



**IAEA**

International Atomic Energy Agency  
*Atoms for Peace and Development*

# Occupational Radiation Protection during High Exposure Operations

Introduction

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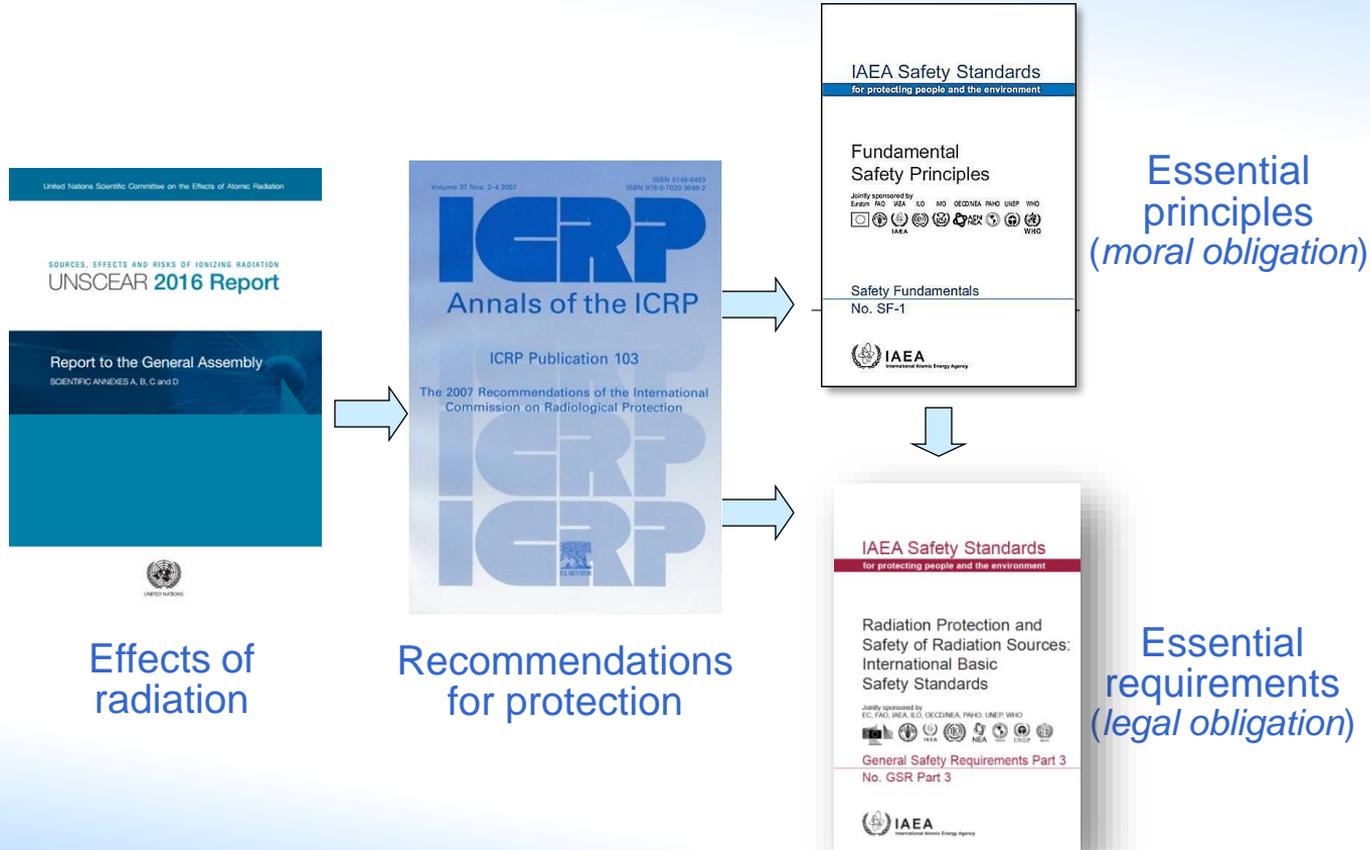
# 1. Background

- At 15:37 on 11th March 2011, a Tsunami struck the Fukushima Dai-ichi Nuclear Power Station (FDNPS), 50 minutes after the Great East Japan Earthquake, which initiated a nuclear accident unprecedented in both scale and timeframe.
- It turned out that **appropriate radiation protection procedures and instructions** that gave the method and the attitude of operational radiation protection to workers in the installation during the emergency were not available.

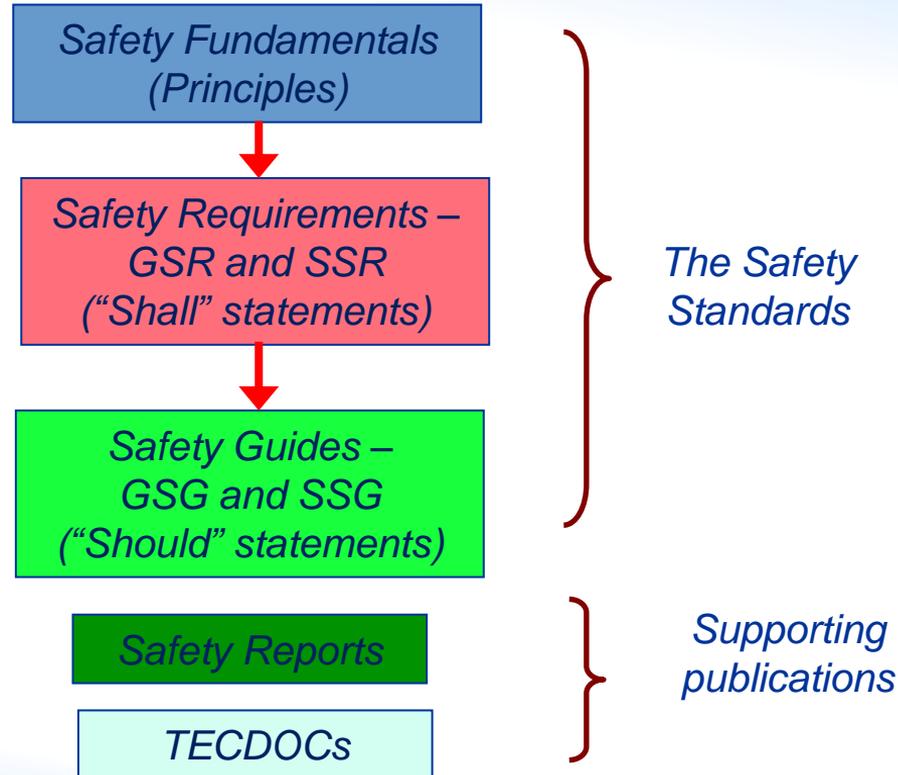
# 1. Background

- The basis for the radiation protection procedures and instructions are presented during these lectures.
- The main aim of these lectures is to enable the planning, preparedness and training of emergency workers so as to mitigate the exposure in facilities during future accidents and emergencies.

# International Framework



# Hierarchy of the safety standards



# IAEA Safety Standards

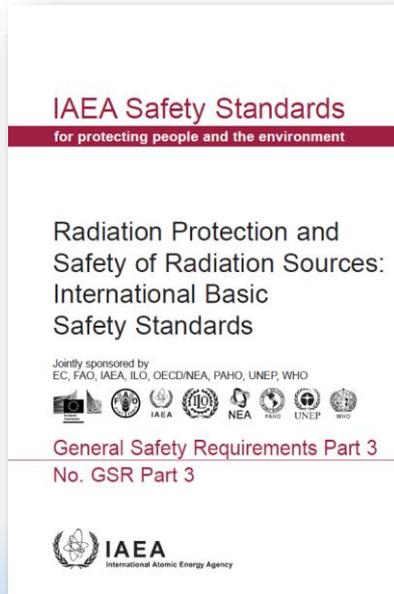
## Fundamental Safety Principles (2006)

- The conceptual basis for the Agency's safety standards
- 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.



# Main IAEA References : Safety Requirements

An integrated and consistent set of Safety Requirements establishes the requirements that must be met to ensure the protection of people and the environment, both now and in the future.

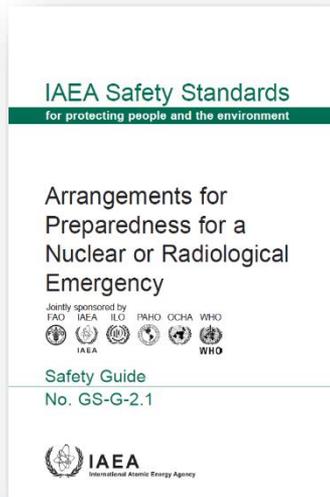


Among other documents (see Lecture 12), the General Safety Requirements on occupational radiation protection and emergency preparedness and response are contained in:

- **GSR Part 3;**  
***Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards***
- **GSR Part 7;**  
***Preparedness and Response for a Nuclear or Radiological Emergency***

# Main IAEA References : Safety Guides

- Safety Guides (such as GS-G-2.1) provide recommendations and guidance on how to comply with the Safety Requirements.
- Recommendations in the Safety Guides are expressed as “should” statements.



A new Safety Guide (GSG-7) on *Occupational Radiation Protection* will be published as a combination of 5 existing Safety Guide

- RS-G-1.1: *Occupational Radiation Protection*
- RS-G-1.2: *Assessment of Occupational Exposure Due to Intakes of Radionuclides*
- RS-G-1.3: *Assessment of Occupational Exposure Due to External Sources of Radiation*
- GS-G-3.2: *The Management System for Technical Services in Radiation Safety*

# 1. Background

- The response to a nuclear or radiological emergency must be well coordinated and arrangements must be appropriately integrated with the conventional aspects of the emergency.
- Lack of appropriate information during a nuclear or radiological emergency could lead to inappropriate actions being taken, in particular for what concerns the health effects of **High Exposure Operations (HEO)**.

## 2. Objective

- The aim of this workshop is
- to provide practical guidance for protection of *emergency workers*\* and other employees involved in operation and radiation control of facilities during operations that could involve situations with a higher occupational exposure (above the annual limits for occupationally exposed workers in planned exposure situations).

**\*emergency worker:** a person having specified duties as a worker in response to an emergency.

- Emergency workers may include workers employed, both directly and indirectly, by registrants and licensees, as well as personnel of response organizations, such as police officers, firefighters, medical personnel, and drivers and crews of vehicles used for evacuation.
- Emergency workers may or may not be designated as such in advance to an emergency. Emergency workers not designated as such in advance of an emergency are not necessarily workers prior to the emergency ( from GSR Part 7).

# 3. Scope

## The lectures

- include emergency response procedures to protect the workers for different types of radiological emergencies or accidents at large nuclear facilities such as nuclear power plant, reprocessing plant, decommissioning activities, or recovery actions after an emergency
- are mainly directed to the Radiation Protection Officers (RPO) who will take responsibility for radiation protection during the operations with high exposure
- apply to the training of trainers of radiation workers in facilities.

## 4. Structure of the workshop

1. Introduction
2. Basic concepts of occupational radiation protection with high exposure
3. Practical radiation monitoring and dose evaluation
4. Personal protection and dose reduction measures
5. Roles and responsibilities on occupational radiation protection with high exposure
6. Preparedness and action in emergency
7. Medical management of radiological casualties
8. Health effect caused by radiation and basis for radiological protection
9. Lessons learnt from occupational radiation protection in past accidents (Chernobyl, Fukushima, Goiania, Samut Prakan)
10. Sources of High Exposure Operations
11. Communication
12. IAEA documents on occupational radiation protection with high exposure
13. Additional information on relevant IAEA activities

## 5. Basis of radiation protection on nuclear and radiological emergency

- Types of radiation emergencies
- Establishing emergency management and operations
- Taking urgent protective action
- Protecting emergency workers
- Managing the medical response

## 5.1. Types of radiation emergencies

### 1) Nuclear emergencies may occur at:

- Nuclear reactors (power reactors, research, ship)
- Fuel cycle facilities (e.g. fuel processing plants)
- Storage facilities for large quantities of spent fuel

## 5.1. Types of radiation emergencies

### 2) Radiological emergencies include:

- Uncontrolled (abandoned, lost, stolen or found) dangerous sources
- Misuse of industrial and medical dangerous sources (e.g. of those used in radiography)
- Re-entry of a satellite containing radioactive material
- Malicious threats and/or acts
- Transport emergencies

## 5.2. Establishing emergency management and operations

- The on-site emergency response shall be promptly executed and managed without impairing the performance of the continuing operational safety functions.

For all facilities:

- The transition from normal to emergency operations shall be clearly defined and shall be effectively made without jeopardizing safety.
- The responsibilities of workers who would be on the site in an emergency shall be defined as part of the arrangements for transition.
- The ability of the operating personnel to ensure safe and secure operation while taking mitigation actions shall be ensured .

## 5.3. Taking urgent protection action

- In a nuclear or radiological emergency, the goals of emergency response are:
  - To regain control of the situation and to mitigate consequences;
  - To save lives;
  - To avoid or to minimize severe deterministic effects;
  - To render first aid, to provide critical medical treatment and to manage the treatment of radiation injuries;
  - To reduce the risk of stochastic effects;
  - To mitigate, to the extent practicable, non-radiological consequences.

## 5.4. Protecting emergency workers

- The Regulatory Authority shall ensure that arrangements are in place to protect emergency workers and to protect helpers (engaged workers) in an emergency.

This shall include:

- Arrangements to assess continually and to record the doses received by emergency workers
- Procedures to ensure that doses received and contamination are controlled in accordance with established procedures and international standard
- Arrangements for the provision of appropriate specialized protective equipment, procedures and training for emergency response in the anticipated hazardous conditions

## 5.5. Managing the medical response

- The Government (through the Regulatory Authority or other competent authorities)
- shall ensure that arrangements are in place
- for the provision of appropriate medical screening and triage, medical treatment and longer term medical actions for those people who could be affected in a nuclear or radiological emergency.

## 6. Radiation protection principles

- The main object of radiation protection (RP) is to avoid deterministic effects by keeping doses below the relevant thresholds and to reduce the probability of stochastic effects as far as is reasonably achievable.

This shall be achieved by the following requirements:

- a) Justification of practices
- b) Optimization of protection and safety
- c) Dose limitation

## a) Justification of practices

- No practice or source within a practice should be authorized unless the practice produces sufficient benefit to the exposed individuals or to society to offset the radiation harm that it might cause;
- That is: unless the practice is justified, taking into account social, economic and other relevant factors.
- In the case of emergencies, this includes justification of mitigating actions.

## b) Optimization of protection and safety

- In relation to exposures from any particular source within a practice, protection and safety shall be optimized in order that
  - the magnitude of individual doses,
  - the number of people exposed and
  - the likelihood of incurring exposures

shall be kept as low as reasonably achievable, economic and social factors being taken into account, within the restriction that the doses to individuals delivered by the source be subject to dose constraints.

## b) Optimization of protection and safety (cont'd)

From the view point of control of accidental and emergency occupational exposures, ICRP shows in Publication 63 and reiterated in Publication 109 the three categories of workers are defined in relation to the actions that may be required following an accident affecting the public.

- a) Category I: Urgent action at the site of the accident  
(plant personnel, emergency workers such as fire fighters)
  
- b) Category II: Implementing early protective actions and taking action to protect public  
(additional workers such as police, medical personnel, drivers and crew of vehicles for evacuation)
  
- c) Category III: Recovery operations  
(workers involved by such operations)

## b) Optimization of protection and safety (cont'd)

### Category I:

- Workers involved in Category 1 operations are most likely to be plant personnel who should be provided with appropriate means to control and quantify their exposures using means appropriate to the situation, such as direct reading or alarming dosimeters.
- For this category, it is recommended to define appropriate reference levels for mitigation actions.
- This type of emergency intervention usually has a high degree of justification and is often aimed at saving human lives or preventing individuals from incurring high doses beyond the thresholds for deterministic effects or prevention the development of catastrophic conditions, which might result in significant exposure of members of the public.

## b) Optimization of protection and safety (cont'd)

### Category II:

- workers who are normally regarded as being occupationally exposed and others such as emergency service personnel who are not;
- The aim is to keep their doses below the occupational limits when feasible;
- In case of no individual monitoring, it would be necessary for estimates to be made of the doses that they have received.

## b) Optimization of protection and safety (cont'd)

### Category III:

- Category III operations involve workers undertaking recovery operations, such as repairs to the plant and site, waste disposal, decontamination of the site and the environment.
- This work can be carefully planned. It should be treated as a practice and doses should be maintained below the dose limits.
- The training required for workers involved in Category III operations will depend on the actual situation and cannot be identified in advance.
- The assessment of doses to workers in Category III operations will be the same as for any occupationally exposed workers, who are subject to the system of radiological protection for practices.

## b) Optimization of protection and safety (cont'd)

- The workers involved in all categories should be informed on request of the doses received and the possible health consequences.
- The doses received in emergency situations should not compromise the further employment of the worker in work with ionizing radiation.
- However, where a worker has received an emergency exposure around or above the reference levels, the worker should be referred to a physician.

## c) Dose limitation

- The exposure of individuals during normal operations shall be restricted so that
- neither the total effective dose nor the total equivalent dose to relevant organs or tissues, caused by the possible combination of exposures from authorized practices, exceeds any relevant dose limit specified, except in special circumstances provided for in the Standards.

## 7. Summary

- In order to be effective, the response to a nuclear or radiological emergency must be well coordinated and arrangements must be appropriately integrated with those for a conventional emergency.
- In addition, the misconceptions prevailing concerning nuclear and radiological emergencies and the possible health effects of radiation exposure could lead to inappropriate actions being taken.
- Consequently, preplanning on the basis of established principles of radiation protection and safety is essential. Such preplanning can be achieved only through a coordinated approach.
- The aim of this workshop is to provide practical guidance on occupational radiation protection for workers involved in operation and radiation control of a plant during operations with high occupational exposure, particularly those engaged in urgent actions at the site of the accident or of the radiological emergency.