



IAEA

International Atomic Energy Agency

Occupational Radiation Protection – Principles/ Concepts/GSR Part 3 Requirements IAEA Standards and Guidance on NORM (GSG-7)

Content

- IAEA Occupational Radiation Protection Programme
- Safety Guide on Occupational Radiation Protection (GSG-7) (coverage on NORM)

Kilogram gets a new definition

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Science & Environment

Kilogram gets a new definition

By Pallab Ghosh
Science correspondent, BBC News

16 November 2018



There are now discrepancies between copies of the kilogram and the master version held in a French vault.

Scientists have changed the way the kilogram is defined.

Currently, it is defined by the weight of a platinum-based ingot called "Le Grand K" which is locked away in a safe in Paris.

On Friday, researchers meeting in Versailles voted to get rid of it in favour of defining a kilogram in terms of an electric current.

The decision was made at the General Conference on Weights and Measures.



SI

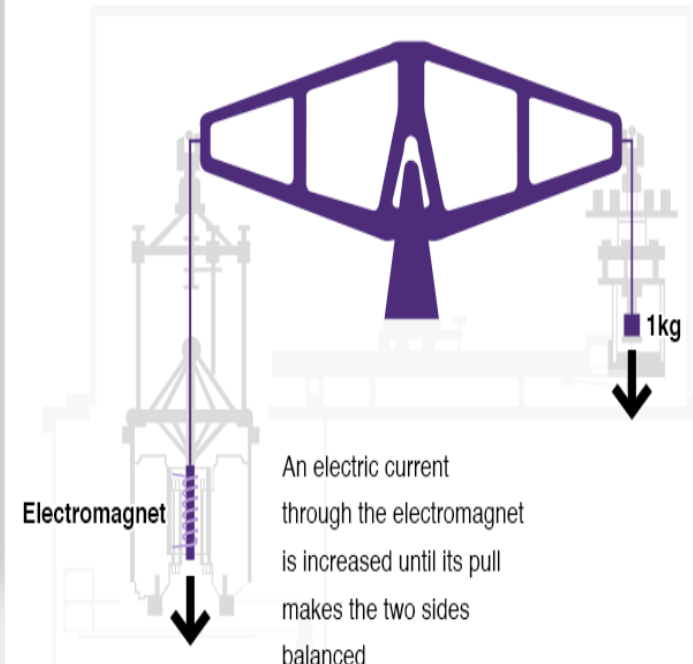
NPL @NPL

IT'S OFFICIAL – the science community has voted! All of the SI units will be defined by fundamental constants of nature as of 20 May 2019!
#SIredefinitionnpl.co.uk/news/internati...

891 1:22 PM - Nov 16, 2018

How an electromagnet can calculate the kilogram

Kibble Balance



Electromagnet

An electric current through the electromagnet is increased until its pull makes the two sides balanced

About a worker

- Any person who works, whether full time, part time or temporarily, for an employer and who has recognized rights and duties in relation to **occupational radiation protection** (*IAEA glossary, 2016*)
 - A self-employed person is regarded as having the duties of both an employer and a worker.
- Protection and safety is an integral part of a general occupational health and safety programme (*specific obligations and responsibilities*)
- The Board of Governors of the IAEA first approved health and safety measures in March 1960



Work environment



ORP in Member States



Regulator

**Protection
of workers**

**Technical
Services / TSO**

End-Users



- **Objective:** To promote an internationally harmonized approach to ORP through the development and application of standards for optimizing protection and safety, restricting exposures and applying current radiation protection techniques in the workplace

To ensure an appropriate control of occupational exposure due to external and internal irradiation from both artificial sources and natural sources of radiation

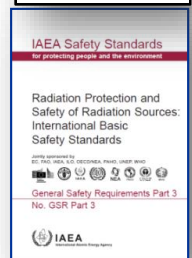
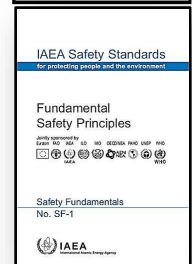
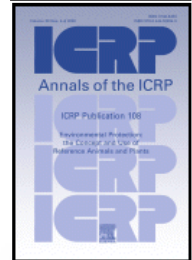
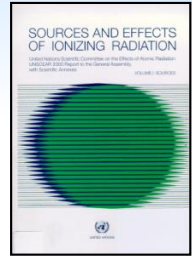
- This is achieved through provision of operational services for radiation monitoring and protection to the Agency's own operations; and through assistance to Member States in establishing, maintaining and, where necessary, improving programs for the radiation protection of workers.
- Activities are targeting workers, employers, regulatory authority staff and radiation protection professionals.

Strategic planning on ORP

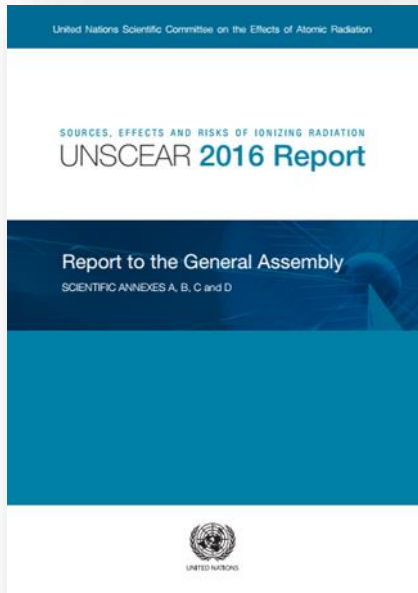
- Occupational radiation protection is one of the important milestones for radiation safety.
- ORP related Safety Standards benefits from decades of research and developments.
- Rapid development in the application of radiation technology in the MSs led to the strong needs on ORP in terms of guidance, training and different kinds of services.
- Based on GSR Part 1 & 3, Safety Guide on Occupational Radiation Protection (GSG-7) and Safety Reports specific to industry sectors have been developed or under preparation.
- So that today, so that tomorrow, ORP is and shall remain a strategic move (*planning & implementation*) for safe and secure operation.

Occupational Exposure

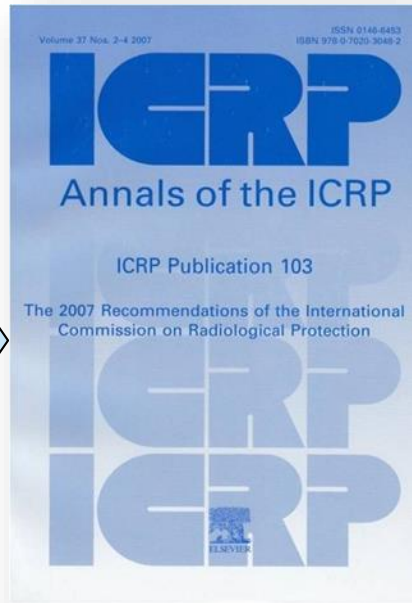
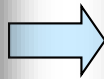
- All exposure of workers incurred in the course of their work (Glossary & GSR Part 3)
- Workers are exposed to ionizing radiation in a wide range of occupational settings (artificial & natural)
- Area with multiple actors (global / national level)
 - Requirements for protection of workers (IAEA - ILO)
 - Ministries, regulators, OHS, etc.
- Guidance to national level implementation (support to Member States)
- **Safety Standards** - To protect occupationally exposed workers against the risks associated with ionizing radiations - Overall objective
- ORP, which is getting more industry characteristics, is resolving itself in favour of personalized, highly efficient and reliable methods and approaches.



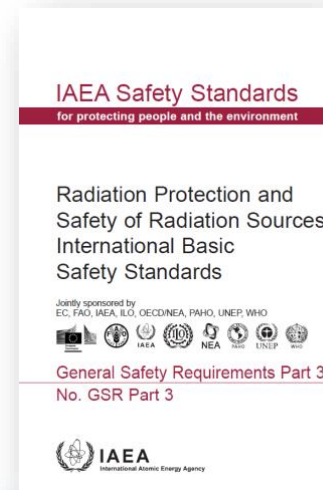
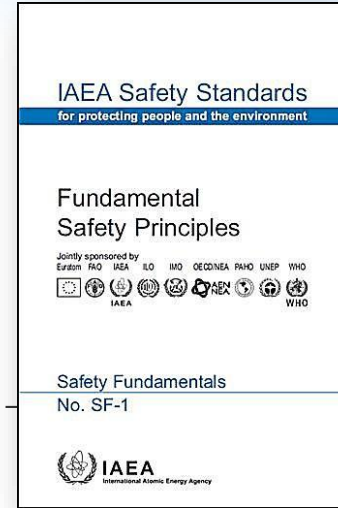
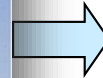
International Framework



Effects of radiation



Recommendations for protection



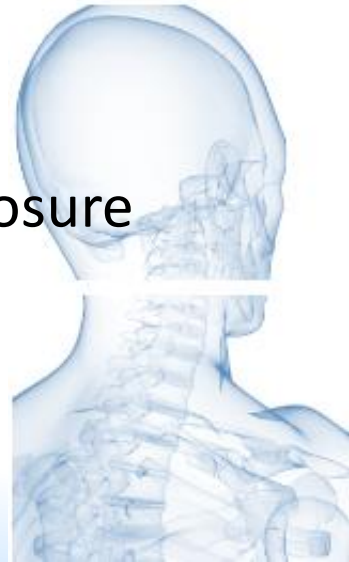
Essential principles
(moral obligation)

Essential requirements
(legal obligation)

Current System of Radiological Protection – three principles

The system follows three principles

- ✓ Justification
(all exposure situations)
- ✓ Optimization of protection with dose constraints
(all exposure situations)
- ✓ Dose limitation (planned exposure situations except for patients)



Current System of Radiological Protection – three principles

- The principles are applied in three exposure situations

Planned



Emergency



Existing



Current System of Radiological Protection – three principles

...and in three categories of exposure

Occupational



Public



Medical



Exposure situations and categories of exposure

Types of exposure situations

Planned exposure situation



Emergency exposure situation



Existing exposure situation



= situations involving the planned introduction and operation of sources *(including decommissioning, disposal of radioactive waste, rehabilitation)*

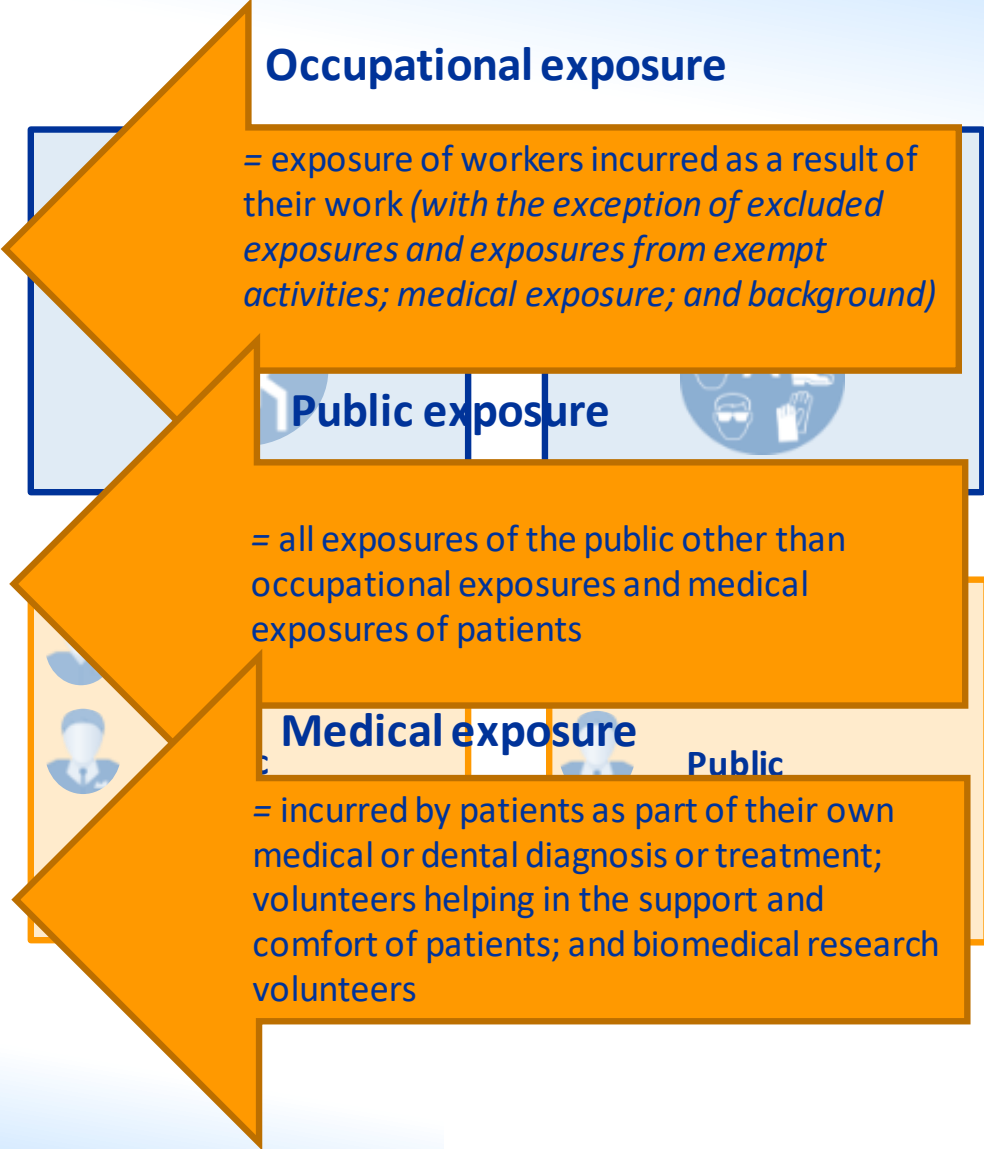
= unexpected situations such as those that may occur during of a planned situation, or from a malicious act, requiring urgent attention

= situations that already exist when a decision on control has to be taken, such as those by natural background radiation and residues from past practices operated outside the system

Exposure situations and categories of exposure

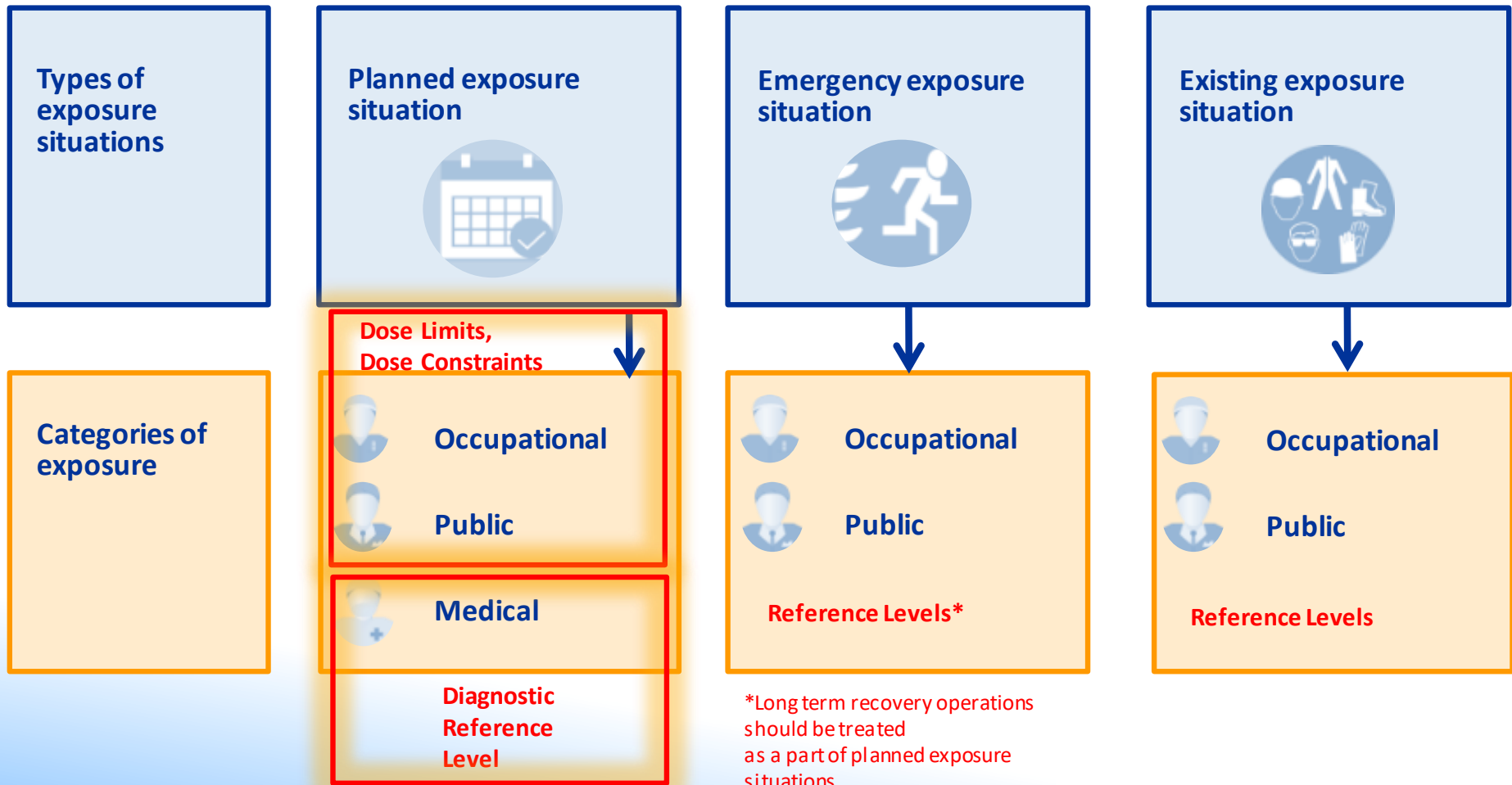
Types of exposure situations

Categories of exposure



Numerical values – constraints, limits, reference levels

to ensure adequate radiation protection



Dose Constraints and Reference Levels

- Terminology
 - Planned exposure: Dose constraints
 - Emergency and existing exposure: Reference levels
- Dose constraints and reference levels are used in conjunction with optimisation to restrict individual doses
- Dose constraints are prospective restrictions on the individual dose from a single source in a planned exposure situation. They represent an upper bound in the optimisations process
- They are always lower than dose limits

Framework for Dose Constraints/Reference Levels

BANDS OF PROJECTED DOSE

CHARACTERISTICS AND REQUIREMENTS

20 - 100 mSv

Exceptional situations. Benefit on a case-by-case basis. Information, training and individual monitoring of workers, assessment of public doses

1 - 20 mSv

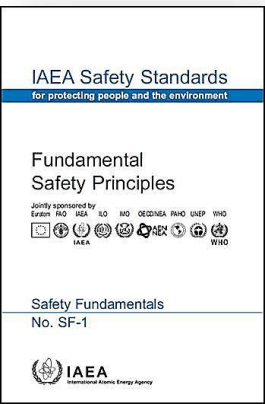
Individual direct or indirect benefit. Information, training and either individual monitoring or assessment

0.01 - 1 mSv

Societal benefit (not individual).

No information, training or individual monitoring. Assessment of doses for compliance

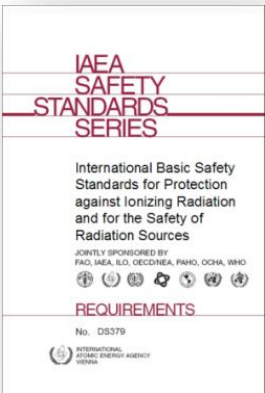
Hierarchy of the safety standards



Safety Fundamentals
(Principles)

Safety Requirements –
GSR and SSR

Safety Guides –
GSG and SSG

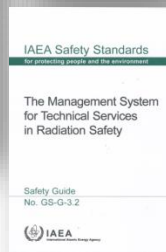
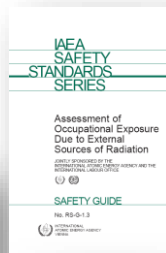
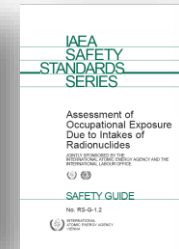
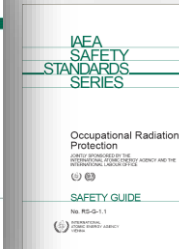
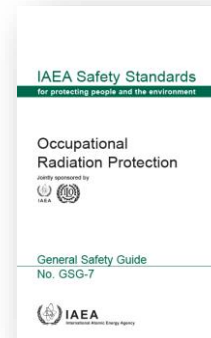


Safety Reports

TECDOCs

MUST have their basis in
IAEA Safety Standards

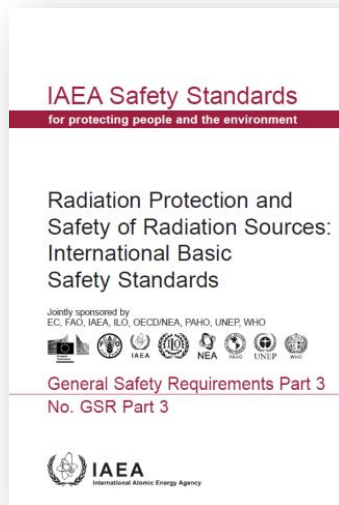
The Safety Standards



Supporting publications

International Basic Safety Standards

- An integrated and consistent set of Safety Requirements that establishes the requirements that must be met to ensure the protection of people and the environment, both now and in the future.
 - GSR Part 3 (BSS) follows ICRP 103 recommendations
 - Protection and Safety requirements of the BSS apply to all facilities and activities
 - **Planned, emergency and existing exposure situations**
 - **Occupational**, public and medical exposure categories
 - 52 overarching requirements – for **governments, regulatory bodies, industry, health and safety professionals, workers, public and service providers** such as technical support organizations
 - **12 requirements for ORP**; Control, monitoring and recording
 - **Regulator, TSO** (authorization or approval of service providers for individual monitoring and calibration services) & **End-users**



- **Planned Exposure Situations**

- **Occupational exposure**

- Req 19: Responsibilities of the regulatory body (*Regulatory Infrastructure for Occupational Radiation Protection*)
- Req 20: Requirements for monitoring and recording of occupational exposure
- Req 21: Responsibilities of employers, registrants and licensees
- Req 22: Compliance by workers (*Responsibilities of workers*)
- Req 23: Cooperation between employers, registrants and licensees
- Req 24: Radiation protection programme
- Req 25: Assessment of occupational exposure and workers' health surveillance
- Req 26: Information, instruction and training
- Req 27: Conditions of service
- Req 28: Protection and safety for female workers and for persons under 18 years of age

- **Emergency Exposure Situations**

- **Exposure of Emergency Workers**

- Req 45: Protection of emergency workers (*arrangements for controlling the exposure*)

- **Existing Exposure Situations**

- **Occupational exposure**

- Req 52: Protection of workers in existing exposure situations (*remedial actions, Rn in workplaces, exposure of air crew*)

Graded approach to regulation

One of the key principles in the GSR Part 3 (Req 6)

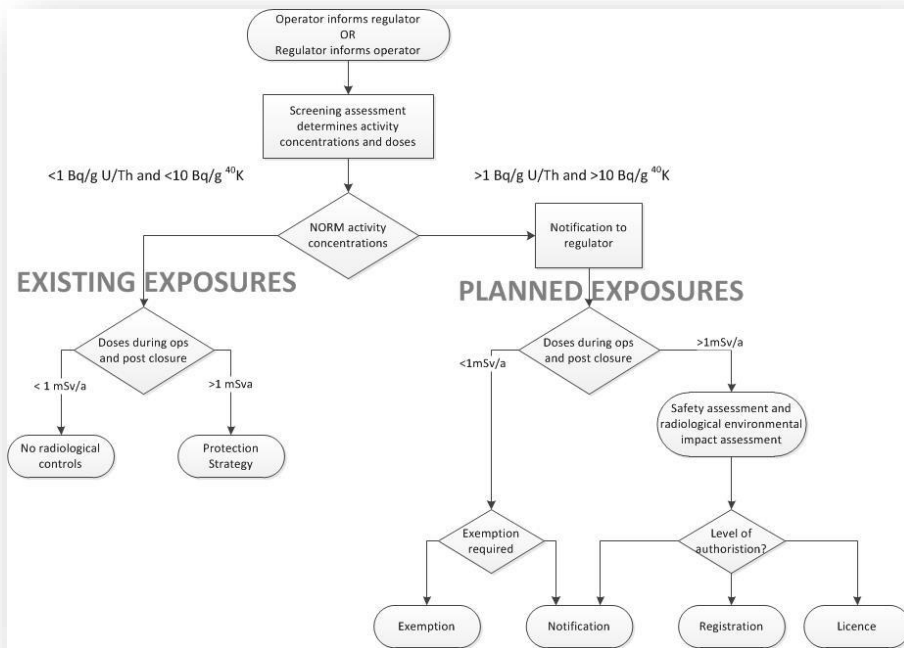
application of the requirements “shall be commensurate with characteristics of the practice or source and with the magnitude and likelihood of exposures.”

- Not limited with regulation (**control, monitor and record of OE**)

Particularly relevant for industries involving NORM

- Economic importance of industries
- Doses are generally (but not always) moderate (exposure pathways; Gamma exposure – external, Radon/Thoron and progeny nuclides – Inhalation, Long-lived alpha emitters – Inhalation, Ingestion and Skin contamination)
- Potentially high cost of regulation in relation to reduction in exposure (exposure levels are already low)
- The graded approach optimizes the use of regulatory and operator resources
- Regulation (and strategy) required when above certain levels

GSR Part 3 Requirements on natural sources



- Treated as planned exposure situation
- Mining and processing of raw materials that involve exposure due to radioactive material
- Mineral extraction, mineral processing facilities
- Natural sources
 - Material containing natural radionuclides above specified level
 - (U/Th decay chains > 1 Bq/g; K-40 > 10 Bq/g)
 - ^{222}Rn and ^{220}Rn & their progeny
 - in workplace where radon levels above reference level
 - occupational exposure due to other radionuclides in the U or Th decay chain is controlled as planned exposure situation

Safety Guide on ORP



IAEA Safety Standards

for protecting people and the environment

Occupational Radiation Protection

Jointly sponsored by



General Safety Guide

No. GSG-7



- Implementation of the Requirements on ORP in GSR Part 3
- Updates of previous safety guides in the field of ORP (*Occupational Radiation Protection in the Mining and Processing of Raw Materials, RSG 1.6*)
- It is applicable to all areas concerning occupational exposure, including medicine, nuclear fuel cycle, industries involving NORM, radiation application industries and scientific as well as educational facilities.
- Provides information on ORP framework, exposures of workers in different exposure situations, protection of workers in special cases, dose assessment, management system for service providers.
- Occupational exposure control measures as well as health surveillance are also included.
- Promoted: in all regions with regional workshop (TC support, 2016-2017)

- To determine the optimum regulatory approach
 - consider, particular types of operation, process and material in more detail
 - a prior radiological evaluation of possible exposure
 - consideration of the costs of regulation in relation to the benefits achievable
 - consideration of arrangements on control, monitor and record of occupational exposure
- Exemption, notification, registration or licensing
- Consider in addition:
 - Other regulations
 - Non-radiological risks

- Planned exposure situations: Exposure of workers due to natural sources
 - Applicability of requirements
 - Graded approach
 - Prior radiological evaluation
 - Control of exposure of workers
 - Awareness and training of workers
- Existing exposure situations:
 - Protection strategies
 - Justification
 - Optimization
 - Exposure arising from remedial actions in areas with contamination by residual radioactive material
 - Exposure due to radon
- Monitoring of exposure:
 - Assessment of internal exposure
- Workers health surveillance

- Monitoring programme conducted in the relevant workplace (as with other occupational exposures) is the only reliable way of assessing the effective dose received by a worker exposed to NORM
- Reasonable knowledge of the characteristics of the material and the work situation in which the material is used (for exposure to gamma radiation and exposure due to airborne dust, it is possible to establish in advance)
- Dose is quite strongly influenced by the activity concentrations of radionuclides in the material, reflecting the underlying linear relationship between these two parameters.
- Broad indication of the dose from exposure to gamma radiation and exposure due to airborne dust can be used during the prior radiological evaluation
 - Prioritization tool to identify, on the basis of activity concentrations in process materials,
 - Types of industrial process and scenarios of exposure

NORM- what circumstances does it become necessary to regulate?

Typical industries

- Uranium mining and processing
- Rare earths extraction
- Thorium extraction & use
- Niobium extraction
- Non-U mining – incl. radon
- Oil and gas
- Production and use of TiO₂
- Phosphate Industry
- Zircon & zirconia
- Metals production (Sn, Cu, Al, Fe, Zn, Pb)
- Burning of coal etc.
- Water treatment

IAEA guidance

- Oil and gas industry – Safety Report No.34, 2003
- Zircon and zirconia industries – No.51, 2006
- Rare earths industry – No. 68, 2011
- Titanium Dioxide and Related Industries - No. 76, 2012
- Phosphate industry – No.78, 2013
- Itinerant workers – No.84, 2015
- Uranium mining – approved (in the process)
- NORM IV – NORM VIII Symposia – IAEA Proceedings series
- Publications on Exposure to Radiation from Natural Sources (<https://www-ns.iaea.org/publications/norm-publications.asp>)
- Training course series No.40 – Oil and gas industries.
- Training package on NORM

Safety Reports Series
No. 49

Assessing the Need for
Radiation Protection
Measures in Work
Involving Minerals and
Raw Materials



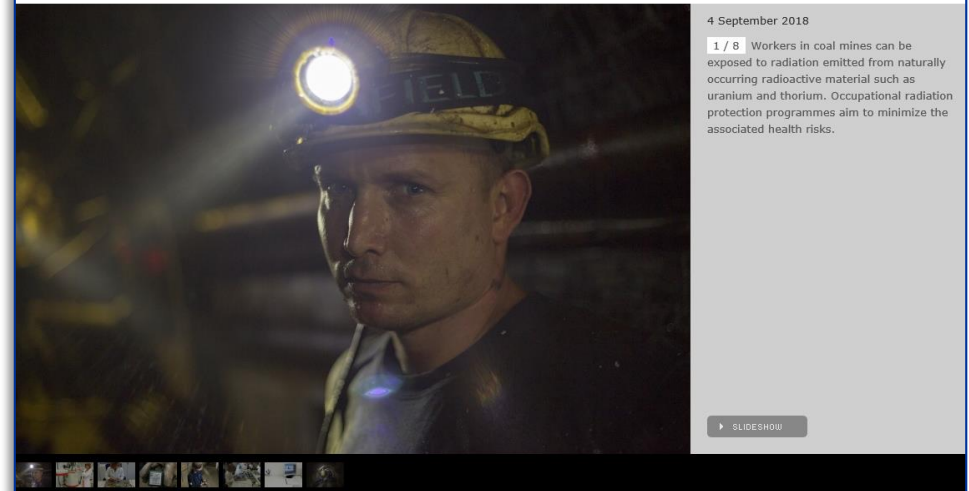
- International agreed system for radiation protection
- IAEA safety standards establish requirements applicable for exposure situation;
 - Planned
 - Emergency
 - Existing
- GSR Part 3 clearly defines requirements for worker protection and guidance is provided by GSG-7

- How these apply to NORM will be discussed in next lecture

How can workers be protected from natural radiation?



Radiation Underground: Measuring and Controlling Miners' Exposure



- NORM worker protection (Video):
<https://www.iaea.org/newscenter/multimedia/videos/how-can-workers-be-protected-from-natural-radiation>
- Radiation Underground- How to measure & control (Photo essay):
<https://www.iaea.org/newscenter/multimedia/photoessays/radiation-underground-measuring-and-controlling-miners-exposure>