remedial actions is the distribution of individual doses to the population affected by the radioactive residues in the area
  • Part of an Environmental Impact Assessment

• The ingestion of contaminated foodstuffs or the inhalation of contaminated dust is often a major exposure pathway

• In such cases the doses should be estimated on the basis of model calculations, with input from a radiological monitoring programme and with realistic scenarios and parameter values
Exposure scenarios for dose calculations

Overview of the main pathways of exposure
Exposure scenarios for dose calculations

Interconnection of pathways

Contaminant source → Atmosphere → Soil → Terrestrial Plants → Terrestrial Animals → Aquatic Plants → Aquatic Animals → Sediment → Surface water → Groundwater → Atmosphere → Dose to Humans
Exposure scenarios for dose calculations

Exposure Scenarios - Examples

• Building dwellings on contaminated land or residue dumps

• Use of residues in building materials

• Use of contaminated ground and surface waters

• Contaminated foodstuffs

• Inhalation of dust

• Soil ingestion (children)
Stakeholder participation

Why is it important?

- Decisions about legacy sites will in most instances affect the people around the site.
- Many people will be concerned about the effects of the legacy site on their health or on the surrounding environment.
- These concerns are often accentuated because of a lack of communication between the site operator and the general public and the publics fear about radioactivity.
- In most countries around the world it is nowadays necessary to engage with citizens and other interested parties about potential radiological hazards.
- Undertaking stakeholder engagement can in many instances assist environmental remediation projects.
Stakeholder participation

How do we define stakeholders?

• A group or individual with an **interest** in or a **role** to play in a project, or a decision making process.

• Why may stakeholders be interested in legacy sites?
  • They may be potentially affected by a decision whether or not to remediate
  • Decisions always result in a trade off of positive and negative issues
  • They may have a view on the outcome of a decision
  • They may wish to see funds spent elsewhere
Stakeholder participation

What is stakeholder engagement?

- The process of informing and involving individuals and organizations that may be affected by decisions being made for a site or project.
Stakeholder participation

What factors may drive the actual decisions you make?

- Available funding
- Technical capability
- **Stakeholders views**
- Regulations
- Availability of waste routes
- Benefits to the region like employment, compensation and improved infrastructure
- Overall reduction in environmental or human health risk
  - **Risk communication**
Stakeholder participation

Stakeholder categories

• Political and economic
  • Government, customers, local community, funding organisations, native populations

• Environmental
  • Environmental regulators, local community, NGO’s

• Social
  • Workforce, local suppliers, local community, native populations

• Technical
  • Nuclear regulator, Operators, R&D institutions, Universities
Stakeholder participation

Benefits

- Allows the development of solutions which have gained community support
- Provides greater transparency to projects
- Can help build trust
- Can assist with the process of risk communication
- Can re-establish effective communication in instances where problems have arisen and trust has been lost
- Can help achieve regulatory support in instances where engagement is expected
Stakeholder participation

Mechanisms

• Public meetings, workshops and “Open House” policy
• Site visits
• Internet based meetings
• Newsletters
• Technical forums and training sessions
• Project information centres
• Opinion surveys
• Focus groups and citizen advisory boards
• Community liaison groups
Sharing experience

- Many countries are struggling to deal properly with legacy sites
- Many countries have also a lack of resources
- In many cases remediation projects are excessively expensive and do not lead to optimal solutions
- IAEA is developing guiding materials in order to help implementing the requirements of the BSS
- Sharing experiences is an important means to avoid pitfalls and to prevent mistakes
- An international data base of successful remediation projects would be helpful in this respect
Sharing experience

IAEA guiding material

- Characterization of radioactively contaminated sites for remediation purposes. TECDOC-1017. IAEA, Vienna (1998)
- Factors for formulating a strategy for environmental restoration activities. TECDOC-1032. IAEA, Vienna (1998)
- Environmental Restoration Activities. TECDOC-1148. IAEA, Vienna (2000)
Sharing experience

IAEA drafts

- Cleanup of Areas Contaminated by Past Activities and Accidents. IAEA Draft Standard DS172
- Release of Sites from Regulatory Control upon Termination of Practice. IAEA Draft Standard DS332
- Remediation Process for Contamination Due to Past Activities and Accidents. IAEA Draft Standard DS468
- Decision Making Process for Remediation Activities at Sites Contaminated with NORM Residues. IAEA Draft Document DD792
Sharing experience

IAEA training material

• Draft Doc: Project B.1: Practical Techniques for Reducing Doses Received by Members of the Public at Legacy Sites Associated with the Mining and Processing of Uranium Ore. IAEA, Vienna (2015)
  • Includes case studies from Canada, China, Germany, Mozambique, South Africa, Australia, USA, Zambia
  • First course organized in Centurion, South Africa, June 2015

  • Includes annex on an example of regulatory criteria for remediation of contaminated areas and structures; an annex on an example of regulatory guidance for restoration of groundwater quality at in situ leach operations; and an annex on an example of regulatory requirements for disposal of tailings and other waste
  • First course organized in Lilongwe, Malawi, September 2015
Summary

- Many countries have legacy sites, giving rise to exposure of the public and environmental contamination.
- The BSS requires that an inventory of such sites must be made, and prioritized according to radiological concern.
- The regulatory body shall set reference levels representing the dose above which it is judged to be inappropriate to allow exposures to occur.
- The challenge in the implementation of the BSS is how to determine the actual value of the reference level.
- A remediation strategy is necessary to establish remediation criteria, which is followed by a formal process to come to the ultimate remediation decision – this includes dose and environmental impact assessments, development of remediation plans, and stakeholder participation.
- The IAEA has developed guiding material and organizes training courses to help Member States in this process.
- An international data base of successful remediation projects would be helpful in this respect.
Thank you for your attention