

# Occupational Radiation Protection during High Exposure Operations

Basic Concepts of  
Occupational Radiation Protection with High Exposure

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# 1. Occupational exposure of emergency workers

## General definitions

### Emergency Workers

Emergency workers are workers who work for emergency exposure situations in the operating organization (registrant, licensee) or in one of the emergency response organizations. The exposure they receive is occupational exposure and GSR Part 3 specifies the requirements.

### Helpers

GSR Part 7 identifies that other people, called “helpers in an emergency”, may volunteer as emergency workers and are integrated in the emergency response. The helpers in an emergency exposure situation are treated and are protected in the same way as the emergency workers.

### First responders

*These are the first members of an emergency service to respond at the site of an emergency*

# 1. Occupational exposure of emergency workers

## Groups of workers in emergency situation (DS453)



There are four groups of workers that may be exposed in an emergency exposure situation either due to their involvement in the emergency response or due to the nuclear or radiological emergency at a facility or an activity itself.

a) Emergency workers who have specified duties;

Protection of these emergency workers should be provided in line with the requirements set out in GSR Part 3 for emergency exposure situation and in GSR Part 7.

b) Workers performing their duties at working places and being not involved in response to a nuclear or radiological emergency;

Protection of these workers should be provided in the same way as for workers in planned exposure situation in line with the requirements set out in GSR Part 3.

# 1. Occupational exposure of emergency workers

## Groups of workers in emergency situation

- (c) Workers who are asked to stop performing their duties at working places and to leave the site;  
Protection of these workers should be provided in the same way as for members of the public in emergency exposure situation in line with the requirements set out in GSR Part 7.
  
- (d) Workers who are accidentally exposed as a result of an accident or incident at a facility or in an activity and whose exposure is not related to the emergency response.  
Protection of these workers who are accidentally exposed in relation to medical follow-up and treatment and dose assessment should be in line with GSR Part 3 and GSR Part 7.

## 2. Responsibilities of the Government and operators

The arrangements for the protection of workers in an emergency should be a part of the emergency plan that is prepared on the basis of the hazard assessment in accordance with GSR Part 7. The degree of planning should be commensurate with the nature and magnitude of the risk and the feasibility of mitigating the consequences should an emergency occur.

## 2. Responsibilities of the operators

With regard to the protection of emergency workers, the emergency plan should include:

- a) The persons or organizations responsible for ensuring compliance with requirements for protection and safety of workers in a nuclear or radiological emergency including those for controlling the exposure of emergency workers;
- b) Defined roles and responsibilities of all workers involved in the response to a nuclear or radiological emergency;
- c) Details of adequate self-protective actions to be taken, protective equipment and monitoring equipment to be used, and dosimetry arrangements;
- d) Consideration access control for workers in a nuclear or radiological emergency on the site.

### 3. Protection of emergency workers

Protection of emergency workers should include, as a minimum:

- a) Training of emergency workers designated as such in advance
- b) Providing instructions immediately before responding to the emergency on the expected radiation conditions, on the protective measures the workers should take and on the actions expected to be performed in the emergency areas (“just in time training”)
- c) Managing, controlling and recording the doses received
- d) Provision of appropriate specialized protective equipment and monitoring equipment
- e) Medical follow-up and psychological counselling, as appropriate
- f) Obtaining informed consent to perform specified duties, when appropriate

### 3. Protection of emergency workers

Emergency workers who are not designated as such at preparedness stage should be registered and integrated into the emergency response operations in line with GSR Part 7. At the same time it may well be necessary to plan for 24-hour working and to have such workers available for shift work.

It is also good practice to limit the number of workers receiving emergency exposures by evacuating all unnecessary people from the vicinity of the accident.

# 4. Justification and Optimization

## 4.1. Justification

At the preparedness stage, the protective actions and other response actions to be taken in a nuclear or radiological emergency should be justified.

Due consideration should be given to the detriment associated with doses received by the emergency workers implementing those actions.

There should be a commitment to the justification process by all stakeholders (regulatory body, response organisations and interested parties).

## 4. Justification and Optimization

### 4.2. Optimization

At the preparedness stage, the process of optimization, including the use of reference levels, should be applied to the protection of workers as well.

There should be a commitment to the optimization process by all stakeholders (regulatory body, response organisations and interested parties).

# 4. Justification and Optimization

## 4.2. Optimization

As part of the process of optimization, reference levels should be established. A reference level should represent the level of dose above which it is judged to be inappropriate to plan to allow exposures to occur and therefore all the actions should be planned and optimized.

The doses to be compared with the reference levels are usually prospective doses, i.e. doses that may be received in the future, as it is only those doses that can be influenced by decisions on protective actions. They are not intended as a form of retrospective dose limit.

# 4. Justification and Optimization

## 4.2. Optimization

The initial phase of a response to a nuclear or radiological emergency is characterized by:

- a lack of information about the event,
- a scarcity of materials for implementation of protective measures and
- the need for urgency in implementing protective actions.

Therefore, there is little or no scope for applying the optimization process when managing the protection of emergency workers during this initial phase. Efforts should be aimed at reducing any exposures as far as practicable taking into account the difficult conditions of the evolving emergency.

# 4. Justification and Optimization

## 4.2. Optimization

The operating organization and response organizations shall ensure that arrangements are in place for the protection of emergency workers and protection of helpers in an emergency for the range of anticipated hazardous conditions in which they might have to perform response functions. These arrangements, as a minimum, shall include:

- (a) Training those emergency workers designated as such in advance;
- (b) Providing emergency workers not designated in advance and helpers in an emergency immediately before the conduct of their specified duties with instructions on how to perform the duties under emergency conditions('just in time' training);
- (c) Managing, controlling and recording the doses received;
- (d) Provision of appropriate specialized protective equipment and monitoring equipment;
- (e) Provision of iodine thyroid blocking, as appropriate, if exposure due to radioactive iodine is possible;
- (f) Obtaining informed consent to perform specified duties, when appropriate;
- (g) Medical examination, longer term medical actions and psychological counselling, as appropriate (GSR Part 7, parag.5.52)

# 4. Justification and Optimization

## 4.2. Optimization

The operating organization and response organizations shall ensure that all practicable means are used to minimize exposures of emergency workers and helpers in an emergency in the response to a nuclear or radiological emergency (see para. I.2 of Appendix I), and to optimize their protection. (GSR Part 7, parag.5.53.)

# 4. Justification and Optimization

## 4.2. Optimization

When implementing protective actions during the late phase and at the transition from an emergency exposure situation to an existing exposure situation, the optimization process should be applied to the protection of emergency workers in the same way as for workers in planned exposure situations.

## 4.3. Restricting exposure of emergency workers

- Because the exposure of emergency workers is deliberate and controlled, the dose limits for workers should be assumed to apply unless there are overriding reasons not to apply them. In terms of para. 4.15 of GSR Part 3 and GSR Part 7 , response organizations and employers have to ensure that no emergency worker is subject to an exposure in an emergency in excess of 50 mSv other than:
  - (a) For the purposes of saving life or preventing serious injury;
  - (b) When undertaking actions to prevent severe deterministic effects and actions to prevent the development of catastrophic conditions that could significantly affect people and the environment; or
  - (c) When undertaking actions to avert a large collective dose.

## 4.3. Restricting exposure of emergency workers

- Reference levels expressed as guidance values for restricting the exposure of emergency workers should be defined in accordance with the assigned task as provided in Table IV-2 of GSR Part 3.

Where lifesaving actions are concerned, every effort should be made to keep individual doses of emergency workers below 500 mSv for exposure to external penetrating radiation, while other types of exposure need to be prevented by all possible means.

However, while estimating dose to emergency workers, the exposure from all pathways, external and internal, should be assessed and included in the total.

The value of 500 mSv should be exceeded only under circumstances in which the expected benefits to others clearly outweigh the emergency worker's own health risks, and the emergency worker volunteers to take the action and understands and accepts this health risk.

**TABLE IV-2.**  
**GUIDANCE VALUES FOR RESTRICTING**  
**EXPOSURE OF EMERGENCY WORKERS**

Tasks	Guidance value
Life saving actions	<ul style="list-style-type: none"> <li>• <math>H_p(10) &lt; 500</math> mSv or</li> <li>• <math>E &lt; 500</math> mSv, or</li> <li>• Total dose less than the generic criteria for which protective actions and other response actions are expected to be undertaken under any circumstance to avoid or to minimize severe deterministic effects.</li> </ul>
Actions to prevent severe deterministic effects and actions to prevent the development of catastrophic conditions that could significantly affect people and the environment	<ul style="list-style-type: none"> <li>• <math>H_p(10) &lt; 500</math> mSv or</li> <li>• <math>E &lt; 500</math> mSv,</li> </ul>
Actions to avert a large collective dose	<ul style="list-style-type: none"> <li>• <math>H_p(10) &lt; 100</math> mSv or</li> <li>• <math>E &lt; 100</math> mSv,</li> </ul>

## 5. Management of high occupational exposures

The government needs to establish a programme for managing, controlling the doses received by emergency workers in a nuclear or radiological emergency. Response organizations and employers should implement this programme.

The group of emergency workers may be further divided into 3 categories of emergency worker:

- a) Category 1
- b) Category 2
- c) Category 3

## 5. Management of high occupational exposures

### Category of emergency worker

#### Category 1

Emergency workers undertaking mitigatory actions and urgent protective actions on the site – include life-saving actions or to prevent serious injury or actions to prevent development of catastrophic conditions that could significantly affect people and the environment, actions to prevent serious deterministic effects and actions to avert large collective dose.

#### Category 2

Emergency workers undertaking urgent protective actions off the site to avert a large collective dose (e.g. evacuation, sheltering, radiation monitoring, etc.).

#### Category 3

Emergency workers undertaking early protective actions and other response actions off site (e.g. relocation, decontamination, environmental monitoring, etc.) as well as other actions aimed to enable the termination of the emergency.

## 5. Management of high occupational exposures

Any limit in duration of work undertaken by emergency workers and conditions by which they will conduct the work should be implemented by planning the emergency work driven by dose guidance values.

Task should be assigned depending on the category of emergency worker:

- a) Category 1 : these emergency workers should carry out actions to save life or prevent serious injury and actions to prevent severe deterministic effects and actions to prevent the development of catastrophic conditions that could significantly affect people and the environment.
- b) Category 2 : these emergency workers should not be the first choice for taking life-saving actions.
- c) Category 1 and 2 : these emergency workers should carry out actions to avert a large collective dose
- d) Category 3 : these emergency workers and helpers should carry out those actions in which they will not receive a dose of more than 50 mSv.

## 5. Management of high occupational exposures

Female workers who are aware that they are pregnant should be encouraged to notify their supervisor and should typically be excluded from emergency tasks unless such tasks can be carried out within the requirements for occupational exposure for the fetus established in GSR Part 3 (equivalent dose lower than 1 mSv during the pregnancy).

Female workers who are breast feeding should be excluded from emergency tasks where open sources are involved.

## 5. Management of high occupational exposures

Emergency workers who undertake actions in which the doses received might exceed 50 mSv do so voluntarily and should have been clearly and comprehensively informed in advance of the associated health risks, as well as of available protective measures, and should be trained, to the extent possible, in the actions they are required to take.

The voluntary basis for response actions by emergency workers is usually covered in the emergency arrangements.

Workers should not normally be precluded from incurring further occupational exposure because of doses received in an emergency exposure situation.

# Examples of administrative controls

## SIMPLIFIED ADMINISTRATIVE CONTROLS FOR ACCESS TO HIGH AND VERY HIGH RADIATION AREAS AT NPP



New detector by safety injection piping in  
the auxiliary building

## HIGH RADIATION AREA – ADM CONTROLS

*Dose Rates > 1 mSv/h but Not Exceeding 10 mSv/hour at 30 centimeters from the Radiation Source or from any Surface Penetrated by the Radiation*



- Barricaded and conspicuously posted
- Access controlled by means of Radiation Work Permit or continuously escorted by qualified personnel
- Radiation monitoring device and a self-reading dosimeter
- Entry only after dose rate determination, knowledge, and pre-job briefing

## HIGH RADIATION AREA – ADM CONTROLS

Dose Rates **Greater than 10 mSv/hour at 30 centimeters** from the Radiation Source, but **less than 5 Sv/hour at 1 meter** from the Radiation Source

- conspicuously posted as a high radiation area
- locked or continuously guarded door or gate that prevents unauthorized entry (or barricaded, visible flashing light)
- Radiation Work Permit
- Radiation monitoring device (dose rate, dose, alarms)
- Continuously transmit dose rate and cumulative dose to a remote receiver monitored by RP, communication means
- Self reading dosimeters and be under surveillance..
- Impractical situation or inconsistent with ALARA – only Radiation Monitor

## 6. Assessment of HEO

Response organizations and employers should take all reasonable steps to assess and record the exposures received by workers in an emergency.

The exposures of emergency workers in an emergency response and of workers who are accidentally exposed should, if possible, be recorded separately from those incurred during routine work, but should be noted on the workers' records of occupational exposure.

## 6. Assessment of HEO

The degree of accuracy required for any exposure assessment should increase with the level of exposure likely to have been received by the worker.

The exposures of emergency workers should be monitored on an individual basis, using means appropriate to the situation, such as direct reading or alarm dosimeters.

Depending on the nature of the accident, it may well be appropriate to conduct an internal exposure assessment of workers.

## 6. Assessment of HEO

Records of occupational exposure should be generated and maintained in a simplified standard format by all response organizations and employers to avoid confusion.

The information on the doses received and the associated health risk should be communicated to the emergency workers involved.

Workers should not normally be precluded from incurring further occupational exposure because of doses received in an emergency exposure situation.

## 7. Medical supervision

Emergency workers and accidentally exposed employees should receive medical supervision appropriate for the dose they may have received.

Screening based on equivalent doses to specific radiosensitive organs as a basis for medical follow-up and counselling should be provided if an emergency worker or accidentally exposed employee has received an effective dose of 100 mSv over a period of a month or if the worker so requests.

Although, an emergency worker or accidentally exposed employee who receives doses in nuclear or radiological emergency should normally not be precluded from incurring further occupational exposure, qualified medical advice should be obtained before any further occupational exposure if an emergency worker or accidentally exposed employee has received an effective dose exceeding 200 mSv or at the request of the worker. Such a qualified medical advice is intended to assess the continued health fitness of the worker in line with the BSS.

## 7. Medical attention

A particular concern should be whether a worker has received a dose sufficient to cause severe deterministic effects. If the dose received by the worker exceeds the thresholds for severe deterministic effects specified in GSR Part 3 and GSR Part 7, protective actions and other response actions should be taken in accordance with GSR Part 7. Such actions may include:

- (a) Performing immediate medical examination, consultation and indicated treatment;
- (b) Carrying out contamination control;
- (c) Carrying out immediate decorporation (if applicable);
- (d) Carrying out registration for longer term medical follow-up;
- (e) Providing comprehensive psychological counselling ■