Lecture 2
IAEA Publications of Relevance to Uranium Mining and Processing
Overview

• IAEA Statute and Mandate.

• Definitions (NORM, Residue and Waste).

• Hierarchy of IAEA guidance and documentation.

• Publications applicable to uranium mines.

• IAEA Glossary.
Overview

There are two types of documents of relevance to uranium operations:

• High Level: The Safety Fundamentals, Basic Safety Standards and supporting documents (Safety Requirements and Safety Guides)- provide rather generic advice in most cases.

• Lower Level: Technical Documents and Reports which provide more practical advice.
The IAEA Statute

Functions – peaceful uses of atomic energy

- Promote research, development, practical application
- Exchange of scientific and technical information
- Exchange and training of scientists and experts
- Establish and administer safeguards
- Establish facilities, plant and equipment

*Develop safety standards and provide for their application*
The Agency is authorized

- To establish or adopt,

  in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned,

  standards of safety for protection of health and minimization of danger to life and property

  ........... and to provide for the application of these standards

  (IAEA Statute 1956 as amended)
Co-sponsorship of Standards
NORM

Abbreviation for:

Naturally Occurring Radioactive Material

e.g. contains radionuclides of the Uranium and Thorium Decay Chains
$^{238}\text{U}$ decay chain

- **Uranium-238**
  - $\alpha$ 4.5 billion years
  - $\beta$ 1.2 minutes

- **Protactinium-234m**
  - $\beta$ 24 days

- **Thorium-234**
  - $\alpha$ 45.5 billion years

- **Thorium-230**
  - $\alpha$ 77,000 years

- **Radium-226**
  - $\alpha$ 1,600 years

- **Radon-222**
  - $\alpha$ 3.8 days

- **Polonium-218**
  - $\alpha$ 3.1 minutes

- **Bismuth-214m**
  - $\beta$ 20 minutes
  - $\beta$ 27 minutes

- **Lead-214*\text{m)**

- **Polonium-214**
  - $\alpha$ 160 microseconds

- **Bismuth-210**
  - $\beta$ 22 years

- **Lead-210**

- **Polonium-210**
  - $\alpha$ 140 days

**NOTES:**

The symbols $\alpha$ and $\beta$ indicate alpha and beta decay, and the times shown are half-lives.

An asterisk indicates that the isotope is also a significant gamma emitter.
$^{232}$Th decay chain

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Naturally Occurring Radioactive Material (NORM)

Definition of NORM in Safety Glossary (version 1.2):

Radioactive material containing no significant amounts of radionuclides other than naturally occurring radionuclides

Material designated in national law or by a regulatory body as being subject to regulatory control because of its radioactivity

TENORM:

• Not defined in the Safety Glossary
• It does not serve any useful purpose for radiation protection
• Its use is discouraged
NORM residues: Material that remains from a process and comprises or is contaminated by naturally occurring radioactive material (NORM). A NORM residue may or may not be waste.

NORM waste: Naturally occurring radioactive material (NORM) for which no further use is foreseen.
Standards Development Process

UNSCEAR
Data on sources and effects of radiation

ICRP
Recommendations for protection

IAEA + other intergovernmental bodies
Regulatory style Standards
Hierarchy of the Safety Standards

- Safety Fundamentals
  (Principles)

- Safety Requirements
  (“Shall” statements)

- Safety Guides
  (“Should” statements)

- Safety Reports

- TECDOCs

The Safety Standards

Supporting publications
Safety Fundamentals

• The fundamental safety objective is to protect people and the environment from harmful effects of ionizing radiation.

• The safety fundamental comprises a set of 10 principles
IAEA Safety Fundamentals – the 10 Principles

1. Operator is responsible for safety
2. Legal & governmental infrastructure, independent regulatory body
3. Justification, limitation of risk
4. ALARA
5. Protect all populations, incl. distant populations, future generations – includes waste minimization and reuse / recycling
6. Graded regulatory approach commensurate with risk
7. Regular safety assessment, apply lessons learned
8. Accident prevention
9. Emergency preparedness and response
10. Intervention must produce net benefit
Safety Fundamentals

IAEA Safety Standards
for protecting people and the environment

Fundamental Safety Principles

Jointly sponsored by

Safety Fundamentals
No. SF-1
Revised Basic Safety Standards
The Safety Standards

IAEA Safety Standards
for protecting people and the environment

Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards
INTERIM EDITION

General Safety Requirements Part 3
No. GSR Part 3 (Interim)

IAEA Safety Standards
for protecting people and the environment

Regulations for the Safe Transport of Radioactive Material
2009 Edition

Safety Requirements
No. TS-R-1

The “BSS”

The “Transport Regulations”
The International Safety Standards

• The IAEA Safety Standards reflect international consensus

• This consensus is necessary to promote a common approach for ensuring safety in work involving exposure to ionising radiation
The International Basic Safety Standards (BSS)

- Cosponsored by FAO, IAEA, ILO, OECD/NEA, PAHO, WHO
- General requirements for protection against exposures to both **natural** and **artificial** radionuclides
- Covers **practices** and **interventions**
- No specific requirements for NORM, but...
  - **Certain NORM activities** are considered to be practices to which the BSS apply (e.g. uranium, oil and gas).
Applicable to NORM:

These Regulations do not apply to:
(e) Natural material and ores containing naturally occurring radionuclides which are either in their natural state, or have only been processed for purposes other than for extraction of the radionuclides, and which are not intended to be processed for use of these radionuclides, provided the activity concentration of the material does not exceed 10 times the values specified in Table 2, or calculated in accordance with paras 403–407;
Transport Safety (TS) documents applicable to NORM

IAEA Safety Standards for protecting people and the environment

Regulations for the Safe Transport of Radioactive Material
2008 Edition

Safety Requirements
No. TS-R-1

IAEA Safety Standards for protecting people and the environment

Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material

Safety Guide
No. TS-G-1.1 (Rev. 1)

IAEA Safety Standards for protecting people and the environment

Radiation Protection Programmes for the Transport of Radioactive Material

Safety Guide
No. TS-G-1.3

IAEA Safety Standards for protecting people and the environment

The Management System for the Safe Transport of Radioactive Material

Safety Guide
No. TS-G-1.4

IAEA Safety Standards for protecting people and the environment

Compliance Assurance for the Safe Transport of Radioactive Material

Safety Guide
No. TS-G-1.5
Safety Requirements

IAEA SAFETY STANDARDS SERIES

Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety

REQUIREMENTS
No. GS-R-1

INTERNATIONAL ATOMIC ENERGY AGENCY VIENNA

IAEA SAFETY STANDARDS SERIES

Preparedness and Response for a Nuclear or Radiological Emergency

REQUIREMENTS
No. GS-R-2

JOINTLY SPONSORED BY FAO, IAEA, ILO, OECD/NEA, PAHO, OCHA, WHO

INTERNATIONAL ATOMIC ENERGY AGENCY VIENNA

IAEA Safety Standards for protecting people and the environment

The Management System for Facilities and Activities

Safety Requirements
No. GS-R-3

INTERNATIONAL ATOMIC ENERGY AGENCY
Safety Requirements

IAEA Safety Standards
for protecting people and the environment

Governmental, Legal and Regulatory Framework for Safety

General Safety Requirements Part 1
No. GSR Part 1

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SAFETY STANDARDS SERIES

Remediation of Areas Contaminated by Past Activities and Accidents

SAFETY REQUIREMENTS
No. WS-R-3

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International Atomic Energy Agency
Safety Requirements

IAEA Safety Standards
for protecting people and the environment

Safety Assessment for Facilities and Activities

General Safety Requirements Part 4
No. GSR Part 4

IAEA
International Atomic Energy Agency
Safety Guide RS-G-1.1
Occupational Protection

- Co-sponsored by IAEA & ILO
- Guidance for occupational exposure to both natural and artificial radionuclides
- Specific guidance for exemption of activities involving occupational exposure to NORM (following ICRP75)
  - criterion: 1–2 mSv per year
Safety Guide RS-G-1.6
Occupational Exposure: Mining & Minerals Processing

- Cosponsored by IAEA and ILO
- Specific to NORM industries
- Guidance on:
  - Regulatory approach
  - Dose calculation
  - Radiation protection programme
Safety Guide RS-G-1.7
Exclusion, Exemption, Clearance

- Applies to both natural and artificial radionuclides
- Activity concentrations in materials for defining the scope of regulatory control including clearance of materials
Safety Guide WS-G-1.2
Radioactive Waste Management: Mining & Minerals Processing

• Applies mainly to uranium mining and milling

• Currently being revised to apply more generally to NORM residues
Waste Classification

IAEA Safety Standards
for protecting people and the environment

Classification of Radioactive Waste

General Safety Guide
No. GSG-1
IAEA Safety Standards
for protecting people and the environment

The Management System for the Processing, Handling and Storage of Radioactive Waste

Safety Guide
No. GS-G-3.3

IAEA Safety Standards
for protecting people and the environment

Remediation Process for Areas Affected by Past Activities and Accidents

Safety Guide
No. WS-G-3.1
REGULATORY CONTROL OF RADIOACTIVE DISCHARGES TO THE ENVIRONMENT

SAFETY GUIDE

No. WS-G-2.3
Safety Reports on Exposure to Natural Sources

Assessing the Need for Radiation Protection Measures in Work Involving Minerals and Raw Materials
Safety Reports on Exposure to Natural Sources
Safety Reports on Exposure to Natural Sources

Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment

International Atomic Energy Agency, Vienna, 2001
Safety Reports on Exposure to Natural Sources

Radiation Protection against Radon in Workplaces other than Mines

Jointly sponsored by IAEA, ILO

International Atomic Energy Agency
Safety Reports on Exposure to Natural Sources

Safety Reports Series
No. 51

Radiation Protection and NORM Residue Management in the Zircon and Zirconia Industries

IAEA International Atomic Energy Agency
Safety Reports Series
No. 34

Radiation Protection and the Management of Radioactive Waste in the Oil and Gas Industry

IAEA
Safety Reports on Exposure to Natural Sources

Radiation Protection and NORM Residue Management in the Titanium Dioxide and Related Industries
Safety Series-Limiting Releases from Mines

The Application of the Principles for Limiting Releases of Radioactive Effluents in the Case of the Mining and Milling of Radioactive Ores

INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1989
Safety Reports *Under development:*

- Phosphate industry
- Industrial uses of thorium
Safety Reports on Exposure to Natural Sources
Safety Reports on Exposure to Natural Sources

Safety Reports Series
No. 67

Monitoring for Compliance with Exemption and Clearance Levels

IAEA
International Atomic Energy Agency
Safety Reports on Exposure to Natural Sources
Safety Reports on Exposure to Natural Sources

Optimization of
Radiation Protection
in the Control of
Occupational Exposure

International Atomic Energy Agency, Vienna, 2002
Safety Reports on Exposure to Natural Sources

Methods for Assessing Occupational Radiation Doses Due to Intakes of Radionuclides
Safety Reports

Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment

International Atomic Energy Agency, Vienna, 2001
Decommissioning Strategies for Facilities Using Radioactive Material
Calibration
Safety Reports on Exposure to Natural Sources
Safety Reports on Exposure to Natural Sources
TECDOCS and Reports

• Focus on practical issues.

• Provide many examples of case studies.

• Examples from many countries on their approach to common problems.

• A wealth of material on uranium mining.
Regulation
Regulatory and management approaches for the control of environmental residues containing naturally occurring radioactive material (NORM)

Proceedings of a technical meeting held in Vienna, 8–10 December 2004

January 2006
Impact of new environmental and safety regulations on uranium exploration, mining, milling and management of its waste

Proceedings of a Technical Committee meeting
held in Vienna, 14–17 September 1998
Impact of new environmental and safety regulations on uranium exploration, mining, milling and management of its waste

Proceedings of a Technical Committee meeting held in Vienna, 14–17 September 1998
IAEA-TECDOC-862

Guidebook on the development of regulations for uranium deposit development and production

INTERNATIONAL ATOMIC ENERGY AGENCY
IAEA-TECDOC-595

Guidebook on the development of projects for uranium mining and ore processing

INTERNATIONAL ATOMIC ENERGY AGENCY IAEA
Exposure of the Public from Large Deposits of Mineral Residues
The long term stabilization of uranium mill tailings

Final report of a co-ordinated research project 2000-2004

IAEA-TECDOC-1403

August 2004
Tailings Management (1992)
Tailings Management (1981)

Current Practices and Options for Confinement of Uranium Mill Tailings

TECHNICAL REPORTS SERIES No. 209

INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1981
Radon and Tailings (1992)

Measurement and Calculation of Radon Releases from Uranium Mill Tailings

INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1992
Guidebook on environmental impact assessment for in situ leach mining projects
Environmental impact assessment for uranium mine, mill and in situ leach projects
Recent developments in uranium exploration, production and environmental issues

Proceedings of a technical meeting organized by the IAEA in cooperation with the OECD Nuclear Energy Agency and DIAMO State Owned Enterprise held in Straz, Czech Republic, 6–8 September 2004
Uranium and the Environment (2002)
Factors for formulating strategies for environmental restoration
Guidebook on good practice in the management of uranium mining and mill operations and the preparation for their closure
Planning for environmental restoration of uranium mining and milling sites in central and eastern Europe

Proceedings of a workshop held under the Technical Co-operation Project RER/9/022 on Environmental Restoration in Central and Eastern Europe, Felix, Romania, 4–8 November 1996
Environmental Management (2010)

IAEA Nuclear Energy Series
No. NF-T-1.2

Best Practice in Environmental Management of Uranium Mining
Remediation-Planning (2009)
IAEA-TECDOC-1279

Non-technical factors impacting on
the decision making processes in
environmental remediation

Influences on the decision making process such as
cost, planned land use and public perception

INTERNATIONAL ATOMIC ENERGY AGENCY

IAEA

April 2002

83
Applicability of Monitored Natural Attenuation at Radioactively Contaminated Sites
Remediation (2004)
Soil sampling for environmental contaminants

IAEA-TECODC-1415

October 2004

International Atomic Energy Agency
Remediation (2003)
Site characterization techniques used in environmental restoration activities

Final report of a co-ordinated research project 1995–1999

INTERNATIONAL ATOMIC ENERGY AGENCY

IAEA

May 2000
Remediation (1999)

Technologies for remediation of radioactively contaminated sites

INTERNATIONAL ATOMIC ENERGY AGENCY

IAEA

June 1999
Remediation (1999)

Compliance monitoring for remediated sites
Characterization of radioactively contaminated sites for remediation purposes
Planning for environmental restoration of uranium mining and milling sites in central and eastern Europe

Proceedings of a workshop held under the Technical Co-operation Project RER/9/022 on Environmental Restoration in Central and Eastern Europe, Felix, Romania, 4–8 November 1996

INTERNATIONAL ATOMIC ENERGY AGENCY

November 1997
Guidebook on good practice in the management of uranium mining and mill operations and the preparation for their closure
Closure (1997)

Closeout of uranium mines and mills: A review of current practices
Planning and management of uranium mine and mill closures

Proceedings of a Technical Committee meeting held in Liberec, Czech Republic, 3-8 May 1994
Groundwater Remediation (1999)

Technical options for the remediation of contaminated groundwater
Effluent Treatment (2004)

Treatment of liquid effluent from uranium mines and mills

Report of a co-ordinated research project 1996-2000

October 2004
Technologies for the treatment of effluents from uranium mines, mills and tailings

Proceedings of a Technical Committee meeting held in Vienna, 1-4 November 1999

June 2002
Quantification of Radionuclide Transfer in Terrestrial and Freshwater Environments for Radiological Assessments
Contaminants in Water (1986)
Contaminants in Water (1984)
Sustainable Development (2009)
Stakeholders (2009)
NORM VII Symposium – 2013 April

7th International Symposium on Naturally Occurring Radioactive Material

First Announcement

Beijing, China
April 22-26, 2013

www.norm7.org
The IAEA glossary provides for:

- A consistent global understanding and harmonisation of terminology.
- Is particularly useful for regulators drafting new regulations.
Web Links

IAEA Publications
• http://www.iaea.org/Publications/index.html

Uranium Production Cycle
• http://www.iaea.org/OurWork/ST/NE/NEFW/nfcms_rawmaterials_publications.html

NORM
Summary

• IAEA produces Standards for Radiation Safety.

• Documentation is drawn up by consensus of Member States and experts as well as IAEA staff.

• There are a wide range of supporting publications.

• There are many publications specific to NORM.

• Almost all documents are freely available as pdf’s.
Thank You