From Fundamental Safety Principles to Operation Radiation Protection Programs

Konstantinos Karfopoulous
Mechanical Engineer, PhD
Environmental Radioactivity Monitoring Department
Greek Atomic Energy Commission, EEAE
konstantinos.karfopoulous@eeae.gr
Learning Objectives

• Insight into fundamental safety principles
• Review of the elements related to the design, development and implementation of a Radiation Protection Programme
• Reflection of the fundamental safety principles into the elements of the RPP
IAEA Mission-Safety and Security

To establish standards of safety

IAEA Functions in Radiation & Waste Safety (Article III.A.6)
Develop Safety Standards

Safety Fundamentals

Safety Requirements

Safety Guides

IAEA Safety Standards
protecting people and the environment

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IAEA Safety Standards

Safety Fundamentals

“The Ten Commandments”

I. Thou shalt have no other gods before me.
II. Thou shalt not make unto thee any graven image.
III. Thou shalt not take the name of the Lord thy God in vain.
IV. Remember the sabbath day, to keep it holy.
V. Honor thy father and thy mother.
VI. Thou shalt not commit adultery.
VII. Thou shalt not steal.
VIII. Thou shalt not bear false witness.
IX. Thou shalt not covet.
X. Thou shalt not covet.

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CONTRIBUTORS TO DRAFTING AND REVIEW
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Safety Fundamentals

Principle 1: Responsibility for safety
The prime responsibility for safety must rest with the person or organization responsible for facilities and activities that give rise to radiation risks.

Principle 2: Role of government
An effective legal and governmental framework for safety, including an independent regulatory body, must be established and sustained.

Principle 3: Leadership and management for safety
Effective leadership and management for safety must be established and sustained in organizations concerned with, and facilities and activities that give rise to, radiation risks
Safety Fundamentals

Principle 4: Justification of facilities and activities
Facilities and activities that give rise to radiation risks must yield an overall benefit.

Principle 5: Optimization of protection
Protection must be optimized to provide the highest level of safety that can reasonably be achieved.

Principle 6: Limitation of risks to individuals
Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm.

Principle 7: Protection of present and future generations
People and the environment, present and future, must be protected against radiation risks.
Safety Fundamentals

**Principle 8: Prevention of accidents**
All practical efforts must be made to **prevent and mitigate** nuclear or radiation accidents.

**Principle 9: Emergency preparedness and response**
Arrangements must be made for **emergency preparedness and response** for nuclear or radiation incidents.

**Principle 10: Protective actions to reduce existing or unregulated radiation risks**
Protective actions to reduce **existing or unregulated radiation risks** must be justified and optimized.
General Safety Requirements

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<td>Part 2. Leadership and Management for Safety</td>
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<td>Part 3. Radiation Protection and the Safety of Radiation Sources</td>
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<td>Part 6. Decommissioning and Termination of Activities</td>
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<td>Part 7. Emergency Preparedness and Response</td>
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Specific Safety Requirements

1. Site Evaluation for Nuclear Installations
2. Safety of Nuclear Power Plants
   2.1. Design and Construction
   2.2. Commissioning and Operation
3. Safety of Research Reactors
4. Safety of Nuclear Fuel Cycle Facilities
5. Safety of Radioactive Waste Disposal Facilities
6. Safe Transport of Radioactive Material

Collection of Safety Guides
IAEA Safety Standards
for protecting people and the environment

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

General Safety Requirements Part 3
No. GSR Part 3

IAEA
International Atomic Energy Agency

✓ 52 overarching requirements
✓ “Shall” statements
General Requirements for Protection and Safety (I)

• The requirements are grouped into:
  • Requirements applicable for all 3 exposure situations: Planned; Emergency; Existing
  • Separate sets of requirements for:

  **Planned**
  - Occupational Exposure
  - Public Exposure
  - Medical Exposure

  **Emergency**
  - Occupational Exposure
  - Public Exposure

  **Existing**
  - Occupational Exposure
  - Public Exposure

A situation of exposure that arises from the **planned operation** of a source or from a **planned activity** that results in an exposure due to a source.

A situation of exposure that arises as a result of an accident, a malicious act or any other unexpected event, and requires prompt action in order to avoid or to reduce adverse consequences.

An exposure situation that already exists when a decision on the need for control needs to be taken.
Management of radiation safety & safety culture

BSS Requirement 5: Management for protection and safety
The principal parties shall ensure that protection and safety are effectively integrated into the overall management system of the organizations for which they are responsible.

• Promoting safety culture.

BSS Requirement 6: Graded Approach
The application of the requirements of these Standards in planned exposure situations shall be commensurate with the characteristics of the practice or source within a practice and within the magnitude and likelihood of the exposures.

BSS Requirement 24: Arrangements under the RADIATION PROTECTION PROGRAMME
RPP – Main Components

Management System
The RPP should reference the management system of the organization and indicate how it integrates and complements it.

Roles & Responsibilities
The RPP should clarify roles and assign responsibilities for radiation protection to all the organizational groups as applicable.

Areas
A radiological area should be included, namely supervised and controlled area management and control.

Local Rules
for workers to follow and the supervision of work.

Monitoring
Radiological monitoring including personnel and workplace monitoring, as well as recording and reporting should be included.

E&T
The RPP should include education and training of occupationally exposed workers and other site users.

Health Surveillance
The health surveillance of occupationally exposed workers to be part of the RPP.
Radiation Protection Programme (RPP)

The purpose is to demonstrate management responsibility for protection, safety and optimization using

- management structures,
- policies,
- procedures and organizational arrangements

The RPP may include protection of both workers and the public

*Principle 7: Protection of present and future generations*
Radiation Protection Perspectives

• Radiation protection is **ONLY ONE** element in ensuring the **overall health and safety of workers**, the public, and protection environment.

• The RPP should be established **in close cooperation with those responsible for other areas of protection and safety** such industrial hygiene, industrial safety, fire safety, environmental protection etc.

• The RPP should consider **all radiation sources** including NORM
Radiation Protection Perspectives

The content of the RPP should be commensurate with **the nature and extent of the risks:**

- Most NORM operations involve only low risks
- There is no real prospect of a radiological emergency
It is essential to consider the effectiveness of other forms of regulation in minimizing radiological risk:

- Occupational Health Safety
- Environmental Protection Regulation
Control Measures

Hierarchy
1. Containment, ventilation, design for ease of decontamination and/or shielding
2. where (1) is not sufficient alone, consider administrative controls
3. Use when (1) and (2) are not sufficient to provide adequate protection

Control of exposure
1. Time
2. Distance
3. Shielding

Only required for high activity NORM
Control of exposure - gamma

• Facility design with respect to bulk material:
  • Distance (dedicated storage areas)
  • Shielding (walls, stockpiles of low activity material)
• Rules and working procedures
  • Exposure times
• Warning signs, physical barriers
• Training and awareness
Control of exposure - dust

• Complete containment of material in industrial facilities involving NORM is often impractical, especially where large quantities are involved.

• **Spills and spread of materials** to other areas are often **of no radiological significance** unless activity concentrations are high.

• **Workplace ventilation**
  (dust may already be controlled by OHS regulation for non-radiological reasons)
Control of exposure - Radon

• **Ventilation**
  In underground mines especially, this can be crucial

• **Occupancy time**
  Where there are practical limitations on the provision of adequate ventilation

• **Workplaces involving minerals with a high $^{232}\text{Th}$ content, e.g. monazite, attention may have to be given also to the control of thoron ($^{220}\text{Rn}$)
Personal Protective Equipment (PPE)

• Selection of PPE depends on the hazards involved in the work
  • Graded approach

• Employer should specify appropriate protective clothing in accordance with risk of internal and external exposure
  • Prime responsibility

• PPE should provide adequate protection and be comfortable and convenient to use
  • Optimization

• Training
Roles and Responsibilities / Qualified Experts (QEs)

Depending on the nature of the operation and the risks involved, the following expert services may be needed in a facility involving NORM:

• Radiation protection and dosimetry
• Ventilation engineer e.g. in underground mines and other facilities with high potential for dust and/or radon
• Occupational medicine (for health surveillance)
• Industrial hygiene and safety
• Environmental practitioner
Roles and Responsibilities / QEs and RPOs

• Radiation Protection Officer (RPO) to be appointed to oversee compliance with regulatory requirements in NORM workplace

• QE provides consultations in all aspects of radiation protection and, proposes professional solutions, has overall responsibility for safety

• QE and RPO to be provided with adequate equipment, resources and staff
Local Rules and Procedures

• Management required to establish **Local Rules**, to ensure protection and safety of workers

• Local Rules to **be made known to workers** and be prominently displayed or otherwise made available

• Local Rules **to be adequately supervised** and all workers to be given adequate training to enable them to comply with Local Rules and procedures
Local Rules and Procedures (2)

• Local rules and procedures must be developed and **tailored to the type of NORM facility involved**

*Example in underground mines and other workplaces where exposure to airborne dust and/or radon is of significant concern*

Special provisions may need to be made:

• Monitoring of dust and/or radon
• The maintenance of adequate quality/quantity of ventilation air
• The control of ventilation
• The provision of alternative means of ventilation if the normal ventilation system fails
Classification of areas

• Area classification should be considered when there is occupational exposure to radiation

• Prior radiological evaluation to identify areas in need of classification (by Whom?)

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<tr>
<th>Controlled Area (&gt; 6 mSv/y)</th>
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<td>A defined area in which specific protection measures and safety provisions are or could be required for <strong>controlling exposures</strong> or preventing the spread of contamination in normal working conditions; and <strong>preventing or limiting</strong> the extent of potential exposures.</td>
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<th>Supervised Area (&lt;1 mSv/y)</th>
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<td>A defined area not designated as a controlled area but for which occupational exposure conditions are kept <strong>under review</strong>; even though specific protection measures or safety provisions are <strong>not normally needed</strong>.</td>
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</table>
Classification of areas - NORM

The classification of areas and means of access control may require special consideration in some types of NORM facility.

Example - *It may be appropriate in some underground mines with high exposure potential (e.g. radon) to designate the entire underground area as a controlled area, rather than trying to distinguish between controlled and supervised areas.*
Monitoring

Monitoring is required where NORM is:
- Produced
- Transported
- Processed
- Disposed
- Handled
- Stored

Optimization of protection
- Principle 5

Compliance with dose limits
- Principle 6

Individual dose records
- Requirement 20: Requirements for monitoring and recording of occupational exposures

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Monitoring

3 types of monitoring are generally recognized, requiring different levels of expertise:

- **Routine monitoring**
  ✓ Continuing operations / Compliance with regulatory requirements

- **Task monitoring**
  ✓ Support immediate decisions / the optimization of protection

- **Special monitoring**
  • Investigate / Provide detailed information

**What to monitor:**
- Gamma
- Dust
- Radon
- Surface contamination

**What else:**
- Controls (e.g. ventilators)
- Interlocks
- Cleanup procedures
- PPE maintenance and use
- House keeping
Education and training

- The education and training programme should include topics specific to radiation protection in NORM industrial operations.
- Depending on the type of the facility, such topics might include:
  - The properties and health effects associated with:
    - Uranium, thorium, radium, etc.
    - U, Th series radionuclides in dust
    - Radon, thoron (where appropriate) and progeny
    - Measurement of airborne activity (dust, radon)
  - The functioning and purpose of the ventilation system, and its importance for radiation protection
  - The purpose of and methods for controlling and suppressing airborne dust
Worker’s Health surveillance

- The working and environmental conditions in many facilities involving NORM, especially mines, may be different from those in normal facilities involving radiation sources
  - occupational physician to periodically visit the workplaces concerned.
- May not be required for all industries
Audits and reviews

- The RPP should always be up-to-date and describe the current situation in the workplace.
- Audits and reviews should be performed using written procedures and check lists at appropriate intervals.
Key messages

• **RPP should be established and maintained** for facilities involving NORM
• The levels of detail should be **commensurate with the risk** (i.e.; a graded approach)
• The content of an RPP is based on components outlined in **GSR Part 3**
• RPP must be **regularly updated**, workers must know it
Thank you very much!

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