



IAEA

International Atomic Energy Agency

Occupational Radiation Protection GSG7

3.Exposure of Workers in Planned Exposure Situations – Part 2

GSG7 Section 3

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WORK PLANNING

Work planning and work permits

- For work where **significant radiation or contamination levels** may be encountered or work is complex and involves several groups of workers
 - Mainly nuclear industry but also, eg accelerator dismantling
- **Written procedures** should be used as part of work planning process (paragraph 3.95 of IAEA GSG7)
- If special radiological precautions are required, work should be carried out under a radiation work permit (RWP, paragraph 3.96 of IAEA GSG7)



EXPOSURE ASSESSMENTS AND MONITORING PROGRAMMES

Monitoring and Exposure Assessment

- Includes interpretation and assessment in addition to measurements
- Monitoring programme may include:
 - Assess worker exposure and demonstrate compliance with regulations
 - Determine whether controls are adequate
 - Provide information for the evaluation of doses in the event of accidental exposures
 - Identify need for additional controls and procedures to reduce exposures if necessary

Monitoring programmes -1

To be set up by employer
in consultation with
appointed Qualified
Expert.

Based on prior radiological
evaluation findings

Monitoring programmes can be divided
into:

Individual monitoring for external
exposure, internal exposure or skin
contamination

Workplace monitoring of external
dose rates and levels of airborne or
surface contamination

Monitoring programmes -2

- Several types:
 - Routine monitoring to demonstrate that working conditions and individual doses remain satisfactory
 - Monitoring during commissioning or other non routine situations to identify problems and any additional protective measures required
 - Confirmatory monitoring to check effectiveness of additional/new protective measures
 - Task-related monitoring during a specific operation to support immediate decisions during the operation

Monitoring programmes -3

- Objectives of monitoring programme should be clearly defined and include basis for interpretation of results, e.g. for controlling operations or for formal assessment of exposure to meet regulatory requirements
- Equipment used should be suitable for radiation type and form of radioactive material and be calibrated to appropriate standards (Section 7 of IAEA GSG7)
- Individual monitoring should be carried out using dosimeters supplied by Approved Dosimetry Services (Section 7 of IAEA GSG7)



WORKPLACE MONITORING

Workplace programmes -1

- ☐ Management required to establish, maintain and review a workplace monitoring programme
- ☐ Supervised by RPO or qualified expert
- ☐ Type and frequency of monitoring shall:
 - ☐ be sufficient to enable radiological conditions to be evaluated
 - ☐ enable exposures in controlled and supervised areas to be assessed and area classifications to be reviewed
 - ☐ be based on radiation levels and likelihood and magnitude of exposures during operational and accident conditions
- ☐ Records of monitoring results should be kept and made available to workers, where appropriate

Workplace programmes -2

- ☐ Workplace monitoring programmes should specify
 - ☐ Quantities to be measured
 - ☐ Location and frequency of measurements
 - ☐ Methods and procedures appropriate to radiation hazard present
 - ☐ Investigation levels and actions to be taken if exceeded
- ☐ Results should be recorded that:
 - ☐ Detail information about the survey undertaken
 - ☐ Demonstrate compliance with regulations
 - ☐ Identify significant changes
 - ☐ Detail any actions taken



INDIVIDUAL MONITORING

Individual monitoring

- Prior radiological evaluation should determine whether individual monitoring is necessary
- Monitoring should be carried out by an approved dosimetry service where possible
- May do individual monitoring at the start of a work activity but cease if exposures are low
- Monitoring for internal exposure usually appropriate if:
 - **Workers in a contamination controlled area and**
 - **Significant intakes likely**
- Internal exposure monitoring **not** normally required if doses are below 1 mSv per year, but workplace monitoring should be undertaken

When is internal dose monitoring required?

Examples in GSG7,
para 3.109:

*This list is not
exhaustive

- 1 Handling large quantities of gaseous/volatile materials (eg H-3)
- 2 Processing of Pu and other transuranic elements
- 3 Reactor maintenance (exposure to fission/activation products)
- 4 Bulk production of radioisotopes
- 5 Production/handling of large quantities of radiopharmaceuticals
- 6 Mining of high grade U ores, processing of U mineral concentrates and production of nuclear fuel
- 7 Processing of mineral concentrates rich in Th, and the production of Th-containing products

Exposure assessment - Individuals

- ❖ Employer shall arrange for individual doses to be assessed where appropriate. Routine and potential exposures should be considered
- ❖ If exposures are likely to vary, either between individuals or with time, exposures should be assessed by individual monitoring
- ❖ For internal exposures it may be appropriate to carry out assessments of individual exposures when airborne or surface concentrations exceed defined trigger levels
- ❖ Accuracy of chosen assessment procedures should be defined. Reasonable and appropriate measures to quantify and minimize uncertainties should be taken.

INVESTIGATION LEVELS

Investigation levels

- ☐ Set in terms of workplace or individual monitoring quantities
- ☐ Important in monitoring programmes as a management tool
- ☐ Should be defined in advance and specified in the RPP
- ☐ Regulators may choose to specify generic investigation levels
- ☐ Should be used retrospectively to initiate a review when the investigation level has been exceeded to determine the causes and review the protection and safety measures to determine where they are sufficient
- ☐ Should be set by management on the basis of a knowledge of the conditions in the workplace, range of expected levels, type and frequency of monitoring and exposure to other sources

Investigations

Management should identify person(s) responsible for initiating investigations when required.

Investigation to address:

- The circumstances leading to the suspected exposure
- Verification of the dosimetric results
- The probability that dose limits or investigation levels will be exceeded under current working conditions
- The corrective actions to be taken

Recording levels and derived investigation levels

- ❖ A recording level is the lowest result that will be entered into individual exposure records. For results of individual dosimetry, the minimum level of detection is usually used as the recording level.
- ❖ When a worker is exposed to more than one type of radiation or radionuclides the recording level for each type of radionuclide needs to be taken into account.
- ❖ Sometimes more convenient to express investigation levels and recording levels in terms of quantities measured. These are known as derived investigation levels (DILs) or derived recording levels (DRLs).

RECORD KEEPING

Record of occupational exposure -1

- ❑ Employers shall maintain records of occupational exposure for every worker subject to exposure assessment
 - Records shall include doses from all exposure pathways
 - Records shall be supplied to individual workers, regulatory body and occupational physician supervising health surveillance programme
 - Records shall be provided to new employers when workers change jobs
 - Records for former workers shall be retained
 - When supplying records to the above persons, due care and attention shall be given to maintaining confidentiality

Record of occupational exposure -2

- Monitoring programme should specify the periods over which the exposure assessments are carried out. Records for separate periods should be separately identifiable
- Records of occupational exposure should be kept up to date and assessment results from any monitoring period should be added to individuals exposure records promptly
- Monitoring records should be easily retrievable and protected against loss

Record of occupational exposure -3

- Consideration should be given to any applicable national requirements concerning the privacy on individual data records
- If the employer ceases to conduct activities where workers are subject to personal monitoring, the employer should make arrangements for their dose records to be retained by the regulatory body or a state registry
- Monitoring for occupational exposure covered in more detail in Section 7 of IAEA GSG7



INFORMATION, INSTRUCTION AND TRAINING

Information, instruction and training -1

- All workers shall be provided with:
 1. **Information** on health risks due to their occupational exposure during normal and accident conditions
 2. **Instruction and training** (including retraining) in protection and safety
 3. **Information** on significance of protection and safety actions
- Workers with a role in or who may be affected by the response to an emergency shall receive appropriate information instruction and training, including refresher training for emergency conditions.

Information, instruction and training -2

- Persons assigned responsibilities in the RPP, workers' representatives and members of relevant safety committees should receive general radiation protection information and training where relevant
- Senior managers should be trained in the risks associated with radiation, the basic principles of protection and safety, their main responsibilities and the principle elements of the RPP

Information, instruction and training -3

- For **workers directly involved**, training provided through appropriate documents, lectures, applied training and on-the-job training.
- Training topics should include:
 - Risks associated with ionizing radiation
 - Radiation protection quantities and units
 - RP principles (optimization, dose limitation, etc)
 - Practical protection (shielding, working procedures, PPE)
 - Specific task-related issues
 - Need to report unforeseen occurrences and implement contingency plans where appropriate

Information, instruction and training -4

- Persons not directly involved who should be provided with relevant **information** include:
 - ❑ Designers, engineers, planners etc.
 - ❑ Cleaners, security staff etc. who work in radiation areas
- **Female workers** need information about the precautions necessary to protect an unborn child
- All employers and self-employed people should co-operate, exchange information as necessary and ensure **contractors, sub-contractors and itinerant workers** have received appropriate training

Information, instruction and training -5

- A process for the evaluation of workers' training and competence should be established by management
- Workers should only be permitted to work unsupervised once trained and competent
- Training programmes should be documented, approved, and reviewed at appropriate intervals
- Formal training records should be kept and periodic retraining undertaken at appropriate intervals
- IAEA Safety Standards Series No. RS-G-1.4 'Building Competence in Radiation Protection and the Safe Use of Radiation Sources' gives further guidance on training and education of workers

Worker qualification and certification

- Workers that require a significant level of expertise eg. diagnostic or industrial radiographers or hot cell operators should be suitably qualified and appropriately certificated
- The regulatory body should provide guidance on qualification requirements for each category of job
- Recognition of such qualifications may be accorded by a designated board, society or professional, academic or regulatory body

AUDITING

Audits and reviews

- ☐ The RPP should be regularly audited and reviewed by persons who are technically competent to enhance the effectiveness and efficiency of the RPP
- ☐ Audits and reviews should be performed using written procedures and check lists at appropriate intervals:
 - ☐ When required by the regulatory body
 - ☐ When considered necessary by management
 - ☐ Following implementation of a new RPP or addition of significant new content
 - ☐ Following significant reorganization/revision of the RPP
 - ☐ To implement previously identified corrective actions



**PLANNED EXPOSURE OF WORKERS
TO NATURAL SOURCES**

Exposures of workers to natural sources

- ❖ Usually subject to requirements for existing exposure situations; except workplaces where:
 - ❖ Material containing U-238 or Th-232 decay chains with an activity concentration above 1 Bq/g is used; or
 - ❖ Material contains K-40 with an activity concentration above 10 Bq/g is used
 - ❖ Exposure to radon in a NORM workplace already subject to planned exposure situation requirements; or
 - ❖ Average annual radon concentration is above the reference level for workplaces

NORM activities subject to requirements for planned exposure situations

- Mining and processing of uranium ore
- Extraction of rare earth elements
- Production and use of thorium and its compounds
- Production of niobium and ferro-niobium
- Mining of ores other than uranium ore
- Production of oil and gas
- Manufacture of titanium dioxide pigments
- The phosphate industry
- The zircon and zirconia industries
- Production of tin, copper, aluminium, zinc, lead, iron and steel
- Combustion of coal
- Water treatment

A graded approach to regulation

- ❖ A graded approach is considered appropriate for NORM because of:
 - ❖ The economic importance of many NORM industries
 - ❖ Generation of large volumes of waste with limited waste management options
 - ❖ Potentially high regulatory cost but risks and exposure levels are generally low
 - ❖ No expected deterministic effects and no prospect of a radiological emergency
- ❖ Where potential annual doses are 1 mSv per year or less, the regulatory body should exempt from regulatory control
- ❖ Work with K-40 almost always expected to give rise to doses below 1 mSv

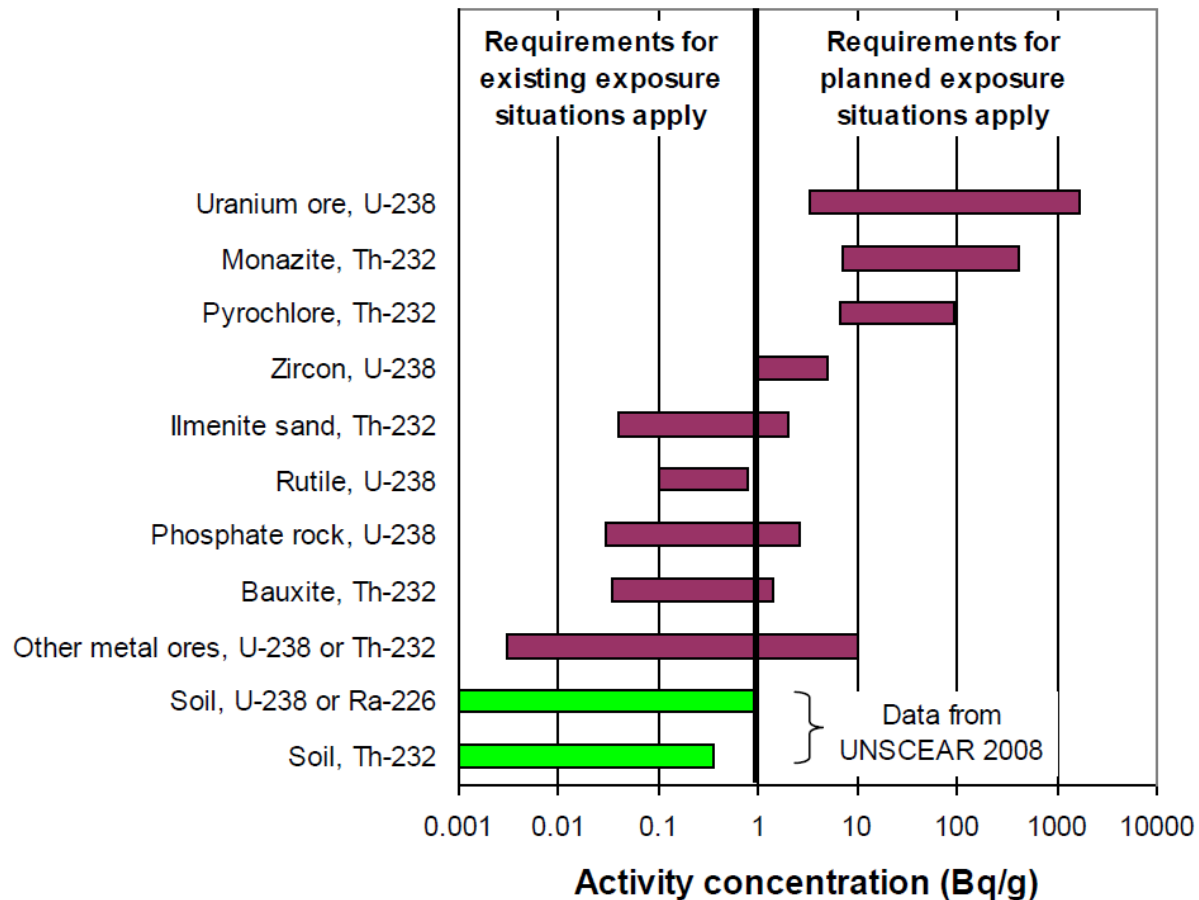
NORM: Prior radiological evaluation

- ❖ Exposure pathways
 - External exposure to gamma radiation
 - Internal exposure due to inhalation of dust
 - Inhalation of Rn-222 (and Rn-220 if material has a high Th-232 content)
- ❖ Expected exposure levels
 - Exposure due to external gamma radiation and dust inhalation usually low
 - Radon exposure may be high, especially if removal by ventilation not practicable
 - Appendix 1 to IAEA GSG7 gives typical exposure levels for a variety of situations

NORM: Control of worker exposure

- ❖ External gamma radiation exposures can usually be controlled by discouraging access
- ❖ Complete containment of material is generally impracticable and the radiological consequences of spills and the spread of materials are usually negligible
- ❖ General dust reduction measures will reduce exposure by inhalation of dust and also reduce radon concentration
- ❖ Prevention of dust resuspension ensures exposures are controlled
- ❖ Access to unventilated/enclosed areas should be prevented unless protection measures in place. Controlled area designation likely to be appropriate

Exposure of workers to natural sources



NORM: Worker awareness and training

- ❖ Protection and safety generally ensured by complying with local rules
- ❖ Appropriate worker training required, including:
 - ❖ Properties and hazards of relevant radionuclides, and main exposure pathways
 - ❖ The function and purpose of any containment and/or ventilation systems
 - ❖ Use of 'time, distance and shielding' to minimize exposure to gamma radiation near large accumulations of NORM, especially when activity concentrations are high
 - ❖ Methods for controlling and suppressing airborne dust
 - ❖ The measurement of airborne activity in the form of dust and Rn-222 and its progeny

Key message

- ❖ Work must be planned to ensure that protection is optimized
- ❖ Employer must ensure that adequate workplace monitoring and assessment of individual exposures are carried out and appropriate records are kept.
- ❖ All workers must receive information, instruction and training appropriate to their role. Regulator to provide guidance on qualification requirements for each category of job. Workers requiring a significant level of expertise should be suitably certificated
- ❖ Natural sources are normally an existing exposure situation. However, some NORM industries are subject to requirements for planned exposure situations. A graded approach is also important for NORM

Questions and Discussion

Group exercise 1

Draft an outline
Radiation Protection
Programme for work
with X-ray security
scanners installed at an
airport



Group exercise 2

You are the RPO at a company that uses a gamma radiography source in an enclosure.

When reviewing the dosimetry results, you notice that one worker's dosimeter has a recorded dose of 80 mSv after a routine monitoring period.

What actions should you take?

