From fundamental safety principles to operational radiation protection programmes:

Overview of operational radiation protection programmes for nuclear Installations

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Introduction

- The objectives of radiation protection are to:
  - *Ensure the effective control of external and internal doses to the workers and public, and of releases to the environment;*
  - *Ensure conformance with the regulatory requirements;*
  - *Enable further optimization of operational practices.*
- An operational radiological protection programme should be in place to achieve these objectives.

Introduction

- The basis of the operational radiological protection programme is set of measures aimed at reducing radiation hazards and radiation doses. It includes:
  - *Incorporating adequate design features;*
  - *Establishing administrative controls;*
  - *Ensuring adequate training of reactor personnel;*
  - *Imposing restrictions in operating procedures;*
  - *Applying extensive monitoring system for radiation and contamination.*

Operational Radiological Protection Programme – General considerations

- The documents for the operational radiological protection programme should include:
  - *Policy statement of operating organization, which includes:*
    - *Radiation protection objectives, and*
    - *Commitment to the radiological protection principles, in particular the optimization principle.*
  - *Organization of radiological protection:*
    - *Functions, roles and responsibilities;*
    - *Qualifications and line of communication;*
    - *Training in practices for radiation protection;*
  - *Measures for controlling compliance with applicable regulations.*

Operational Radiological Protection Programme – General considerations

- Operational radiological protection programme should also include measures for:
  - ✓ *Ensuring cooperation between radiological protection staff and the operating staff;*
  - ✓ *Providing for decontamination (personnel, areas, surfaces, objects);*
  - ✓ *Recording inventory of radioactive material;*
  - ✓ *Eensuring adequate records keeping for personnel (personnel dose, training, etc.) and facility (survey, releases, etc.);*
  - ✓ *Providing for the review and update of the programme.*

Dose Limitation

- Dose limits should be established (exposure should be restricted):
  - *Total effective dose;*
  - *Total equivalent dose to relevant organs or tissue.*
- Dose limits set by international organizations (*IAEA Safety Standards No GSR Part 3*).
- Dose constrains:
  - *Not a limit - Ceiling on individual dose values that should be considered acceptable in the optimization process.*
  - *Used prospectively for the planning and execution of tasks as well as for design purposes.*

Reference levels

- Values of measured quantities (dose rate, activity concentration) above which specific action or decision should be taken:
  - *Recording levels: Values at which (or above) the exposure of a worker should be entered to his individual exposure records;*
  - *Investigation levels: Values at which (or above) an investigation should be conducted;*
  - *Intervention and action levels: Serve to protect members of the public in the event of emergency.*
- Reference levels are set by the operating organizations on the basis of the national regulations on dose limits.

Dose Control

- Off site (Public) dose control: Minimization of releases
- Dose control on the site:
  - *Source control: Considerations in design and operation.*
  - *Physical controls: Considerations in design and operation.*
  - *Administrative Controls:*
    - *An essential part of the operational radiological protection programme;*
    - *Defined in local rules and requirements and procedures.*

Dose control on the site : Source control

- *Material selection: Materials should be unlikely to be activated, and of high corrosion resistance. Impurities should be investigated.*

- *Quality of reactor coolant: Should be maintained as free from impurities as possible. Maintaining good coolant quality reduces corrosion and minimize activation of corrosion products.*

- *Beam tubes (research reactors): Beam tube ports should be well designed, shielded and monitored. Beam tubes that are not in use should be closed and shielded.*

- *Irradiated fuel: Handled and stored in a way that criticality, and cladding corrosion, melting, and damage are avoided.*

Dose control on the site : Source control

– *Minimization of production of gaseous material:*

- *Reduction of ingress of air near reactor core,*
- *Sealing air spaces,*
- *Purging spaces with inert gases,*
- *Use of filters to prevent build up of radioactive materials in ducts.*

– *Minimization of waste:*

- *Segregation of waste,*
- *placement of designated locations prior to its storage,*
- *storage,*
- *treatment, and*
- *disposal.*

Dose control on the site : Physical controls

- *Shielding: Adequate shielding should be provided for all sources or radiation in and around the facility.*

- *Ventilation:*
  - *Control Ar^{41} and fission product gases in case of fuel failure;*
  - *Differential pressure between areas of different potential contamination;*
  - *Filtration system provided for normal and emergency conditions;*
  - *System efficiency (integrity, air exchange rate, flow rates) and efficiency of filters routinely checked.*

- *Distance: Use of special operating tools.*

Dose control on the site : Physical controls

- *Time: This may be the only viable method of dose control in some cases (e.g. dose rate is high in spite of shielding and distance).*

- *Decay: Irradiated materials/equipment, should be allowed to decay as long as possible before they are handled. (Carful planning of activities).*

- *Decontamination: Contamination monitors, decontamination procedures and facilities for personnel, areas, and equipment; control of items for contamination before transfer outside controlled areas.*

- *Personnel protective equipment: Laboratory coats, gloves, overshoes, full protective suite with air supply and masks. (To be chosen in accordance with the anticipated hazard).*

Dose control on the site : Administrative controls

- *Working area classification and access control: Depending on the potential for radiation and contamination hazards. Area classification should be indicated with a appropriate signs and give warning of the hazard. (Controlled and Supervised areas).*

- *Workplace monitoring programme: External radiation, surface contamination, and airborne contamination.*

- *Approval: Formal approval is required for undertaking work involving control of radiation hazards:*
  - *Radiation work permits;*
  - *Experiment approval (research reactors);*
  - *Routine irradiation approvals: Non-routine irradiation should be treated as a new experiment;*
  - *Modification to the facility: Radiological implication should be assessed;*
  - *Training: operating personnel, temporary workers, visitors, etc.*
  - *Radiation protection procedures.*

Dose control on the site: Administrative controls (Procedures)

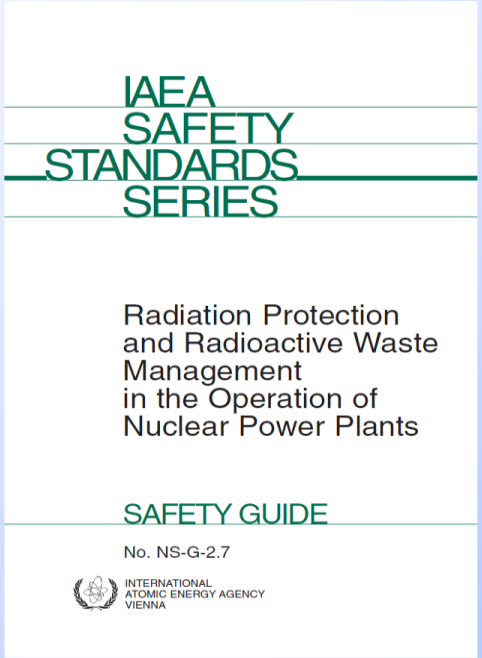
- To ensure that all the activities that could lead to exposure are planned, supervised, and executed in a way that ensure that the radiological protection objectives are met.
- Cover all activities that have radiological significance, and for all routine activities for radiation protection purposes.
- Are to be enforced and followed by the reactor staff, transient personnel and visitors.

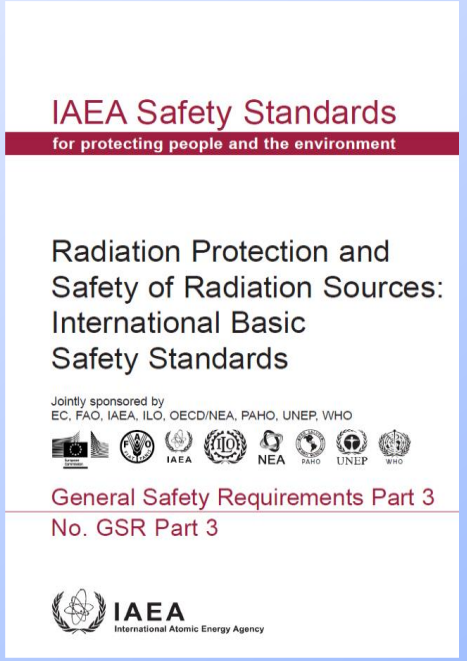
Dose control on the site: Administrative controls (Procedures - Examples)

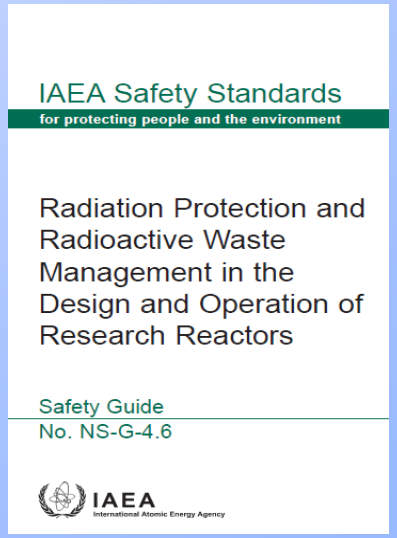
- Working area classification and access to different areas;
- Routine monitoring: (Personnel, areas, surfaces and objects)
  - *Radiation levels at workplace;*
  - *Contamination control;*
  - *Environmental mentoring (including releases);*
  - *Radioactive waste.*
- Monitoring of operation and maintenance tasks: Fuel/irradiated material handling, maintenance of ventilation system, maintenance of control rods, working with resins, etc.
- Decontamination: personnel, areas/surfaces and objects;
- Calibration and testing of radiation protection equipment;
- Use of protective equipment.

IAEA Safety Standards and Guidance

- GSR Part 3: BSS;
- Nuclear installations:
  - *NPP;*
  - *Research reactors;*
  - *Fuel cycle facilities.*
- Provide good practices in operational radiation protection and radioactive waste management programmes and their optimization.







Feedback from IAEA activities

- Feedback from the IAEA Safety Review Missions indicated the need to improve the operational radiological protection programme.

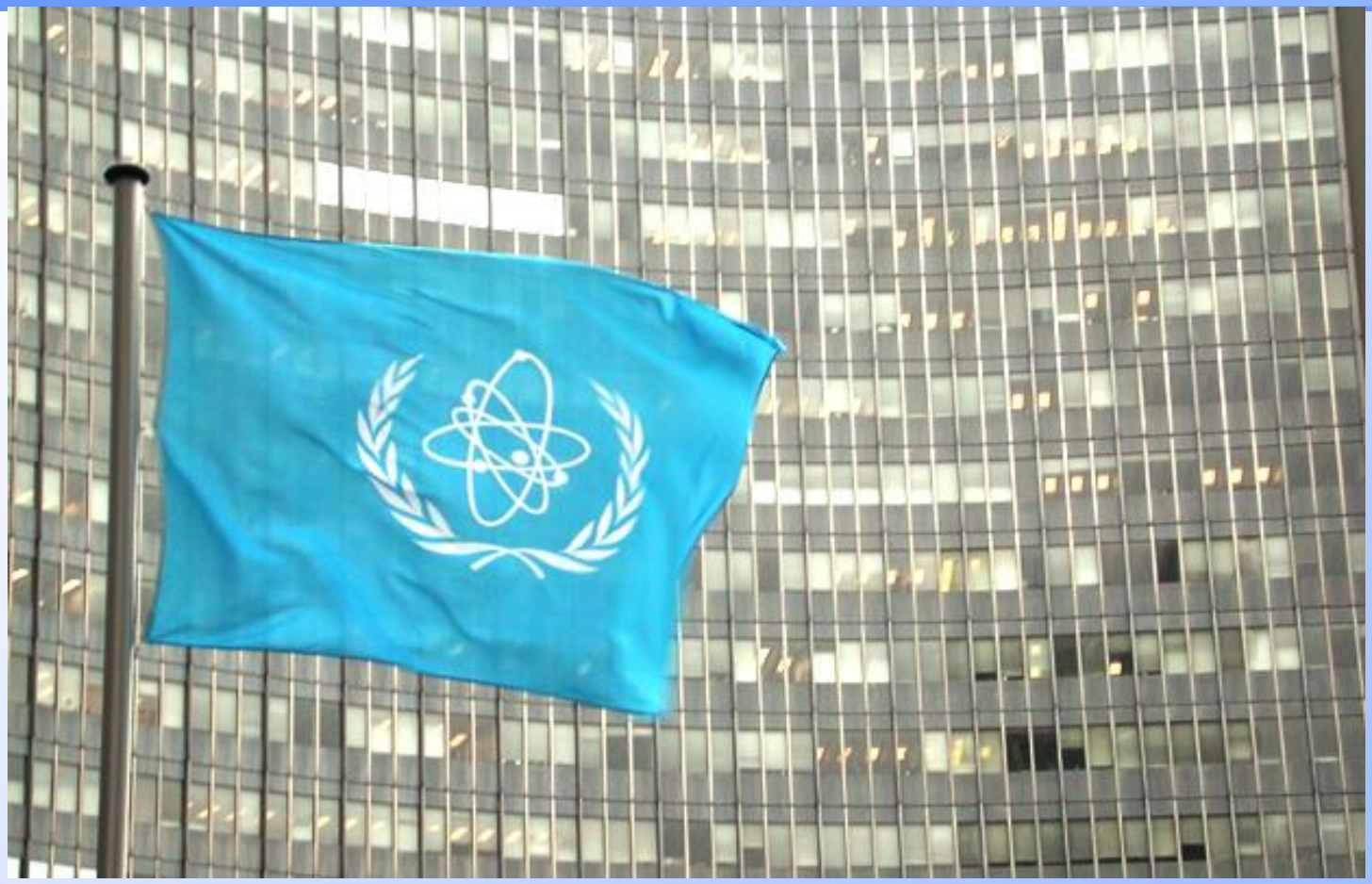
- Deficiencies were found mainly in the administrative part of the programme:
  - *Working area classification;*
  - *Workplace monitoring;*
  - *Radiation work permits, and*
  - *Procedures.*

Concluding remarks

- Effective operational radiation protection programmes ensure that dose to individuals are within limits and should provide for optimization of safety and protection.

- Programme objectives are achieved mainly through off-site and on site dose controls (source, physical and administrative).

- Administrative controls form an essential part of the programme, and feedback from IAEA activities showed that improvements are needed in this regard (working area classification, monitoring, and approval processes).



…Thank you?