



**Australian Government**  
**Australian Radiation Protection  
and Nuclear Safety Agency**



# **Guide for Radiation Protection in Emergency Exposure Situations – The Framework**

**Radiation Protection Series G-3 Part 1**



## Radiation Protection Series

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) publishes Fundamentals, Codes and Guides in the Radiation Protection Series (RPS), which promote national policies and practices that protect human health and the environment from harmful effects of radiation. ARPANSA develops these publications jointly with state and territory regulators through the Radiation Health Committee (RHC), which oversees the preparation of draft policies and standards with the view of their uniform implementation in all Australian jurisdictions. Following agreement and, as relevant, approvals at the Ministerial level, the RHC recommends publication to the Radiation Health and Safety Advisory Council, which endorses documents and recommends their publication by the CEO of ARPANSA.

To the extent possible and relevant for Australian circumstances, the RPS publications give effect in Australia to international standards and guidance. The sources of such standards and guidance are varied and include the International Commission on Radiological Protection (ICRP); the International Commission on Non-Ionizing Radiation Protection (ICNIRP); the International Atomic Energy Agency (IAEA); and the World Health Organization (WHO).

**Fundamentals** set the fundamental principles for radiation protection and describe the fundamental radiation protection, safety and security objectives. They are written in an explanatory and non-regulatory style and describe the basic concepts and objectives of international best practice.

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# **Guide for Radiation Protection in Emergency Exposure Situations – The Framework**

***Radiation Protection Series G-3 Part 1***

**30 May 2019**

**This publication was prepared jointly with the Radiation Health Committee. The Radiation Health and Safety Advisory Council advised the CEO to adopt the Guide.**

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## **Acknowledgement of Country**

ARPANSA respectfully acknowledges Australia's Aboriginal and Torres Strait Islander communities and their rich culture and pays respect to their Elders past and present. We acknowledge Aboriginal and Torres Strait Islander people as Australia's first peoples and as the Traditional Owners and custodians of the land and water on which we rely.

We recognise and value the ongoing contribution of Aboriginal and Torres Strait Islander peoples and communities to Australian life and how this enriches us. We embrace the spirit of reconciliation, working towards the equality of outcomes and ensuring an equal voice.

## Foreword

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The management of risks from ionising radiation requires actions that are based on fundamental principles of radiation protection, safety and security. The *Fundamentals for Protection Against Ionising Radiation*, Radiation Protection Series (RPS) F-1 (ARPANSA 2014a) provides an understanding of the effects of ionising radiation and associated risks for the health of humans and of the environment. As the top tier document in the Australian national framework to manage risks from ionising radiation, RPS F-1 also explains how radiation protection, safety and security can work individually and collectively to manage radiation risks. Finally, it presents ten fundamental principles and outlines how they can be applied in the management of radiation risks.

Exposures to ionising radiation can be incurred under different circumstances. RPS F-1 differentiates between *planned exposure situations* (where management of the exposure can be planned in advance); *existing exposure situations* (an exposure that exists when a decision on its management needs to be taken); and *emergency exposure situations* arising from loss of control or breakdown of radiation protection, from malicious acts, or from any other unexpected situation that requires urgent action in order to reduce or avoid undesirable consequences. This *Guide for Radiation Protection in Emergency Exposure Situations - The Framework*, RPS G-3 Part 1, sets out the framework in Australia for the protection of emergency workers, helpers, the public and the environment in emergency exposure situations.

The application of this guide is intended to ensure that suitable actions are taken to reduce any adverse health effects directly related to radiation, by preventing harmful tissue reactions and minimising the stochastic risk (such as the risk for cancer) to both members of the public and workers, in emergency exposure situations. It considers all hazard types in Australia regardless of potential consequences. For example, an emergency involving a nuclear reactor will require a comprehensive approach to establishing arrangements for preparedness and response. Other emergencies involving radioactive materials may only require consideration of certain elements of the preparedness arrangements. This guide applies a graded approach when considering the application, justification and optimisation of preparedness strategies and response actions.

An important consideration in nuclear and radiological emergencies is the effects on mental and social well-being that can be attributed to the event. This guide includes advice on information and engagement with affected parties. Other health authorities, other than the radiation regulators, may have to be consulted for advice on such matters; this is also an area of much research and learnings from nuclear and radiological emergencies around the world.

This guide should be read in combination with the *Guide for Radiation Protection in Emergency Exposure Situations - Planning, Preparedness, Response and Transition*, RPS G-3 Part 2, (ARPANSA 2019) and is intended to be used in conjunction with guidance for planned exposure situations and existing exposure situations. These exposure situations are dealt with by other publications in the Radiation Protection Series.

Carl-Magnus Larsson  
CEO of ARPANSA

30 May 2019

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# 1. Introduction

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## 1.1 Citation

This publication may be cited as the *Emergency Exposure Guide - The Framework* (2019).

## 1.2 Background

The International Commission on Radiological Protection (ICRP) in its *2007 Recommendations of the International Commission on Radiological Protection*, ICRP Publication 103 (ICRP 2007), take a consistent approach for all types of radiation exposure situations (planned, emergency and existing exposure situations), with the central consideration being the optimisation of radiation protection.

This guide applies to emergency exposure situations and aims to promote the implementation of the relevant requirements of the International Atomic Energy Agency (IAEA) General Safety Requirements No. GSR Part 3, *Radiation Protection and Safety of Radiation Sources: International Basic Safety* (IAEA 2014), and the IAEA General Safety Requirements No. GSR Part 7, *Preparedness and Response for a Nuclear or Radiological Emergency* (IAEA 2015).

## 1.3 Purpose

The purpose of this guide is to outline the Australian framework for establishing the level of preparedness and response required in order to effectively respond to a nuclear or radiological emergency, to mitigate and minimise consequences of emergencies, including impact on health<sup>1</sup>, and for protection of occupationally exposed persons, members of the public and the environment from the harmful effects of ionising radiation in emergency exposure situations.

It is intended that the relevant regulatory authorities, response organisations and operating organisations around Australia will use this document in conjunction with the *Guide for Radiation Protection in Emergency Exposure Situations - Planning, Preparedness, Response and Transition*, RPS G-3 Part 2 (ARPANSA 2019) to guide their actions for preparedness and response in emergency exposure situations.

## 1.4 Scope

This guide applies to emergency exposure situations and covers:

- preparedness and response for a nuclear or radiological emergency in relation to all facilities and activities, including radioactive sources, that have the potential for causing radiation exposure, environmental contamination or concern on the part of the public, that warrant protective actions and other response actions
- preparedness and response for a nuclear or radiological emergency in relation to off-site jurisdictions, which may need to take protective actions and other response actions

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<sup>1</sup> Health is defined by the World Health Organization as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.



- preparedness and response for a nuclear or radiological emergency irrespective of the initiator of the emergency; whether the emergency follows a natural event, a human error, a mechanical or other failure, or a nuclear security event. Such security events include, but are not limited to, criminal or intentional unauthorised acts involving or directed at nuclear or radiological material, associated facilities or associated activities.

This guide applies to the protection of people in an emergency, and does not provide advice on the protection of non-human biota (i.e. wildlife or domestic animals). Calculation of dose rate to wildlife during emergency exposure situations is considered in the *Guide for Radiation Protection of the Environment*, RPS G-1 (ARPANSA 2015).

## 1.5 Interpretation

This guide is explanatory in nature and provides guidance on radiation protection and emergency planning and response considerations, based on international best practice that should be implemented by relevant parties where appropriate and/or practicable.

This guide will use the generic term *emergency* throughout, which may be interpreted in reference to a radiological or nuclear incident, accident or event.

This guide should be used in conjunction with the following publications:

- *Guide for Radiation Protection in Emergency Exposure Situations - Planning, Preparedness, Response and Transition*, RPS G-3 Part 2 (ARPANSA 2019)
- *Code for Radiation Protection in Planned Exposure Situations*, RPS C-1 (ARPANSA 2016)
- *Guide for Radiation Protection in Existing Exposure Situations*, RPS G-2 (ARPANSA 2017)
- *Fundamentals for Protection Against Ionising Radiation*, RPS F-1 (ARPANSA 2014a).

## 1.6 Structure

This guide consists of:

- Section 1: background, purpose and scope
- Section 2: application of the radiation protection principles in emergency exposure situations
- Section 3: framework for preparedness and response in emergency exposure situations
- Annex A: guidance values for restricting exposure of emergency workers
- Annex B: generic criteria for doses for which protective actions and other response actions are expected to be taken in a nuclear or radiological emergency
- Annex C: Australian framework for preparedness and response applicable to radiation or nuclear events
- Appendix 1: ten principles of radiation risk management
- Appendix 2: derivation of the emergency exposure guide clauses from GSR Part 7 (IAEA 2015).

Explanations of technical terms used in this guide are provided in the Glossary. Publications underpinning this guide are listed in the References section.

## 2. Radiation protection for emergency exposure situations

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### 2.1 Principles of protection

The international system of radiation protection is underpinned by principles that guide actions to assess, control and manage radiation risks to protect human health and the environment.

Building on the international system, the *Fundamentals for Protection Against Ionising Radiation*, RPS F-1 (ARPANSA 2014a) sets out the underlying principles that form the basis of the system used to manage risks from ionising radiation in Australia. RPS F-1 (ARPANSA 2014a) provides an understanding of the effects of ionising radiation and associated risks for the health of humans and of the environment, and further explains how radiation protection, safety and security can work individually and collectively to manage radiation risks. These principles are outlined in Appendix 1.

All exposures are classified into the following three types of exposure situation consistent with ICRP 103 (ICRP 2007) and GSR Part 3 (IAEA 2014).

- **Planned Exposure Situations:** situations where radiation protection can be planned in advance, before exposures occur and where the magnitude and extent of exposures can be reasonably predicted. Planned exposure situations may result in exposures that are anticipated to occur (normal exposures) and in potential exposures that are not anticipated to occur, but may do so. The requirements for planned exposure situations can be found in RPS C-1 (ARPANSA 2016).
- **Emergency Exposure Situations:** situations that may occur during the operation of planned exposure situations if loss of control or breakdown of radiation protection occurs, or from malicious acts, or from any other unexpected situation that requires urgent action in order to reduce or avoid undesirable radiological and non-radiological consequences. These exposure situations are not planned and the source may not be possible to fully control. Emergency exposure situations are dealt with in this guide.
- **Existing Exposure Situations:** these are exposure situations that already exist when a decision on control has to be taken, including prolonged exposure situations after emergencies. Guidance for existing exposure situations can be found in RPS G-2 (ARPANSA 2017).

The system also considers the three principles of radiation protection, being:

- justification – that any activity involving radiation or that alters radiation exposure should do more good than harm
- optimisation – that actual exposure, likelihood of exposures and number of exposed persons should be as low as reasonably achievable
- limitation – measures for controlling radiation risks in planned exposure situations must ensure that no exposed bears an unacceptable risk of harm, and that the environment is protected.

There are four categories of exposure identified in the RPS F-1 (ARPANSA 2014a), specifically:

- occupational (all exposure incurred by workers during the course of their work)

- public (exposure incurred by members of the public from radiation sources, excluding any occupational or medical exposure and the normal local natural background radiation)
- medical (incurred by patients undergoing medical diagnosis or treatment)
- environmental (associated with protection of the environment and incurred by non-human biota (or wildlife)).

Dose criteria serve as boundaries within which the optimisation process takes place and serve to reduce inequities of exposure. The three types of dose criteria are the following:

- reference levels (in emergency or existing controllable exposure situations) represent a level of dose to individuals that guides the optimisation process, above which it is judged to be inappropriate to plan to allow exposures to occur, and below which optimisation of protection should be implemented. The chosen value for a reference level will depend upon the prevailing circumstances of the exposure under consideration for the public and non-human biota, and the optimisation process may have to initially take a point of departure from levels that are above the reference level
- dose constraints (planned exposure situations except in medical exposure of patients) are prospective and source-related restriction on the individual dose from a source, which can be applied in the planning stage to provide a basic level of protection for the most highly exposed individuals from a source. Dose constraints serve as upper bounds on the dose in optimisation of protection for that source
- dose limits (planned exposure situations) are the value of the effective dose or the equivalent dose that shall not be exceeded.

For protection of non-human biota, the *Guide to Radiation Protection of the Environment*, RPS G-1 (ARPANSA 2015) provides guidance on screening dose rates and methodologies that may assist in reaching a regulatory decision. Further guidance on environmental protection under different exposure situations can be found in *Protection of the Environment under Different Exposure Situations*, ICRP Publication 124 (ICRP 2014).

The interrelationship between the components of the radiation protection system applied in Australia are illustrated in Figure 2.1.



**Figure 2.1:** The system of radiological protection illustrating the interrelationships of the principles of protection, the exposure situations, the categories of exposure, the dose criteria, and the application for implementation of the system.

## 2.2 Goals for radiation protection in an emergency exposure situation

Principle 9 of RPS F-1 (ARPANSA 2014a) specifies that arrangements must be made for emergency preparedness and response for incidents, accidents and malicious acts that may give rise to radiation risks.

The GSR Part 7 (IAEA 2015) further establishes the requirements and outlines that the goal of emergency preparedness is to ensure that an adequate level of capability is in place within operating organisations, and at local, regional and national levels for an effective response. This capability relates to an integrated set of infrastructural elements that include, but are not limited to: authority and responsibilities; organisation and staffing; coordination; plans and procedures; tools, equipment and facilities; training, drills and exercises; and a management system. In a nuclear or radiological emergency, the goals of emergency response are to:

- save lives
- regain control of the situation and to mitigate consequences
- render first aid, to provide critical medical treatment and to manage the treatment of radiation injuries
- avoid or to minimise severe tissue reactions (also known as deterministic effects)
- reduce the risk of stochastic effects
- keep the public informed and to maintain public trust
- mitigate, to the extent practicable, non-radiological consequences
- protect, to the extent practicable, property and the environment
- prepare, to the extent practicable, for the resumption of normal social and economic activity, and return to normal operations to the extent it is possible and can be done safely.

The implementation of the system of radiological protection requires that the exposure situation is well understood through an assessment that considers all relevant aspects of the exposure. The information from the assessment will form the basis for decisions on actions (if deemed necessary). Such decisions need to be taken in a transparent manner. Stakeholders are regarded as an asset who will contribute knowledge to the process, and engagement with stakeholders contributes to informed decisions and the best possible outcomes. Accountabilities need to be established and communicated, so that it becomes clear who the decision maker is and on what grounds decisions are taken.

## **2.3 Basic concepts of radiation protection, safety and security in emergency exposure situations**

Emergency exposure situations may be caused by many types of initiating events involving different radioactive materials and scenarios. ‘Events’ can occur, for example, at nuclear sites, medical facilities using radioactive materials, industrial sites that use or make radioactive sources or process materials containing naturally occurring radioactive material, or during the transport of radioactive materials. For these situations, where the use of radioactive material is regulated and therefore planned or documented in advance, it is possible to develop a protection strategy tailored to the specific characteristics of potential events.

Radiological emergencies could also be caused maliciously, for example, through the dispersal of radioactive material in a public place, or arise without warning in unexpected locations, for example, radioactive material out of regulatory control. For these scenarios, it is not always possible to plan a protection strategy in detail because the likely exposure pathways, time and location of exposure cannot always be known in advance. However, this does not preclude the preparation of generic protection strategies and the associated response plans. The inclusion of flexibility is of paramount importance to enable these generic plans to be adapted to the situation that may arise.

A ‘nuclear security event’ is an event that has potential or actual implications for nuclear security that must be addressed. Such events include criminal or intentional unauthorised acts involving or directed at nuclear or radiological material, associated facilities or associated activities. A nuclear security event, such as the

sabotage of a nuclear facility (either physically, electronically or both), the functioning of a radiological dispersal device, the use of a radiological exposure device, or the use of an improvised nuclear device by an adversary with malicious intent, may give rise to a nuclear or radiological emergency. It should be noted that a hoax situation may also give rise to a nuclear security event.

A security regime is implemented to protect persons, property, society, and the environment from malicious acts involving nuclear material and other radioactive material and seeks to achieve these objectives<sup>2</sup> through:

- prevention of a malicious act by means of deterrence and by protection of sensitive information
- management of an attempted malicious act or a malicious act by an integrated system of detection, delay, and response
- mitigation of the consequences of a malicious act.

NSS-13 (IAEA 2011a) requires that the definitions of ‘unacceptable exposure levels’ and ‘high radiological consequences’ are adopted into the Australian context. The consequences of a release of radioactive material are independent of the initiating event, therefore a consistent approach across security and safety related emergencies is recommended. The alignment of nuclear security terms to the relevant protective actions and dose criteria is provided in Table 2.1.

Unacceptable exposure levels recognise that emergencies may arise through both deliberate acts and accidents, and understanding that any exposure within the maximum permitted annual limit (50 mSv in a single year for workers) is considered tolerable. Australia has adapted the term ‘unacceptable radiological consequences’ from NSS-13 (IAEA 2011a) to unacceptable exposure levels in order to harmonise specific thresholds for safety, security and emergency preparedness and response. High radiological consequences are those for which the consequences would require the initiation of urgent protective actions ‘off-site’ or for the prevention of tissue reactions for people ‘off-site’ as described in Table B.1.

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<sup>2</sup> *Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities* NSS-13 (IAEA 2011a).

**Table 2.1:** Australian definitions for nuclear security events

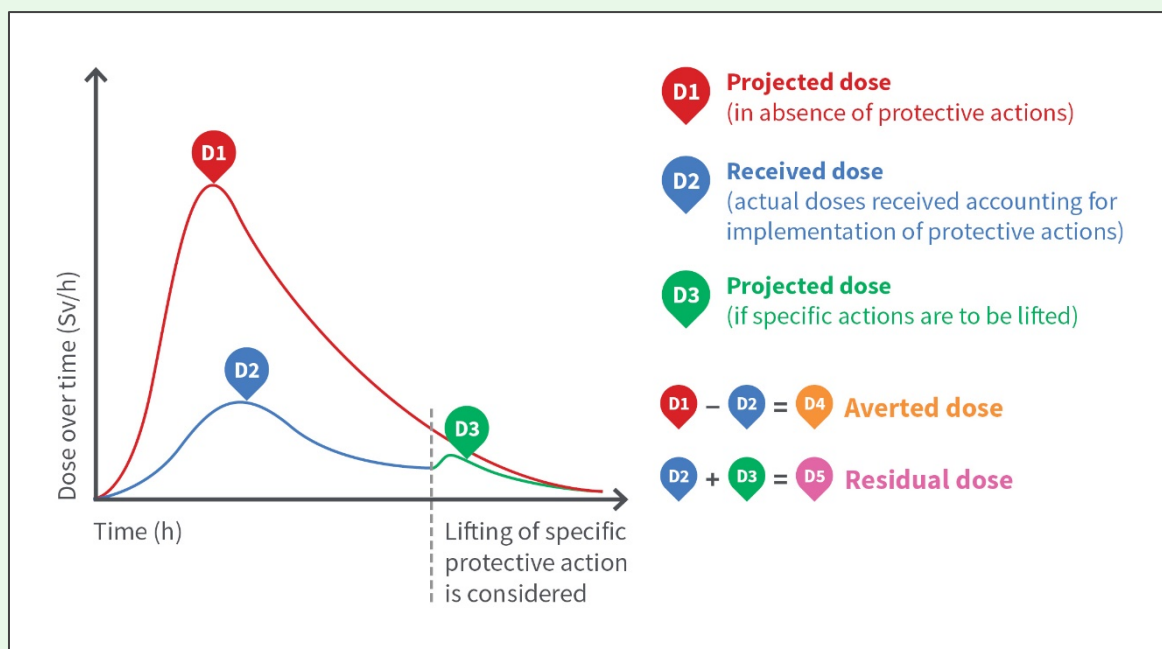
Security definitions	Basis for implementation of protective actions	This guide (Annex B)
High radiological consequences	Prevent severe tissue reactions (Annex C in RPS G-3 Part 2 (ARPANSA 2019))	Expected doses above those specified in Table B.1
Unacceptable exposure levels	Reducing the risk of stochastic effects (Annex C in RPS G-3 Part 2 (ARPANSA 2019))	Expected dose above those specified in Tables B.2 – B.5
Tolerable exposure levels	Optimisation of protection	Expected dose below those specified in Tables B.2 – B.5

In emergency exposure situations, the application of justified and optimised protection strategies is of importance. The optimisation process is guided by reference levels. An overall protection strategy is necessary, including an assessment of the radiological scenario and implementation of a range of protective measures. These measures will vary with time, as the emergency exposure situation evolves, and with place, as the emergency exposure situation may affect distinct geographic areas differently.



## Dose concepts explained

Figure 2.2 describes the dose concepts used during an emergency exposure situation. The dose which is predicted to occur as a result of the emergency exposure situation, should no protective actions be employed, is called the **projected dose**. The predicted dose that would result when a protection strategy is implemented is called the **residual dose**. In response, each protective measure will reduce the **received dose** by an amount. The difference between projected dose and received dose is referred to as **averted dose**. This quantity is a measure of the effectiveness of the individual protective measure.



**Figure 2.2:** Doses that occur during a response to an emergency. Adapted from IAEA training material.

## 2.4 Phases of an emergency exposure situation

The phases of a nuclear or radiological emergency can be distinguished on the basis of the timescales in which protective actions and other response actions are to be undertaken in order to achieve the goals of emergency response and to fulfil the prerequisites that would allow the declaration of the end of the emergency.

Defining discrete phases of a nuclear or radiological emergency supports the planning process. These efforts depend on the characteristics of each phase, subject to the information available and the specific activities to be carried out (see Figure 2.3).

The *preparedness stage* is when arrangements for an effective emergency response are established prior to a nuclear or radiological emergency. These arrangements include the development of a hazard assessment and a protection strategy. Hazard assessments identify potential consequences of an emergency and provide a basis for establishing arrangements for preparedness and response for a nuclear or radiological emergency. Assessed hazards are grouped in accordance with the categories shown in Section 3, Table 3.1. The five emergency preparedness categories in Table 3.1 establish the basis for a graded approach to the application of this guidance. Protection strategies are developed, justified and optimised at the preparedness stage for taking protective actions and other response actions. These strategies are needed for planning and executing effective communication during a nuclear or radiological emergency. Annex C provides the Australian framework for preparedness and response applicable to a nuclear or radiological emergency.

The *declaration of an emergency* is when a nuclear or radiological emergency is identified and the activation of emergency response plans and arrangements, which have been established at the preparedness stage, begins.

The *emergency response phase* is the period of time from the declaration of an emergency until the completion of all actions taken in anticipation of, or in response to, the radiological conditions expected during the emergency. This phase typically ends when the situation is under control, and the off-site radiological conditions have been characterised sufficiently well that all protective measures, such as food restrictions and temporary relocations, have been implemented. While the distinction between various phases of a nuclear or radiological emergency may be helpful for planning purposes, it can be difficult to clearly define the delineation of the different phases of an emergency during the emergency response as the emergency response actions are implemented on a continuous basis.

The *transition phase* is the period following the emergency response phase, when the situation is under control, detailed characterisation of the radiological situation has been carried out and activities are planned and implemented in order to enable the emergency to be declared terminated. For example, the transition phase may last only a few days for small scale emergencies (e.g. short-term loss of control of a hazardous radioactive source) but could take months or years for large scale emergencies (e.g. emergencies at nuclear installations resulting in significant off-site contamination).

The *termination of the nuclear or radiological emergency* marks the end of the transition phase in a particular area or site and the beginning of an existing exposure situation or a return to a planned exposure situation.



**Figure 2.3:** Phases of an emergency exposure situation as documented in this guide and an example of their alignment with phases of an emergency response plan.

## 2.5 National hazard assessment

The national hazard assessment is an evaluation of hazards within and beyond the boundaries of facilities, activities, sources or materials in order to identify those events that may require protective actions and/or other response actions.

A national hazard assessment should be carried out in order to provide a basis for developing generic arrangements in the preparedness and response for a nuclear or radiological emergency. The national hazard assessment should support categorisation relevant to Table 3.1 of this guide, which lists the five emergency preparedness categories that are used to group the assessed hazards with respect to their potential consequences.

In Australia, radioactive sources used for radiotherapy and for industrial radiography are strictly controlled and regulated. Other sources are used for a wide variety of purposes in industry, medicine, research and teaching as well as in a number of consumer products on sale to the public. These sources vary enormously in activity and activity concentration. These applications cannot be entirely free of the risk of accidents.

The public must feel confident that those organisations and authorities responsible do all in their power to minimise these risks; a process which includes learning from any accident that may occur despite all the precautions taken.

Nuclear or radiological emergencies are infrequent occurrences. Given the number of radioactive sources in use in Australia and around the world, the rarity of such emergencies bears witness to the effectiveness of the system of radiation protection, safety and security. The fact that accidents are uncommon should not, however, give grounds for complacency. No radiological accident is acceptable, and one that threatens widespread contamination is bound to alarm the public.

The following describes a variety of scenarios for certain events involving radioactive sources to assist in evaluating hazards that are relevant in the Australian context. Whether an event has occurred in Australia or not is immaterial. What matters is whether it can occur in Australia. These emergency scenarios, with the exception for nuclear power plant reactor emergencies, can occur in Australia and assist in the identification of national hazards and their potential consequences.

### 2.5.1 Nuclear power plant reactor emergencies

Nuclear power plant reactor emergencies may occur for a variety of reasons including degradation of irradiated fuel elements due to loss of ultimate heat sink. If the containment is breached or otherwise fail, doses above statutory limits may be received by on-site workers or members of the public in the vicinity of the reactor. Widespread environmental contamination may occur and lead to external exposure of the public from the ground and from immersion in radioactive material in the air, and to internal exposure from inhalation and ingestion of released radioactive material with contaminated food and water supplies. Reactor emergencies may also result in widespread non-radiological consequences including long-lasting effects on mental and social well-being, as well as effects on local economy and infrastructure. Australia does not have a nuclear power industry (Category I). Nuclear power plant reactor emergencies overseas may affect Australians living overseas and impact food and goods imported into Australia. In 2012,

ARPANSA assessed that the impact on the health of people living in Australia due to the 2011 Japan nuclear power plant accident was negligible (ARPANSA 2012).

### **2.5.2 Research reactor emergencies**

Research reactors are less hazardous than nuclear power plant reactors. They generally have much lower thermal effect, operate at lower temperatures, and are not pressurised. Like nuclear power plant reactors, research reactor emergencies may occur when breach of irradiated fuel elements occurs. Radiation doses above statutory dose limits may be received by on-site workers and potentially by members of the public in the vicinity of the reactor. Very localised environmental contamination may occur and lead to external exposure of the public from radioactive material in the air or on the ground or to internal exposure from inhalation and ingestion of released radioactive material. Reactor emergencies may also result in non-radiological consequences including effects on mental and social well-being. The Australian Nuclear Science and Technology Organisation (ANSTO) operates the 20 MW OPAL Research Reactor. A hazard assessment has been undertaken for the operation of the research reactor based on a reference accident approach (ARPANSA 2014b).

### **2.5.3 Nuclear powered warship emergencies**

Australia receives visits by nuclear powered warships to a number of approved ports around the country, including submarines and aircraft carriers. A nuclear reactor used for propulsion generates less thermal effect than most land-based power plant reactors, but more than most research reactors. Emergencies may occur from uncontrolled releases from a nuclear reactor on a visiting ship. Public exposures due to environmental contamination may occur due to exposure from radioactive material in the air (inhalation and external exposure) or deposited on the ground (ingestion of contaminated food and water, and external exposure). In Australia, a hazard assessment has been undertaken for each validated port, based on the use of a reference accident approach (ARPANSA 2000).

### **2.5.4 Criticality emergencies**

A criticality accident is an uncontrolled nuclear fission chain reaction that occurs when sufficient quantities of nuclear material are inadvertently allowed to undergo fission. The radiological consequence of a criticality accident could be severe in the vicinity of the accident. Prompt, high level exposure is generally associated with a criticality emergency, and can be lethal to workers in close proximity. Members of the public may also receive low doses due to the criticality accident. There is potential for a criticality accident in handling, storing, processing, and transporting fissile material. In Australia, there are a number of facilities where fissile materials are stored, handled, processed and transported. In most operations with fissile materials the risk of inadvertent criticality is very low, though this risk cannot be eliminated.

### **2.5.5 Space debris re-entry**

Satellites and space probes may use radioisotope thermoelectric generators or small fission-based reactors as power sources. Satellites that use these power sources have the potential to re-enter and burn-up in the atmosphere and disperse radioactive material. Widespread environmental contamination may occur and lead to internal exposure from inhalation and ingestion of released radioactive material. ARPANSA considered various dispersion scenarios from the controlled re-entry of the USA-193 Satellite in 2008

(ARPANSA 2008). In Australia, there has not been a serious injury or environmental contamination from re-entry of satellites and it is unlikely to occur in the future.

### **2.5.6 Material out of regulatory control**

A lost or stolen source is a special case of emergency involving radioactive material. The risk to the public will depend mainly on the type of radioactive material and its activity, and on the length of time that people may be exposed to the source. There is a high likelihood that the source may be in the vicinity or possession of persons who do not know its nature and hazard, who may handle or break it resulting in contamination. Such emergencies can result in high doses to the whole body or localised body areas, and internal or external contamination. Serious injury or death may be a consequence of these emergencies. Internationally, serious injury, death and wide spread environmental contamination has occurred, for example the 1987 Goiânia abandoned source accident in Brazil (IAEA 1988) and the 1994 Tammiku stolen source in Estonia (IAEA 1998).

### **2.5.7 Misuse of industrial radioactive material**

The misuse of industrial radioactive material may occur when proper procedures are not followed in industries that use ionising radiation, e.g. for industrial irradiators, industrial radiography, borehole logging and radiation gauges. Failure to use exposure control may lead to inadvertent overexposure to workers in the immediate work area. Touching the source for any reason often leads to serious injury to the body parts exposed. Whole body exposure in high doses may lead to death.

Emergencies for borehole logging that have occurred usually are due to operator error, equipment failure and loss or theft of the equipment. In Australia, serious radiation-related injuries were reported from a borehole logging operation event in 2014 in Queensland (Queensland Government 2017).

### **2.5.8 Transport emergencies**

Many transport operations involving radioactive material occur daily in Australia by road, rail, air, or sea. The spectrum of items transported varies greatly and includes nuclear industry products, radiography sources for industrial and medical use, gauges, and consumer products. The largest fraction of transport operations is associated with radiopharmaceuticals for medical use. Transport emergencies have the potential to occur anywhere and potentially affect the public. Nevertheless, transport emergencies involving the release of radioactive material are, compared to all other categories of transport emergencies, extremely rare. Moreover, when appropriately packaged for transport, these consignments are designed to retain integrity when subjected to foreseeable incident conditions (fire, pressure, etc.). Therefore, even in an emergency, it is unlikely that radioactive material will cause exposures if properly packed in accordance with the transport regulations. In 2010, a motor vehicle crash resulted in release of nuclear medicine radioactive material (ARPANSA 2011). The site was cordoned off and radiation safety staff attended. Post-incident, staff were monitored for contamination and the area cleaned up. Debris and contamination was removed and placed in bags and containers and disposed or stored appropriately. Due to the small area of contamination and the short half-life of radioactive substance there was no risk to persons or the environment.

### **2.5.9 Laboratory emergencies**

Emergencies in laboratories (research or hospital) that have occurred are usually due to operator error and involving spill of radioactive material. Emergencies in these laboratories could have a potential for severe exposure to personnel due to external exposure and/or internal exposure. In 2017, an accident leading to contamination of a worker at the Australian Nuclear Science and Technology Organisation (ANSTO) occurred during a routine quality control procedure causing radiation exposure to the skin of the hands. This exposure later resulted in tissue reactions to the hands (ARPANSA 2018).

### **2.5.10 Malicious use of radioactive material**

There is the possibility that a malicious act may be committed which involves the use of radioactive materials that could have widespread radiological consequences. These scenarios include:

- a threat to commit a malevolent act involving the use of radioactive materials
- the use of conventional explosives or other mechanisms to disperse radioactive materials, such as a Radiation Dispersal Device (RDD)
- a deliberate act to irradiate persons using Radiation Exposure Devices (RED), including but not limited to:
  - a deliberate act to contaminate food or water supplies with radioactive materials
  - a deliberate act to contaminate a site or the environment with radioactive materials
- a sabotage attack upon a nuclear facility aimed at causing an uncontrolled release of radioactive materials.

The suitability of a radioactive source for malevolent use will depend on the activity of the source, the type of radiation emitted by the source, the half-life of the source, the ease of accessibility to the radioactive material in the source, the portability of the source and the physical and chemical properties of the source. Radiological dispersal incidents are divided into two broad categories: those involving small and generally highly localised sources and those involving the dispersal of large amounts of radioactive materials over large areas.

#### **Localised sources**

Radioactive material may be used with the principal objective of causing fear and disruption within a population. People exposed to high levels of radiation to the whole body could develop acute adverse health effects, such as vomiting, nausea, diarrhoea or erythema. The effects of lower dose or localised exposures may only become apparent after some time.

#### **Widely dispersed sources**

Events that result in the dispersal of radioactive materials over large areas could occur through the use of explosives, or another mechanical device, coupled with large volumes of radioactive material, such as RDDs. If the target area is populated, individuals injured by the explosion are also likely to be contaminated with radioactive material.



Large sources of penetrating radiation are difficult to handle safely and without detection by authorities. If large sources are used in such devices, individuals may develop immediate adverse health effects from radiation exposure. Widespread contamination of air, food products and water supplies may also result. RDD dispersion analysis has been evaluated for a variety of scenarios by the Australian Department of Defence (DSTO 2012).

Nuclear reactors, spent fuel storage facilities including storage pools, transport vehicles, or any spent fuel and high-level waste facilities or sites are potential targets for the dispersal and release of radioactive materials into the environment.

Radioactive material may be distributed into water supplies or dispersed into the air. Because of the effect of dilution, the levels of radioactive material decrease rapidly and is likely to significantly reduce the exposure of people. The harm from this kind of source may primarily be psychological.

Radioactive material can also be hazardous if it enters a person's body, via inhalation, ingestion or through open wounds. Radiation-induced trauma and conventional trauma may act synergistically. The rate of morbidity and mortality depends on the treatment outcomes of the trauma that a person may have obtained (DoH 2012).

Inhalation of radioactive material in the vicinity of a fire or an explosion involving a very large activity radioactive source could lead to the development of immediate adverse health effects. However, this is only likely if the person is not wearing respiratory protection and is present either wittingly or unwittingly in the path of the prevailing wind for an extended period of time.

On the basis of these types of high activity radioactive sources in use in Australia, the RED, RDD, and contamination of food or water scenarios have been used for planning in the Australian Clinical Guidelines for Radiological Emergencies (Australian Government – Department of Health 2012).

### ***2.5.11 Emergencies involving improvised nuclear devices***

An Improvised Nuclear Device (IND) is an illicit nuclear weapon. They are very difficult to fabricate, relying on clandestine activities to construct and transport and are unlikely to function correctly when detonated. However, an explosion of an IND may result in a nuclear emergency. There are a number of significant effects that should be considered in preparing to respond to such an event. A functioning device may produce an intense pulse of heat, light, air pressure, and prompt radiation. Radioactive material may also be rapidly propelled into the atmosphere. Much of this material would fall directly back down close to ground zero within several minutes after the explosion, but some material may also travel high into the atmosphere to be carried long distances by any prevailing wind. The U.S. National Council on Radiation Protection and Measurements (NCRP) has provided guidance on effective responses to radiological and nuclear terrorism incidents (NCRP 2010). For a 10 kT detonation (equivalent to the energy of a ten thousand tons of TNT) prompt radiation can be an important contributor to casualties. The prompt radiation, however, is of short duration and its intensity decreases with increasing distance. Fallout that is immediately hazardous to emergency workers, helpers and members of the public is likely to descend to the ground within the first few hours. The most significant hazard area will extend downwind from ground zero, and this area will decrease in size over a few days as the fallout decays.



Planning and response to these emergencies can vary depending on the assessment of the credible worst-case scenario<sup>3</sup>. The characteristics of possible health consequences arising from these different types of radiation emergencies in Australia are summarised in Table 2.2.

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<sup>3</sup> This hazard assessment does not attempt to determine the likelihood of security initiated events. These assessments are the role of the Australian Intelligence Community and may change rapidly or without notice.

**Table 2.2:** Australian hazard assessment

Type of radiation emergency	Emergency preparedness category	Potential for health effects related to radiation			Potential for health effects related to emergency			Potential number of people involved	
		Tissue reactions	Stochastic effects	Contaminated persons	Conventional trauma	Psychological localised	Psychological widespread	Limited	Large
Improvised nuclear device	Cat IV	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Reactor (OPAL)	Cat II	Possible	Possible	Possible	Possible	Yes	Yes	Yes	Possible
Reactor (NPW)	Cat V, with conditions of Cat I or II	Possible	Possible	Possible	Possible	Yes	Yes	Yes	Possible
Criticality	Cat III or IV	Possible	No	Possible	Possible	Yes	Possible	Yes	No
Radioisotope thermoelectric generators	Cat IV	Possible	No	Possible	No	Yes	Possible	Yes	Possible
Lost or stolen radioactive material	Cat IV	Possible	No	Possible	No	Yes	Possible	Possible	Possible
Misuse of industrial radioactive material	Cat IV	Possible	Possible	Possible	No	Yes	Possible	Yes	Possible
Transport/laboratory	Cat IV	No	No	Possible	Possible	Yes	No	Yes	No
Malicious use of radioactive material	Cat IV	Possible	Possible	Possible	Possible	Yes	Yes	Yes	Yes

## 2.6 National protection strategy

The national protection strategy should cover the period from the declaration of the emergency until the termination of the emergency to ensure all the goals of emergency response are met (Section 2.2).

Comprehensive emergency management strategies for facilities, practices, activities, sources or materials should be developed at the preparedness stage. Emergency management strategies should extend beyond the termination of an emergency, allowing for the necessary activities in achieving any long-term objective and should take into account the national protection strategy.

A complete hazard and threat assessment together with a fully developed, justified and optimised national protection strategy are needed for planning and executing effective communication during a nuclear or radiological emergency. Additionally, the emergency management strategies should use the hazards and threat assessment, and the national protection strategy to be coordinated and linked with other potential hazards, such as chemical, biological, natural disasters, i.e. an all-hazards approach.

A national protection strategy describes the outcomes required in response to a nuclear or radiological emergency during all its phases and how this will be achieved through implementation of a justified and optimised set of protective actions and other response actions. The development of a national protection strategy should be based on the national hazards identified in Section 2.4 and their potential consequences. This guide should be used to establish emergency management strategies for plans and arrangements at the preparedness stage.

Under Australian constitutional arrangements, the state and territory jurisdictions have primary responsibility for the protection of life, property and the environment within their jurisdiction. They have established plans in place to respond to, and recover from, natural and human-caused emergencies. To complement the efforts of State and Territory jurisdictions responding to a disaster or emergency, the Australian Government coordinates disaster assistance and maintains a range of preparedness and response plans.

Annex C describes the Australian framework for preparedness and response applicable to radiation and nuclear events. This guide should be considered as part of a national protection strategy for nuclear or radiological emergencies within Australia.

### 2.6.1 Reference levels for emergency exposure situations

GSR Part 7 (IAEA 2015) requires that national authorities to set a reference level in the range of 20 mSv to 100 mSv effective dose (acute or per year), including dose contributions via all exposure pathways.

For each emergency management strategy, the national reference level of 50 mSv effective dose (RHSAC 2017) should be used as a benchmark for optimisation of protection and safety, and planned actions to avoid or minimise severe tissue reactions.

This reference level acknowledges that it would be unacceptable to receive a dose during an emergency in Australia above which radiation workers are annually legislated (50 mSv). Any dose below 50 mSv would be tolerable, although not desirable, and any dose that requires the implementation of urgent protective actions would be high.

This national reference level should be used to reduce the risk of stochastic effects together with the generic criteria for taking protective actions and other response actions. The national reference level informs operational criteria (Annex A and B of RPS G-3 Part 2 (ARPANSA 2019)) in order to determine when to declare an emergency and initiate the different emergency response actions in line with clauses 3.1.27 - 3.1.31. The generic criteria (Annex B) are established as the basis for implementation of protective actions (RPS G-3 Part 2 (ARPANSA 2019)) and other response actions.

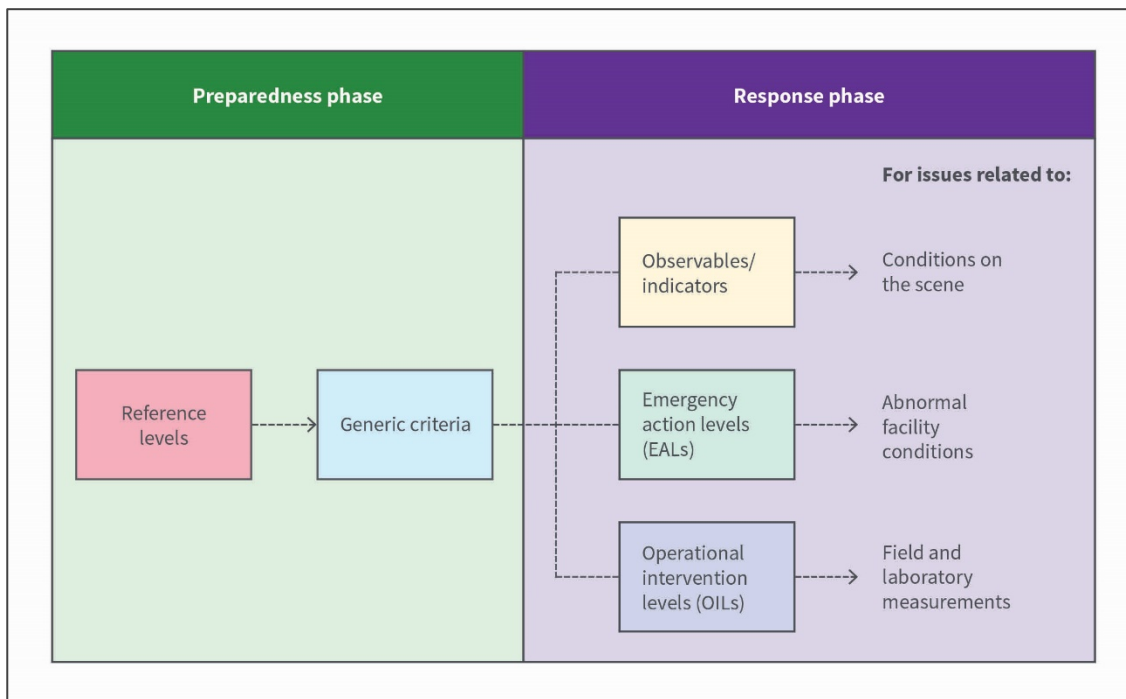
### **2.6.2 Generic criteria and operational criteria**

The system of generic criteria and operational criteria is illustrated in Figure 2.4. Since a national reference level of 50 mSv has been selected, all generic criteria and operational criteria have been adapted to reflect this selection. Generic criteria have been established on the basis of broad optimisation in consideration of the range of conditions that prevail in an emergency. These criteria are expressed in terms of the dose that has been projected or the dose that has been received (Section 2.3). Generic criteria are established as the basis for implementation of protective actions (RPS G-3 Part 2 (ARPANSA 2019)) and other response actions to meet the following three objectives:

- to prevent severe tissue reactions
- to take effective protective actions and other response actions to reasonably reduce the risk of stochastic effects
- to ensure the safety of emergency workers.

Generic criteria are not measurable quantities and cannot be used as a basis for quick actions in an emergency. There is a need to establish operational criteria (values of measurable default quantities or observables) as a surrogate for the generic criteria for undertaking different protective actions and other response actions.

The operational criteria are values of measurable quantities or observables that include operational interventional levels (OILs) (RPS G-3 Part 2 (ARPANSA 2019)), emergency action levels (EALs) (RPS G-3 Part 2 (ARPANSA 2019)), specific observables and other indicators (RPS G-3 Part 2 (ARPANSA 2019)) of conditions on the scene that should be used in decision-making during an emergency. The operational criteria can be used immediately and directly to determine the need for appropriate protective actions and other response actions (RPS G-3 Part 2 (ARPANSA 2019)).



**Figure 2.4:** System of generic criteria and operational criteria.

### 3. Framework for managing emergency exposure situations

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The Australian framework for emergency exposure situations is derived from recent ICRP and IAEA recommendations, in particular the requirements of GSR Part 7 (IAEA 2015). The framework that is presented in this Section is intended for the use of government organisations, emergency management organisations and response organisations. Well implemented, it will promote consistency and alignment with best practice for the preparedness and response to a nuclear or radiological emergency, across all Australian jurisdictions.

#### 3.1 General guidance

##### The emergency management system

*An integrated and coordinated emergency management system for preparedness and response for a nuclear or radiological emergency should be established and maintained.*

- 3.1.1. An emergency management system should be established and maintained on the territories of and within the jurisdiction of the country for the purposes of emergency response to protect human life, health, property and the environment in the event of a nuclear or radiological emergency.
- 3.1.2. The emergency management system should be designed to be commensurate with the results of the hazard assessment (see clauses 3.1.18 – 3.1.26) and should enable an effective emergency response to reasonably foreseeable events (including very low probability events).
- 3.1.3. The emergency management system should be integrated, to the extent practicable, into an all-hazards emergency management system (see clauses 3.2.6 and 3.2.7).
- 3.1.4. The coordination of and consistency of national emergency arrangements with the relevant international emergency arrangements<sup>4</sup> should be ensured.

##### Roles and responsibilities in emergency preparedness and response

*Provisions should be made to ensure that roles and responsibilities for preparedness and response for a nuclear or radiological emergency are clearly specified and clearly assigned.*

##### General

- 3.1.5. Adequate preparations should be made to anticipate, prepare for, respond to and recover from a nuclear or radiological emergency at the operating organisation, local, regional and national levels, and also, as appropriate, at the international level. These preparations should include

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<sup>4</sup> Arrangements set under the Assistance Convention (IAEA 1987) are examples of international emergency arrangements that are relevant for countries that are parties to these conventions.

adopting legislation and establishing regulations for effectively governing the preparedness and response for a nuclear or radiological emergency at all levels.

- 3.1.6. Arrangements should be in place for effectively governing the provision of prompt and adequate compensation of victims for damage due to a nuclear or radiological emergency.
- 3.1.7. All roles and responsibilities for preparedness and response for a nuclear or radiological emergency should be clearly allocated in advance among operating organisations, response organisations and the relevant authority<sup>5</sup>.
- 3.1.8. Operating organisations, response organisations and the relevant authority should ensure that they have the necessary human, financial and other resources, in view of their expected roles and responsibilities and the assessed hazards, to prepare for and to deal with both radiological and non-radiological consequences of a nuclear or radiological emergency, whether the emergency occurs within or beyond national borders.
- 3.1.9. Operating organisations, response organisations and the relevant authority should ensure the establishment, maintenance and demonstrate leadership in relation to preparedness and response for a nuclear or radiological emergency in the context of the IAEA General Safety Requirements No. GSR Part 2, Leadership and Management of Safety (IAEA 2016b).

### **Coordinating mechanism**

- 3.1.10. A national coordinating mechanism<sup>6</sup> should be established to be functional at the preparedness stage, consistent with the country's emergency management system, with the following functions:

- a. to ensure that roles and responsibilities are clearly specified and are understood by operating organisations, response organisations and the relevant authority (see clause 3.1.7)

To coordinate the hazard assessment within the country (see clauses 3.1.18 - 3.1.26) and periodic reviews of the assessed hazards (see clause 3.1.25)

- b. to coordinate and ensure consistency between the emergency arrangements of the various operating organisations, response organisations and the relevant authority at local, regional and national levels under the all-hazards approach, including those arrangements for response to relevant nuclear security events and, as appropriate, those arrangements of other countries and of international organisations
- c. to ensure consistency among requirements for emergency arrangements, contingency plans and security plans of operating organisations specified by the relevant authority and by other competent authorities with responsibilities for regulating nuclear security,

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<sup>5</sup> This also includes the allocation of roles and responsibilities, as appropriate, among members of the government.

<sup>6</sup> The mechanism for ensuring coordination may differ for different tasks. It may involve an existing body or a newly established body (e.g. a committee consisting of representatives from different organisations and bodies) that has been given the authority to ensure the necessary coordination.

as relevant, and to ensure that these arrangements and plans are integrated (see clause 3.1.14(b))

- d. to ensure that appropriate emergency arrangements are in place, both on-site and off-site, as appropriate, in relation to facilities and activities under regulatory control, both within the country and, as relevant, beyond its borders, and also for sources that are not under regulatory control<sup>7</sup>
- e. to coordinate arrangements made for enforcing compliance with the national requirements for emergency preparedness and response as established by legislation and regulations (see clauses 3.1.5 and 3.1.12)
- f. to coordinate a subsequent analysis of an emergency, including analysis of the emergency response (see clauses 3.2.102 – 3.2.105)
- g. to ensure that appropriate and coordinated programs of training and exercises are in place and implemented, and that training and exercises are systematically evaluated
- h. to coordinate effective communication with the public in preparedness for a nuclear or radiological emergency.

### **Regulatory body**

- 3.1.11. Arrangements for preparedness and response to a nuclear or radiological emergency for facilities and activities under the responsibility of the operating organisation should be dealt with through the regulatory process.
- 3.1.12. The regulatory body should establish or adopt regulations and guides to specify the principles, requirements and associated criteria for safety upon which its regulatory judgements, decisions and actions are based (IAEA 2016a). These regulations and guides should include principles, requirements and associated criteria for emergency preparedness and response for the operating organisation (see also clause 3.1.5).
- 3.1.13. Arrangements for preparedness and response for a nuclear or radiological emergency should require that an on-site area will be in place for any regulated facility or activity that could necessitate emergency response actions. Appropriate emergency arrangements should be established by the time the source is brought to the site, and complete emergency arrangements should be in place before the commencement of operation of the facility or commencement of the activity. The relevant authority should verify compliance with the requirements for such arrangements.
- 3.1.14. Before commencement of operation of the facility or commencement of the activity, there should be assurance, for all facilities and activities under regulatory control that could necessitate emergency response actions, that the on-site emergency arrangements:

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<sup>7</sup> Examples of sources not under regulatory control are sources that have been abandoned, lost or stolen and sources under governmental control but not under regulatory control. Examples also include radioactive material that is out of regulatory control as discussed in *Nuclear Security Recommendations on Nuclear and Other Radioactive Material out of Regulatory Control* NSS-15 (IAEA 2011c).



- a. are integrated with those of other response organisations, as appropriate
- b. are integrated with contingency plans in the context of NSS-13 (IAEA 2011a) and with security plans in the context of Nuclear Security Recommendations on Radioactive Material and Associated Facilities NSS-14 (IAEA 2011b)
- c. provide, to the extent practicable, assurance of an effective response to a nuclear or radiological emergency.

3.1.15. There should be assurance that the operating organisation is given sufficient authority to promptly take necessary protective actions on-site in response to a nuclear or radiological emergency that could result in off-site consequences.

### **Operating organisation**

3.1.16. The operating organisation should establish and maintain arrangements for on-site preparedness and response for a nuclear or radiological emergency for facilities or activities under its responsibility, in accordance with the applicable requirements (see clauses 3.1.5 and 3.1.12).

3.1.17. The operating organisation should demonstrate that, and should provide the relevant authority with an assurance that, emergency arrangements are in place for an effective response on-site to a nuclear or radiological emergency in relation to a facility or an activity under its responsibility.

## **Responsibilities of international organisations in emergency preparedness and response**

*Relevant international organisations should coordinate their arrangements in preparedness for a nuclear or radiological emergency and their emergency response actions.<sup>8</sup>*

## **Hazard assessment**

*A hazard assessment should be performed to provide a basis for a graded approach in preparedness and response for a nuclear or radiological emergency.*

3.1.18. Hazards should be identified and potential consequences of an emergency should be assessed to provide a basis for establishing arrangements for preparedness and response for a nuclear or radiological emergency. These arrangements should be commensurate with the hazards identified and the potential consequences of an emergency.

3.1.19. For the purposes of these safety requirements, assessed hazards are grouped in accordance with the emergency preparedness categories shown in Table 3.1. The five emergency

<sup>8</sup> The Inter-Agency Committee on Radiological and Nuclear Emergencies and its Joint Radiation Emergency Management Plan of the International Organisations are examples of such coordination.

preparedness categories (hereinafter referred to as ‘categories’) in Table 3.1 establish the basis for a graded approach to the application of these requirements and for developing generically justified and optimised arrangements for preparedness and response for a nuclear or radiological emergency.

**Table 3.1:** Emergency preparedness categories

Category	Description
I	Facilities, such as nuclear power plants, for which on-site events <sup>a, b</sup> (including those not considered in the design <sup>c</sup> ) are postulated that could give rise to severe tissue reactions off-site that would warrant precautionary urgent protective actions or early protective actions and other response actions to achieve the goals of emergency response in accordance with international standards <sup>d</sup> , or for which such events have occurred in similar facilities.
II	Facilities, such as some types of research reactors and nuclear reactors used to provide power for the propulsion of vessels (e.g. ships and submarines), for which on-site events <sup>a, b</sup> are postulated that could give rise to doses to people off-site that would warrant urgent protective actions or early protective actions and other response actions to achieve the goals of emergency response in accordance with international standards <sup>d</sup> , or for which such events have occurred in similar facilities. Category II (as opposed to category I) does not include facilities for which on-site events (including those not considered in the design) are postulated that could give rise to severe tissue reactions off-site, or for which such events have occurred in similar facilities.
III	Facilities, such as industrial irradiation facilities or some hospitals, for which on-site events <sup>b</sup> are postulated that could warrant protective actions and other response actions on-site to achieve the goals of emergency response in accordance with international standards <sup>d</sup> , or for which such events have occurred in similar facilities. Category III (as opposed to category II) does not include facilities for which events are postulated that could warrant urgent protective actions or early protective actions off-site, or for which such events have occurred in similar facilities.
IV	Activities and acts that could give rise to a nuclear or radiological emergency that could warrant protective actions and other response actions to achieve the goals of emergency response in accordance with international standards <sup>d</sup> in an unforeseen location. These activities and acts include: (a) transport of nuclear or radioactive material and other authorised activities involving mobile dangerous sources such as industrial radiography sources, nuclear powered satellites or radioisotope thermoelectric generators; and (b) theft of a dangerous source and use of a radiological dispersal device (RDD) <sup>e</sup> or radiological exposure device (RED) <sup>e</sup> . This category also includes: (i) detection of elevated radiation levels of unknown origin or of commodities with contamination; (ii) identification of clinical symptoms due to exposure to radiation; and (iii) a transnational emergency that is not in category V arising from a nuclear or radiological emergency in another country. Category IV represents a level of hazard that applies for all countries and jurisdictions.
V	Areas within emergency planning zones and emergency planning distances <sup>f</sup> in a country for a facility in category I or II located in another country.
a	That is, on-site events involving an atmospheric or aquatic release of radioactive material, or external exposure (due, for example, to a loss of shielding or a criticality event), that originates from a location on-site.
b	Such events include nuclear security events.
c	This includes events that are beyond the design basis accidents and, as appropriate, conditions that are beyond design extension conditions.
d	See the goals of emergency response in Section 2.2 and the generic criteria in Annex B.
e	A RDD is a device to spread radioactive material using conventional explosives or other mechanical means. A RED is a device with radioactive material designed to intentionally expose members of the public to radiation. They could be fabricated, modified or improvised devices.
f	See clause 3.2.38.

- 3.1.20. For facilities and activities, a hazard assessment on the basis of a graded approach should be performed. The hazard assessment should include consideration of:
- a. events that could affect the facility or activity, including events of very low probability and events not considered in the design
  - b. events involving a combination of a nuclear or radiological emergency with a conventional emergency such as an emergency following an earthquake, a volcanic eruption, a tropical cyclone, severe weather, a tsunami, an aircraft crash or civil disturbances that could affect wide areas and/or could impair capabilities to provide support in the emergency response
  - c. events that could affect several facilities and activities concurrently, as well as consideration of the interactions between the facilities and activities affected
  - d. events at facilities in other countries or events involving activities in other countries.
- 3.1.21. The hazard assessment should ensure the identification of those facilities and locations at which there is a significant likelihood of encountering a dangerous source that is not under control.<sup>9</sup>
- 3.1.22. The hazard assessment should include consideration of the results of threat assessments made for nuclear security purposes (IAEA 2011a, IAEA 2011b, IAEA 2011c).<sup>10</sup>
- 3.1.23. In the hazard assessment, facilities and activities, on-site areas, off-site areas and locations should be identified for which a nuclear or radiological emergency could — with account taken of the uncertainties in and limitations of the information available — warrant any of the following:
- a. precautionary urgent protective actions to avoid or to minimise severe tissue reactions by keeping doses below levels approaching the generic criteria at which urgent protective actions and other response actions are required to be undertaken under any circumstances, with account taken of Annex B
  - b. urgent protective actions and other response actions to avoid or to minimise severe tissue reactions and to reduce the risk of stochastic effects, with account taken of Annex B
  - c. early protective actions and other response actions, with account taken of Annex B
  - d. other emergency response actions such as longer term medical actions, with account taken of Annex B, and emergency response actions aimed at enabling the termination of the emergency (see clauses 3.2.95 - 3.2.101)
- or

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<sup>9</sup> Examples of such facilities and locations are: scrap metal processing facilities, border crossing points, seaports, airports and abandoned military facilities or other facilities where dangerous sources might have been used in the past.

<sup>10</sup> This includes consideration of 'strategic locations', i.e. locations of high security interest in the country which are potential targets for attacks using nuclear and other radioactive material and locations for detection of nuclear and other radioactive material that is out of regulatory control, in line with NSS-15 (IAEA 2011c).

- e. protection of emergency workers in accordance with clauses 3.2.49 - 3.2.61 and with account taken of Annex A.

- 3.1.24. The hazard assessment should also identify non-radiation-related hazards<sup>11</sup> to people on-site and off-site that are associated with the facility or activity and that may impair the effectiveness of the response actions to be taken.
- 3.1.25. The review of the hazard assessment should be performed periodically with the aims of:
- a. ensuring that all facilities and activities, on-site areas, off-site areas and locations where events could occur that would necessitate protective actions and other response actions are identified
  - b. taking into account any changes in the hazards within the country and beyond its borders, any changes in assessments of threats for nuclear security purposes, the experiences and lessons from research, operation and emergency exercises, and technological developments (see clauses 3.3.30, 3.3.36 and 3.3.38). The results of this review should be used to revise the emergency arrangements as necessary.
- 3.1.26. Operating organisations should review appropriately and, as necessary, revise the emergency arrangements:
- a. prior to any changes in the facility or activity that affect the existing hazard assessment
  - b. when new information becomes available that provides insights into the adequacy of the existing arrangements.<sup>12</sup>

### Protection strategy for a nuclear or radiological emergency

*Protection strategies should be developed, justified and optimised at the preparedness stage for taking protective actions and other response actions effectively in a nuclear or radiological emergency.*

- 3.1.27. On the basis of the hazards identified and the potential consequences of a nuclear or radiological emergency, protection strategies should be developed, justified and optimised at the preparedness stage for taking protective actions and other response actions effectively in a nuclear or radiological emergency to achieve the goals of emergency response.
- 3.1.28. Development of a protection strategy should include, but should not be limited to, the following:
- a. Consideration should be given for actions to be taken to avoid or to minimise severe tissue reactions and to reduce the risk of stochastic effects. Tissue reactions should be

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<sup>11</sup> Examples of non-radiation-related hazards are the release of toxic chemicals, e.g. uranium hexafluoride (UF<sub>6</sub>), fires, explosions and floods.

<sup>12</sup> Examples of such changes and available information include the movement of irradiated nuclear fuel to a new location, projected flooding, and information on storms or other meteorological hazards.

evaluated on the basis of relative biological effectiveness (RBE) weighted absorbed dose to a tissue or organ. Stochastic effects in a tissue or organ should be evaluated on the basis of equivalent dose to the tissue or organ. The detriment associated with the occurrence of stochastic effects in individuals in an exposed population should be evaluated on the basis of the effective dose.

- b. A reference level expressed in terms of residual dose has been set as 50 mSv, acute or annual effective dose that includes dose contributions via all exposure pathways (Section 2.5). This reference level should be used in conjunction with the goals of emergency response (Section 2.2) and the specific time frame in which particular goals are to be achieved.<sup>13</sup>
- c. On the basis of the outcome of the justification and the optimisation of the protection strategy, national generic criteria for taking protective actions and other response actions, expressed in terms of projected dose or of dose that has been received, have been developed with account taken of the generic criteria in Annex B. If the national generic criteria for projected dose or received dose are exceeded, protective actions and other response actions, either individually or in combination, should be implemented.
- d. Once the protection strategy has been justified and optimised and a set of national generic criteria have been developed, pre-established operational criteria on-site for initiating the different parts of an emergency plan and for taking protective actions and other response actions should be derived from the generic criteria<sup>14</sup> in Annex B. Operational criteria have been developed based on the generic criteria for Observables, EALs and OILs which are in Annex A and B of RPS G-3 – Part 2. Arrangements should be established in advance to revise these operational criteria, as appropriate, in the course of a nuclear or radiological emergency, with account taken of the prevailing conditions as they evolve.

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<sup>13</sup> The application solely of the reference level for effective dose would not be sufficient to develop the protection strategy. Consideration needs to be given to the particular goal to be met in the response, the time to allow for actions to be taken effectively, and the appropriate dose quantity to be used to ensure that organ doses will be kept below those at which protective actions and other response actions are justified (see clause 3.1.28 (a)). For example, actions to avoid or to minimise severe tissue reactions are to be taken urgently when projected doses expected to be received within a short period of time exceed those given in Table B.1 of Annex B for the RBE weighted absorbed dose to a tissue or organ. In this case, if such doses are received, then prompt and appropriate medical actions are necessary. Moreover, selection of a particular value (to be used for optimisation purposes and for retrospective assessment of the effectiveness of actions and strategy taken) within the reference level of 50 mSv acute or annual effective dose would depend on the phase of the emergency, the practicality of reducing or preventing exposures, and other factors. In the urgent response phase of an emergency, an effective dose of 50 mSv, acute or annual, might be justified as one of the dosimetric bases for implementing and optimising a protection strategy. In the later phases, such as during the transition, an effective dose of 20 mSv per year may be justified as one of the dosimetric bases for implementing and optimising a protection strategy to enable the transition to an existing exposure situation to be made.

<sup>14</sup> The operational criteria (i.e. operational intervention levels) need to be derived for a representative person with account taken of those members of the public that are most vulnerable to radiation exposure (i.e. pregnant women and children).

- 3.1.29. Each protective action, in the context of the protection strategy, and the protection strategy itself should be demonstrated to be justified (i.e. to do more good than harm), with account taken not only of those detriments that are associated with radiation exposure but also of those detriments associated with impacts of the actions taken on public health<sup>15</sup>, the economy, society and the environment.
- 3.1.30. All interested parties should be involved and to be consulted, as appropriate, in the development of the protection strategy.
- 3.1.31. The protection strategy should be implemented safely and effectively in an emergency response through the implementation of emergency arrangements, including but not limited to:
- a. promptly taking urgent protective actions and other response actions with account taken of Annex B to avoid or to minimise severe tissue reactions, if possible, on the basis of observed conditions and before any exposure occurs
  - b. taking early protective actions and other response actions to reduce the risk of stochastic effects with account taken of Annex B
  - c. providing for registration, health screening and longer term medical follow-up, as appropriate, with account taken of Annex B
  - d. taking actions to protect emergency workers, with account taken of guidance values provided in Annex A
  - e. taking actions to mitigate non-radiological consequences, with account taken of Annex B
  - f. assessing the effectiveness of the actions taken and adjusting them as appropriate on the basis of prevailing conditions and available information as well as the reference level expressed in terms of residual dose
  - g. revising the protection strategy as necessary and its further implementation
  - h. discontinuing protective actions and other response actions when they are no longer justified.

## 3.2 Functional guidance

### *General*

- 3.2.1. The requirements established in this section address the functions that are essential for the emergency response in a nuclear or radiological emergency to be effective and for achieving the goals of emergency response (Section 2.2).

### Managing operations in an emergency response

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<sup>15</sup> Examples of such impacts include possible deaths among patients evacuated without the necessary medical care and possible reduced life expectancy due to resettlement.

*Arrangements should be in place for operations in response to a nuclear or radiological emergency to be appropriately managed.*

- 3.2.2. For facilities in categories I, II and III, arrangements should be made for the on-site emergency response to be promptly executed and managed without impairing the performance of the continuing operational safety and security functions both at the facility and at any other facilities on the same site. The transition from normal operations to operations under emergency conditions on-site should be clearly specified and should be effectively made. The responsibilities of all personnel who would be on-site in an emergency should be designated as part of the arrangements for this transition. It should be ensured that the transition to the emergency response and the performance of initial response actions do not impair the ability of operating personnel (such as operating personnel in the control room) to ensure safe and secure operation while taking mitigatory actions.
- 3.2.3. For facilities in categories I, II and III, and, where appropriate, for activities in category IV, arrangements should be made for an off-site emergency response to be promptly executed, effectively managed and coordinated with an on-site emergency response.
- 3.2.4. For a site where several facilities in categories I and II are collocated, adequate arrangements should be made to manage the emergency response at all the facilities if each of them is under emergency conditions simultaneously. This should include arrangements to manage the deployment of and the protection of personnel responding on and off-site (see clauses 3.2.49 - 3.2.61).
- 3.2.5. For facilities and activities in categories I, II, III and IV, arrangements should be made, as far as practicable, so that the facility or activity has a nuclear security system or systems (IAEA 2011a, IAEA 2011b, IAEA 2011c) that would be functional in a nuclear or radiological emergency.
- 3.2.6. Arrangements for response to a nuclear or radiological emergency should be coordinated and integrated with arrangements at the local, regional and national levels for response to a conventional emergency and to a nuclear security event.<sup>16</sup> These arrangements should take into consideration the fact that the initiator of the nuclear or radiological emergency may not be known early in the response.
- 3.2.7. Arrangements should be made for the establishment and use of a clearly specified and unified command and control system for emergency response under the all-hazards approach as part of the emergency management system (see clauses 3.1.1 - 3.1.3). The command and control system should provide sufficient assurance for effective coordination of the on-site and off-site response. The authority and responsibility for directing the emergency response and for making decisions on emergency response actions to be taken should be clearly assigned. The responsibility for directing the emergency response and for decision making on emergency

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<sup>16</sup> The coordination and integration of arrangements for response to a nuclear or radiological emergency with arrangements for response to a nuclear security event includes coordination with and integration of arrangements for response measures such as identification, collection, packaging and transport of evidence contaminated with radionuclides, nuclear forensics and related activities in the context of an investigation into the circumstances surrounding a nuclear security event.

response actions to be taken should be promptly discharged following a notification of an emergency.

- 3.2.8. Arrangements should be made for obtaining and assessing the information necessary for making decisions on the allocation of resources for all response organisations throughout a nuclear or radiological emergency.
- 3.2.9. For facilities in category I or II and areas in category V, arrangements should be made for coordinating the emergency response between response organisations (including those of other countries) within the emergency planning zones and emergency planning distances (see clause 3.2.38) and for providing mutual support.
- 3.2.10. Arrangements should be made with other countries, as appropriate, for coordinated response to a radiological emergency.

### Identifying and notifying of a nuclear or radiological emergency and activating an emergency response

*Arrangements should be in place for the prompt identification and notification of a nuclear or radiological emergency and for the activation of an emergency response.*

- 3.2.11. An off-site notification point<sup>17</sup>, or more than one, should be established to receive notification of an actual or potential nuclear or radiological emergency. The notification point(s) should be maintained in a state of continuous availability to receive any notification or request for support and to respond promptly, or to initiate a pre-planned and coordinated off-site emergency response appropriate to the emergency class or the level of emergency response. The notification point(s) should be able to initiate immediate communication by suitable, reliable and diverse means with the response organisations that are providing support.
- 3.2.12. For facilities in categories I and II and for areas in category V, the notification point should be able to initiate immediate communication with the authority that has been assigned the responsibility to decide on and to initiate precautionary urgent protective actions and urgent protective actions off-site (see also clause 3.2.7).
- 3.2.13. For facilities and locations at which there is a significant likelihood of encountering a dangerous source that is not under control (see clause 3.1.21), arrangements should be made to ensure that the on-site managers of operations and other personnel are aware of the indicators of a potential radiological emergency, the appropriate notification, and protective actions and other response actions that are immediately warranted in an emergency. For facilities and locations for which there is a significant likelihood of encountering a dangerous source that is not under control and for an emergency at an unforeseen location, arrangements should be made to ensure that the local officials responsible for the response and first responders are aware of the

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<sup>17</sup> This may be the notification point used to receive notification of and to initiate an off-site emergency response to an emergency of any type (conventional, or nuclear or radiological).



indicators of a potential radiological emergency, the appropriate notification, and protective actions and other response actions that are warranted immediately in an emergency.

- 3.2.14. The operating organisation of a facility or activity in category I, II, III or IV should make arrangements for promptly classifying, on the basis of the hazard assessment, a nuclear or radiological emergency warranting protective actions and other response actions to protect workers, emergency workers, members of the public and, as relevant, patients and helpers in an emergency, in accordance with the protection strategy (see clauses 3.1.27 - 3.1.31). This should include a system for classifying all types of nuclear or radiological emergencies<sup>18</sup> as follows:
- a. *General emergency* at facilities in category I or II for an emergency that warrants taking precautionary urgent protective actions, urgent protective actions, and early protective actions and other response actions on-site and off-site. Upon declaration of this emergency class, appropriate actions should promptly be taken, on the basis of the available information relating to the emergency, to mitigate the consequences of the emergency on-site and to protect people on-site and off-site.
  - b. *Site area emergency* at facilities in category I or II for an emergency that warrants taking protective actions and other response actions on-site and in the vicinity of the site. Upon declaration of this emergency class, actions should promptly be taken: (i) to mitigate the consequences of the emergency on-site and to protect people on-site; (ii) to increase the readiness to take protective actions and other response actions off-site if this becomes necessary on the basis of observable conditions, reliable assessments and/or results of monitoring; and (iii) to conduct off-site monitoring, sampling and analysis.
  - c. *Facility emergency* at facilities in category I, II or III for an emergency that warrants taking protective actions and other response actions at the facility and on-site but does not warrant taking protective actions off-site. Upon declaration of this emergency class, actions should promptly be taken to mitigate the consequences of the emergency and to protect people at the facility and on-site. Emergencies in this class do not present an off-site hazard.
  - d. *Alert* at facilities in category I, II or III for an event that warrants taking actions to assess and to mitigate the potential consequences at the facility. Upon declaration of this emergency class, actions should promptly be taken to assess and to mitigate the potential consequences of the event and to increase the readiness of the on-site response organisations.
  - e. *Other nuclear or radiological emergency*<sup>19</sup> for an emergency in category IV that warrants taking protective actions and other response actions at any location. Upon declaration of this emergency class and the level of emergency response, actions should promptly be taken to mitigate the consequences of the emergency on-site, to protect those in the

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<sup>18</sup> The emergency classes may differ from those specified in (a) - (e) provided that emergencies of all these types are included.

<sup>19</sup> This class covers broad types of emergencies (see Table 1 and clauses 3.1.21 and 3.1.22). A graded approach may need to be taken when postulating emergencies and expected consequences within this class in order to determine the level of emergency response warranted.

vicinity (e.g. workers, emergency workers and the public) and to determine where and for whom protective actions and other response actions are warranted.

- 3.2.15. For facilities in category I, II or III and for category IV, arrangements should be made to review the declared emergency class in light of any new information and, as appropriate, to revise it.
- 3.2.16. The emergency classification system for facilities and activities in categories I, II, III and IV should take into account all postulated emergencies, including those arising from events of very low probability. The operational criteria for classification should include emergency action levels and other observable conditions (i.e. ‘observables’) and indicators of the conditions at the facility and/or on-site or off-site and can be found in Annex A and B of RPS G-3 Part 2 (ARPANSA 2019). The emergency classification system should be established with the aim of allowing for the prompt initiation of an effective response in recognition of the uncertainty of the available information. It should be ensured that any process for rating an event on the International Nuclear and Radiological Event Scale (INES) (IAEA 2013) does not delay the emergency classification or emergency response actions.<sup>20</sup>
- 3.2.17. For facilities and activities in categories I, II and III and IV, arrangements should be made: (a) to promptly recognise and classify a nuclear or radiological emergency; (b) upon classification, to promptly declare the emergency class and to initiate a coordinated and pre-planned on-site response; (c) to notify the appropriate notification point (see clause 3.2.11) and to provide sufficient information for an effective off-site response; and (d) upon notification, to initiate a coordinated and pre-planned off-site response, as appropriate, in accordance with the protection strategy. These arrangements should include suitable, reliable and diverse means of warning persons on-site, of notifying the notification point (see clauses 3.2.41 - 3.2.43, 3.3.22 and 3.3.34) and of communication between response organisations.
- 3.2.18. In the event of a transnational emergency, the notifying country should promptly notify<sup>21 22</sup> the IAEA of the emergency and, either directly or through the IAEA, those countries that could be affected by it. The notifying country should provide information on the nature of the emergency and on its potential transnational consequences, and should respond to requests from other countries and from the IAEA for information for the purposes of mitigating any consequences.
- 3.2.19. The country should make known to the IAEA and to other countries, directly or through the IAEA, its single warning point responsible for receiving emergency notifications and information from other countries and information from the IAEA. This warning point should be maintained in a state of continuous availability to receive any notification, request for assistance or request

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<sup>20</sup> The emergency classification system is not to be confused with the INES. The INES is a scale developed for use by countries solely for the purpose of communicating with the public on the safety significance of events associated with sources of radiation. The INES is not to be used as a basis for emergency response actions.

<sup>21</sup> Such a notification is in accordance with the country’s obligations under the general principles and rules of international law and, for the case of a transboundary release that could be of radiological safety significance for another country, it is in accordance with the Assistance Convention (IAEA 1987).

<sup>22</sup> A transnational emergency that is considered to represent a public health emergency of international concern may also be expected to be notified in accordance with the International Health Regulations (WHO 2005).

for verification and to promptly initiate a response or verification. The country should promptly inform the IAEA and should inform other countries, directly or through the IAEA, of any changes that occur in respect of the warning point. The country should make arrangements for promptly notifying and for providing relevant information, directly or through the IAEA, to those countries that could be affected by a transnational emergency.

- 3.2.20. The notifying country should have arrangements in place for promptly responding to requests from other countries or from the IAEA for information in respect of a transnational emergency, in particular with regard to minimising any consequences. These arrangements should include making known to the IAEA and to other countries, directly or through the IAEA, the notifying country's designated organisation(s) for so doing.
- 3.2.21. Arrangements should be made for promptly and directly notifying any country within the emergency planning zones and emergency planning distances (see clause 3.2.38) within which urgent protective actions, early protective actions and other response actions could be required to be taken.
- 3.2.22. Appropriate emergency response actions should be initiated in a timely manner upon the receipt of a notification from another country or of information from the IAEA on a notification relating to an actual or potential transnational emergency that could have impacts on the country or its nationals.

## Taking mitigatory actions

*Arrangements should be in place for taking mitigatory actions in a nuclear or radiological emergency.*

- 3.2.23. The operating organisation of a facility or activity in category I, II, III or IV should promptly decide on and take actions<sup>23</sup> on-site that are necessary to mitigate the consequences of a nuclear or radiological emergency involving a facility or an activity under its responsibility.
- 3.2.24. Off-site emergency services should be made available for the purpose of, and should be capable of, supporting the on-site emergency response at facilities and activities in category I, II, III or IV.<sup>24</sup>
- 3.2.25. For facilities in category I, II or III, arrangements should be made for mitigatory actions to be taken by the operating personnel, in particular:
- a. to prevent escalation of an emergency
  - b. to return the facility to a safe and stable state

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<sup>23</sup> Such actions may include actions with off-site consequences such as discharge of radioactive material to the environment, provided that the appropriate off-site organisations are notified in advance.

<sup>24</sup> This is not to be understood as diminishing the responsibility of the operating organisation to have adequate capabilities to respond to an emergency arising in the facility or activity under its responsibility.

- c. to reduce the potential for, and to mitigate the consequences of, radioactive releases or exposures.

These arrangements should take into account the full range of possible conditions affecting the emergency response, including those resulting from conditions in the facility and those resulting from impacts of postulated natural, human induced or other events and affecting regional infrastructure or affecting several facilities simultaneously. Arrangements should include emergency operating procedures and guidance for operating personnel on mitigatory actions for severe conditions (for a nuclear power plant, as part of the accident management program (IAEA 2016c)) and for the full range of postulated emergencies, including accidents that are not considered in the design and associated conditions. As far as practicable, the continued functionality of nuclear security system(s) (IAEA 2011a, IAEA 2011b, IAEA 2011c) needs to be considered in these arrangements.

- 3.2.26. The operating organisation of a facility or activity in category I, II, III or IV should assess and determine, at the preparedness stage, when and under what conditions assistance from off-site emergency services may need to be provided on-site, consistent with the hazard assessment and the protection strategy.

- 3.2.27. For facilities in category I, II or III, arrangements should be made, in particular by the operating organisation, to provide technical assistance to the operating personnel. On-site teams for mitigating the consequences of an emergency (e.g. damage control, firefighting) should be available and should be prepared to perform actions at the facility. The IAEA *Safety of Nuclear Power Plants: Design SSR-2/1* (IAEA 2016d) states that:

“Any equipment that is necessary for actions to be taken in manual response and recovery processes should be placed at the most suitable location to ensure its availability at the time of need and to allow safe access to it under the environmental conditions anticipated.”

The operating personnel directing mitigatory actions should be provided with information and technical assistance to allow them to take actions effectively to mitigate the consequences of the emergency. Arrangements should be made to obtain support promptly from the emergency services (e.g. law enforcement agencies, medical services and firefighting services) off-site. Off-site emergency services should be afforded prompt access to the facility, and should be informed of on-site conditions and provided with instructions and with means for protecting themselves as emergency workers.

- 3.2.28. Arrangements should be made for the operating organisation of an activity in category IV, first responders in an emergency at an unforeseen location, and those personnel at locations where there is a significant likelihood of encountering a dangerous source that is not under control (see clause 3.1.21) to take promptly all practicable and appropriate actions to mitigate the consequences of a nuclear or radiological emergency. These arrangements should include providing basic instructions and training in the means of mitigating the potential consequences of a nuclear or radiological emergency (see clause 3.2.44).
- 3.2.29. Arrangements should be made to provide expertise and services in radiation protection promptly to local officials, first responders in an emergency at an unforeseen location and

specialised services (e.g. law enforcement agencies) responding to emergencies involving activities and acts in category IV, and to those personnel at locations where there is a significant likelihood of encountering a dangerous source that is not under control (see clause 3.2.44). This should include arrangements for on-call advice or other appropriate mechanisms and arrangements to dispatch to the site an emergency team capable of assessing radiation hazards, mitigating radiological consequences and managing the exposure of emergency workers. In addition, arrangements should be made to determine whether and when additional assistance is necessary and to determine how to obtain such assistance (see clauses 3.2.24 and 3.2.94).

- 3.2.30. Arrangements should be made to initiate a prompt search in the event that a dangerous source could possibly be in the public domain as a result of its loss or unauthorised removal (see clause 3.2.47).

### **Taking urgent protective actions and other response actions**

*Arrangements should be in place to assess emergency conditions and to take urgent protective actions and other response actions effectively in a nuclear or radiological emergency.*

- 3.2.31. Arrangements should be made so that the magnitudes of hazards and the possible development of hazardous conditions are assessed initially and throughout a nuclear or radiological emergency in order to promptly identify, characterise or anticipate, as appropriate, new hazards or the extent of hazards and to revise the protection strategy.
- 3.2.32. The operating organisation of a facility in category I, II or III should make arrangements to promptly assess and anticipate:
- a. abnormal conditions at the facility
  - b. exposures and radioactive releases and releases of other hazardous material
  - c. radiological conditions on-site and, as appropriate, off-site
  - d. any exposures or potential exposures of workers and emergency workers, the public and, as relevant, patients and helpers in an emergency.
- 3.2.33. These assessments as stated in clause 3.2.32 should be used:
- a. for deciding on mitigatory actions to be taken by the operating personnel
  - b. as a basis for emergency classification (see clause 3.2.14)
  - c. for deciding on protective actions and other response actions to be taken on-site, including those for the protection of workers and emergency workers
  - d. for deciding on protective actions and other response actions to be taken off-site
  - e. where appropriate, to identify those individuals who could potentially have been exposed on-site at levels requiring appropriate medical attention in accordance with Annex B.

3.2.34. These arrangements as stated in clause 3.2.32 should include the use of pre-established operational criteria (Annex A and B of RPS G-3 Part 2 (ARPANSA 2019)) in accordance with the protection strategy (see clause 3.1.28(d)) and provision for access to instruments displaying or measuring those parameters that can readily be measured or observed in a nuclear or radiological emergency. In these arrangements, the expected response of instrumentation and of structures, systems and components at the facility under emergency conditions should be taken into account.

3.2.35. The operating organisation for activities in category IV should make arrangements to assess promptly the extent and/or the significance of any abnormal conditions on-site, any exposures or any contamination. These assessments should be used:

- a. for initiating the mitigatory actions
- b. as a basis for protective actions and other response actions to be taken on-site
- c. for determining the level for emergency response and for communicating the extent of the hazards to the appropriate off-site response organisations.

These arrangements should include the use of pre-established operational criteria in accordance with the protection strategy (see clause 3.1.28(d)) in Annex A and B of RPS G-3 Part 2 (ARPANSA 2019).

3.2.36. Arrangements should be made such that information on emergency conditions, assessments and protective actions and other response actions that have been recommended and have been taken is promptly made available, as appropriate, to all relevant response organisations and to the IAEA throughout the emergency.

3.2.37. Arrangements should be made for actions to save human life or to prevent serious injury to be taken without any delay on the grounds of the possible presence of radioactive material (see clauses 3.2.39 and 3.2.64). These arrangements should include providing first responders in an emergency at an unforeseen location with information on the precautions to take in giving first aid or in transporting an individual with possible contamination.

3.2.38. For facilities in category I or II, arrangements should be made for effectively making decisions on and taking urgent protective actions, early protective actions and other response actions<sup>25</sup> off-site in order to achieve the goals of emergency response, on the basis of a graded approach and in accordance with the protection strategy. The arrangements should be made with account taken of the uncertainties in and limitations of the information available when protective

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<sup>25</sup> Although defined under this overarching requirement, emergency planning zones and emergency planning distances are applicable for both urgent protective actions and early protective actions, and other response actions. Within emergency planning zones, the main focus is on taking precautionary urgent protective actions, urgent protective actions and other response actions. However, within emergency planning distances, urgent decisions may be warranted, as a precaution, to prevent inadvertent ingestion and to restrict the consumption of food, milk and drinking water that could be directly contaminated following a significant release of radioactive material to the environment and then consumed.

actions and other response actions have to be taken to be effective, and should include the following:

- a. the specification of off-site emergency planning zones and emergency planning distances<sup>26</sup> for which arrangements should be made at the preparedness stage for taking protective actions and other response actions effectively. These emergency planning zones and emergency planning distances should be contiguous across national borders, where appropriate, and should include:
  - i. a precautionary action zone (PAZ), for facilities in category I, for which arrangements should be made for taking urgent protective actions and other response actions, before any significant release<sup>27</sup> of radioactive material occurs, on the basis of conditions at the facility (i.e. conditions leading to the declaration of a general emergency; see clause 3.2.14), in order to avoid or to minimise severe tissue reactions
  - ii. an urgent protective action planning zone (UPZ), for facilities in category I or II, for which arrangements should be made to initiate urgent protective actions and other response actions, if possible before any significant release of radioactive material occurs, on the basis of conditions at the facility (i.e. conditions leading to the declaration of a general emergency; see clause 3.2.14), and after a release occurs, on the basis of monitoring and assessment of the radiological situation off-site, in order to reduce the risk of stochastic effects.<sup>28</sup> Any such actions should be taken in such a way as not to delay the implementation of precautionary urgent protective actions and other response actions within the precautionary action zone
  - iii. an extended planning distance (EPD) from the facility, for facilities in category I or II (beyond the urgent protective action planning zone), for which arrangements should be made to conduct monitoring and assessment of the radiological situation off-site in order to identify areas, within a period of time that would allow the risk of stochastic effects in the areas to be effectively reduced by taking protective actions and other response actions within a day to a week or to a few weeks following a significant radioactive release
  - iv. an ingestion and commodities planning distance (ICPD) from the facility, for facilities in category I or II (beyond the extended planning distance), for which arrangements should be made to take response actions (a) for protecting the food

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<sup>26</sup> The off-site emergency planning zones and emergency planning distances may differ from those specified provided that, at the preparedness stage, such areas and distances are designated and arrangements are made to effectively take precautionary urgent protective actions, early protective actions and other response actions within these areas and distances in order to achieve the goals of emergency response.

<sup>27</sup> A significant release of radioactive material is a radioactive release that could lead to severe tissue reactions off-site and thus warrants taking protective actions or other response actions off-site.

<sup>28</sup> Taking actions within the urgent protective action planning zone in order to reduce the risk of stochastic effects would not mean that no severe tissue reactions could possibly be observed within the urgent protective action planning zone. However, any severe tissue reactions are most likely to occur within the precautionary action zone.



chain and water supply<sup>29</sup> as well as for protecting commodities other than food from contamination following a significant radioactive release and (b) for protecting the public from the ingestion of food, milk and drinking water and from the use of commodities other than food with possible contamination following a significant radioactive release

- b. criteria, based on the emergency classification and on conditions at the facility and off-site (see clauses 3.1.28(c), 3.1.28(d), 3.2.14 and 3.2.15), for initiating and for adjusting urgent protective actions and other response actions within the emergency planning zones and emergency planning distances, in accordance with the protection strategy
- c. authority and responsibility to provide sufficient and updated information to the notification point at any time to allow for an effective off-site emergency response.

3.2.39. Within the emergency planning zones and emergency planning distances, arrangements should be made for taking appropriate protective actions and other response actions effectively, as necessary, promptly upon the notification of a nuclear or radiological emergency. These arrangements should include arrangements for:

- a. prompt exercise of authority and discharge of responsibility for making decisions to initiate protective actions and other response actions upon notification of an emergency (see clause 3.2.12)
- b. warning the permanent population, transient population groups and special population groups or those responsible for them and warning special facilities
- c. taking urgent protective actions and other response actions such as evacuation, restrictions on the food chain and on water supply, prevention of inadvertent ingestion, restrictions on the consumption of food, milk and drinking water and on the use of commodities, decontamination of evacuees, control of access and traffic restrictions
- d. protection of emergency workers and helpers in an emergency.

The arrangements should be coordinated with all jurisdictions (including, to the extent practicable, jurisdictions beyond national borders, where relevant) within any emergency planning zone or distance. These arrangements should ensure that services necessary for ensuring public safety (e.g. rescue services and health services for the care of critically ill patients) are provided continuously throughout the emergency, including during the period when protective actions and other response actions are being taken.

3.2.40. Within emergency planning zones and emergency planning distances, arrangements should be made for the timely monitoring and assessment of contamination, radioactive releases and exposures for the purpose of deciding on or adjusting the protective actions and other response actions that have to be taken or that are being taken. These arrangements should include the use of pre-established operational criteria in accordance with the protection strategy (see clause 3.1.28(d)) in Annex A and B of RPS G-3 Part 2 (ARPANSA 2019).

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<sup>29</sup> 'Water supply' refers to water supplies that use rainwater or other untreated surface water.



- 3.2.41. The operating organisation of a facility in category I, II or III should make arrangements to ensure protection and safety for all persons on-site in a nuclear or radiological emergency. These should include arrangements to do the following:
- a. to notify all persons on-site of an emergency on-site
  - b. for all persons on-site to take appropriate actions immediately upon notification of an emergency
  - c. to account for those persons on-site and to locate and recover those persons unaccounted for
  - d. to provide immediate first aid
  - e. to take urgent protective actions.
- 3.2.42. Arrangements as stated in clause 3.2.41 should also include ensuring the provision, for all persons present in the facility and on-site, of:
- a. suitable assembly points, provided with continuous radiation monitoring
  - b. a sufficient number of suitable escape routes
  - c. suitable and reliable alarm systems and other means for warning and instructing all persons present under the full range of emergency conditions.
- 3.2.43. The operating organisation of a facility in category I, II or III should ensure that suitable, reliable and diverse means of communication are available at all times, under the full range of emergency conditions, for use in taking protective actions and other response actions on-site and for communication with off-site officials responsible for taking protective actions and other response actions off-site or within any emergency planning zones or emergency planning distances.
- 3.2.44. Operating personnel for activities in category IV, first responders in an emergency at an unforeseen location and those personnel at locations where there is a significant likelihood of encountering a dangerous source that is not under control (see clause 3.1.21) should be provided with guidance and training on taking urgent protective actions and other response actions. This should include guidance and training on the approximate radius of the inner cordoned off area in which urgent protective actions and other response actions would initially be taken and on the adjustment of this area on the basis of observed or assessed conditions on-site.

### **Providing instructions, warnings and relevant information to the public for emergency preparedness and response**

*Arrangements should be in place to provide the public who are affected or are potentially affected by a nuclear or radiological emergency with information that is necessary for their protection, to warn them promptly and to instruct them on actions to be taken.*

- 3.2.45. For facilities in category I or II and areas in category V, arrangements should be made to provide the permanent population, transient population groups and special population groups or those

responsible for them and special facilities within the emergency planning zones and emergency planning distances (see clause 3.2.38), before operation and throughout the lifetime of the facility, with information on the response to a nuclear or radiological emergency. This information should include information on the potential for a nuclear or radiological emergency, on the nature of the hazards, on how people would be warned or notified, and on the actions to be taken in such an emergency. The information should be provided in the languages mainly spoken by the population residing within the emergency planning zones and emergency planning distances. The effectiveness of these arrangements for public information should be periodically assessed.

- 3.2.46. For facilities in category I or II and in areas in category V, arrangements should be made to register those members of the public in special population groups and, as appropriate, those responsible for them, and to promptly issue them and the permanent population and transient population groups, as well as special facilities in the emergency planning zones and emergency planning distances, with a warning and with instructions to be followed upon declaration of a general emergency (see clause 3.2.14). This should include providing instructions on the actions to be taken in the languages mainly spoken by the population residing within these emergency planning zones and emergency planning distances (see clause 3.2.38).
- 3.2.47. For facilities in category III and category IV, arrangements should be made to provide the public with information and instructions in order to identify and locate people who may have been affected by a nuclear or radiological emergency and who may need response actions such as decontamination, medical examination or health screening. These arrangements should include arrangements for issuing a warning to the public and providing information in the event that a dangerous source could be in the public domain as a consequence of its loss or unauthorised removal.
- 3.2.48. Arrangements should be made by response organisations in a country to promptly provide information and advice to its nationals and to those people with interests in other countries<sup>30</sup> in the event of a nuclear or radiological emergency declared beyond national borders, with due account taken of the response actions recommended in the country in which the emergency occurs as well as in the country or countries affected by that emergency (see clauses 3.2.73 and 3.3.14).

### Protecting emergency workers and helpers in an emergency

*Arrangements should be in place to protect emergency workers and to protect helpers in a nuclear or radiological emergency.*

- 3.2.49. Arrangements should be made to ensure that emergency workers are, to the extent practicable, designated in advance and are fit for the intended duty. These arrangements should include

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<sup>30</sup> Examples of people with interests in other countries include people travelling, people working and/or living abroad, importers and exporters, and people working in companies operating abroad.

health surveillance for emergency workers for the purpose of assessing their initial fitness and continuing fitness for their intended duties (see also GSR Part 3 (IAEA 2014)).

- 3.2.50. Arrangements should be made to register and to integrate into operations in an emergency response those emergency workers who were not designated as such in advance of a nuclear or radiological emergency and helpers in an emergency. This should include designation of the response organisation(s) responsible for ensuring protection of emergency workers and protection of helpers in an emergency.
- 3.2.51. The operating organisation and response organisations should determine the anticipated hazardous conditions, both on-site and off-site, in which emergency workers might have to perform response functions in a nuclear or radiological emergency in accordance with the hazard assessment and the protection strategy.
- 3.2.52. The operating organisation and response organisations should 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, should 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 specialised protective equipment and monitoring equipment
  - e. provision of iodine tablets to protect the thyroid (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.
- 3.2.53. The operating organisation and response organisations should ensure that all practicable means are used to minimise exposures of emergency workers and helpers in an emergency in the response to a nuclear or radiological emergency (see Annex A), and to optimise their protection.
- 3.2.54. In a nuclear or radiological emergency, the relevant requirements for occupational exposure in planned exposure situations established in GSR Part 3 (IAEA 2014) should be applied, on the basis of a graded approach, for emergency workers, except as stated in clause 3.2.55.
- 3.2.55. The operating organisation and response organisations should ensure that no emergency worker is subject to an exposure in an emergency that could give rise to an effective dose in excess of 50 mSv other than:
- a. for the purposes of saving human life or preventing serious injury

- b. when taking actions to prevent severe tissue reactions or actions to prevent the development of catastrophic conditions that could significantly affect people and the environment.

- 3.2.56. For the exceptional circumstances of clause 3.2.55, national guidance values should be established for restricting the exposures of emergency workers, in accordance with Annex A.
- 3.2.57. The operating organisation and response organisations should ensure that emergency workers who undertake emergency response actions in which doses received might exceed an effective dose of 50 mSv do so voluntarily<sup>31</sup>; that they have been clearly and comprehensively informed in advance of associated health risks as well as of available protective measures; and that they are, to the extent possible, trained in the actions that they might be required to take. Emergency workers not designated as such in advance should not be the first emergency workers chosen for taking actions that could result in their doses exceeding the guidance values of dose for lifesaving actions, as given in Annex A. Helpers in an emergency should not be allowed to take actions that could result in their receiving doses in excess of an effective dose of 50 mSv.
- 3.2.58. Arrangements should be made to assess as soon as practicable the individual doses received in a response to a nuclear or radiological emergency by emergency workers and helpers in an emergency and, as appropriate, to restrict further exposures in the response to the emergency (see Annex A).
- 3.2.59. Emergency workers and helpers in an emergency should be given appropriate medical attention for doses received in a response to a nuclear or radiological emergency (see Annex B) or at their request.
- 3.2.60. Emergency workers who receive doses in a response to a nuclear or radiological emergency should normally not be precluded from incurring further occupational exposure. However, qualified medical advice<sup>32</sup> should be obtained before any further occupational exposure occurs if an emergency worker has received an effective dose exceeding 200 mSv, or at the request of the emergency worker.
- 3.2.61. Information on the doses received in the response to a nuclear or radiological emergency and information on any consequent health risks should be communicated, as soon as practicable, to emergency workers and to helpers in an emergency.

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<sup>31</sup> The voluntary basis for response actions by emergency workers is usually covered in the emergency arrangements.

<sup>32</sup> Such qualified medical advice is intended for assessing the continuing fitness of workers for their intended tasks involving occupational exposure in line with GSR Part 3 (IAEA 2014). In line with clause 3.2.59 of this Guide, any emergency worker is to be given appropriate medical attention for doses received. To illustrate this, the generic criterion for a dose that is received (50 mSv effective dose in a month), as provided in Table B.2 of Annex B, will indicate that an emergency worker receiving such a dose needs to be registered and subjected to health screening and that the emergency worker will then need appropriate longer term medical follow-up in order to detect radiation induced health effects early and to treat them effectively.

## Managing the medical response in a nuclear or radiological emergency

*Arrangements should be 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.*

- 3.2.62. On the presentation by an individual with clinical symptoms of radiation exposure or other indications associated with a possible nuclear or radiological emergency, the medical personnel or other responsible parties who identify the clinical symptoms or other indications should notify the appropriate local or national officials and should take response actions as appropriate.
- 3.2.63. Arrangements should be made for medical personnel, both general practitioners and emergency medical staff, to be made aware of the clinical symptoms of radiation exposure, and of the appropriate notification procedures and other emergency response actions to be taken if a nuclear or radiological emergency arises or is suspected.
- 3.2.64. Arrangements should be made so that, in a nuclear or radiological emergency, individuals with possible contamination can promptly be given appropriate medical attention. These arrangements should include ensuring that transport services are provided where needed and providing instructions<sup>33</sup> to medical personnel on the precautions to take.
- 3.2.65. For facilities in categories I, II and III, arrangements should be made to manage an adequate number of any individuals with contamination or of any individuals who have been overexposed to radiation, including arrangements for first aid, the estimation of doses, medical transport and initial medical treatment in predesignated medical facilities.
- 3.2.66. For areas within emergency planning zones (see clause 3.2.38), arrangements should be made for performing medical screening and triage, and for assigning to a predesignated medical facility any individual exposed to levels exceeding the criteria in Table B.1 of Annex B. These arrangements should include the use of pre-established operational criteria in Annex A and B of RPS G-3 Part 2 (ARPANSA 2019) in accordance with the protection strategy (see clause 3.1.28(d)).
- 3.2.67. Arrangements should be made to identify individuals with possible contamination and individuals who have possibly been sufficiently exposed for radiation induced health effects to result, and to provide them with appropriate medical attention, including longer term medical follow-up. These arrangements should include:
- (a) guidelines for effective diagnosis and treatment
  - (b) designation of medical personnel trained in clinical management of radiation injuries

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<sup>33</sup> These instructions should include advice that universal precautions in health care against infection (e.g. surgical masks and gloves) generally provide medical personnel with adequate protection when treating individuals with possible contamination.

- (c) designation of institutions for evaluating radiation exposure (external and internal), for providing specialised medical treatment and for longer term medical actions.

These arrangements should also include the use of pre-established operational criteria in Annex A and B of RPS G-3 Part 2 (ARPANSA 2019) in accordance with the protection strategy (see clause 3.1.28(d)) and arrangements for medical consultation on treatment following any exposure that could result in severe tissue reactions (Annex B) with medical personnel experienced in dealing with such injuries.<sup>34</sup>

- 3.2.68. Arrangements should be made for the identification of individuals who are in those population groups that are at risk of sustaining increases in the incidence of cancers as a result of radiation exposure in a nuclear or radiological emergency. Arrangements should be made to take longer term medical actions to detect radiation induced health effects among such population groups in time to allow for their effective treatment. These arrangements should include the use of pre-established operational criteria in Annex A and B of RPS G-3 Part 2 (ARPANSA 2019) in accordance with the protection strategy (see clause 3.1.28(d)).

### Communicating with the public throughout a nuclear or radiological emergency

*Arrangements should be in place for communication with the public throughout a nuclear or radiological emergency.*

- 3.2.69. Arrangements should be made for providing useful, timely, true, clear and appropriate information to the public in a nuclear or radiological emergency, with account taken of the possibility that the usual means of communication might be damaged in the emergency or by its initiating event (e.g. by an earthquake or by flooding) or overburdened by demand for its use. These arrangements should also include arrangements for keeping the international community informed, as appropriate. These arrangements should take into account the need to protect sensitive information in circumstances where a nuclear or radiological emergency is initiated by a nuclear security event. Communication with the public in a nuclear or radiological emergency should be carried out on the basis of a strategy to be developed at the preparedness stage as part of the protection strategy. Arrangements should be made to adjust this strategy in the emergency response on the basis of prevailing conditions.
- 3.2.70. Arrangements should be made to ensure that information provided to the public by response organisations, operating organisations, the relevant authority, international organisations and others in a nuclear or radiological emergency is coordinated and consistent, with due recognition of the evolutionary nature of an emergency.
- 3.2.71. Arrangements should be made so that in a nuclear or radiological emergency information is provided to the public in plain and understandable language.

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<sup>34</sup> Such arrangements for medical consultation on treatment could include international assistance to be provided through or to be coordinated by the IAEA and by WHO; for example, under the Assistance Convention (IAEA 1987).

3.2.72. Arrangements should be made to ensure that a system for putting radiological health hazards in perspective in a nuclear or radiological emergency is developed and implemented with the following aims:

- a. to support informed decision making concerning protective actions and other response actions to be taken
- b. to help in ensuring that actions taken do more good than harm
- c. to address public concerns regarding potential health effects.

In the development of such a system, due consideration should be given to pregnant women and children as the individuals who are most vulnerable with regard to radiation exposure.

3.2.73. Arrangements should be made to explain to the public any changes in the protective actions and other response actions recommended in the country and any differences from those recommended in other countries (see clauses 3.3.13 – 3.3.15).

3.2.74. Arrangements should be made to identify and address, to the extent practicable, misconceptions, rumours and incorrect and misleading information that might be circulating widely in a nuclear or radiological emergency, in particular those that might result in actions being taken beyond those emergency response actions that are warranted<sup>35</sup> (see clauses 3.2.89 – 3.2.92).

3.2.75. Arrangements should be made to respond to enquiries from the public and from news media, both national and international, including enquiries received from or through the IAEA. These arrangements should recognise the evolutionary nature of emergencies and the need to respond in a timely manner to enquiries even when the information requested is not yet available.

### **Taking early protective actions and other response actions**

*Arrangements should be in place to take early protective actions and other response actions effectively in a nuclear or radiological emergency.*

3.2.76. Within the extended planning distance (see clause 3.2.38), arrangements should be made for effective relocation that may be required following a significant radioactive release and for the prevention of inadvertent ingestion, in accordance with the protection strategy (see clauses 3.1.27 – 3.1.31). These arrangements should include:

- a. provision of instructions and advice to prevent inadvertent ingestion

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<sup>35</sup> Actions beyond those emergency response actions that are warranted include, but are not limited to: actions that interfere with prompt implementation of protective actions, such as self-evacuation both from within and from outside areas from which evacuation is ordered; actions that unnecessarily burden the health care system; actions that shun or otherwise discriminate against people or products from an area affected by a nuclear or radiological emergency; elective terminations of pregnancy that are not radiologically informed; and cancellations of commercial flights that are not radiologically informed.



- b. prompt monitoring and assessment
- c. use of pre-established operational criteria in Annex A and B of RPS G-3 Part 2 (ARPANSA 2019) in accordance with the protection strategy (see clause 3.1.28(d))
- d. the means for accomplishing relocation and for assisting those persons who have been relocated
- e. provisions to extend monitoring and assessment, and actions beyond the extended planning distance if necessary.

3.2.77. For areas within the ingestion and commodities planning distance (see clause 3.2.38), arrangements should be made for prompt protection in relation to, and for restriction of, non-essential local produce, forest products (e.g. wild berries, wild mushrooms), milk from grazing animals, drinking water supplies, animal feed and commodities with contamination or possibly with contamination following a significant radioactive release, in accordance with the protection strategy (see clauses 3.1.27 – 3.1.31). These arrangements should include:

- a. provision of instructions and advice:
  - i. to protect the food chain, water supply and commodities from contamination
  - ii. to prevent ingestion of food, milk and drinking water with contamination or possibly with contamination
  - iii. to prevent use of commodities with contamination or possibly with contamination
- b. prompt monitoring, sampling and analysis
- c. use of pre-established operational criteria in Annex A and B of RPS G-3 Part 2 (ARPANSA 2019) in accordance with the protection strategy (see clause 3.1.28(d))
- d. the means to enforce the restrictions
- e. provisions to expand monitoring and assessment, and actions beyond this distance if necessary.

3.2.78. Within the emergency planning zones and the inner cordoned off area, arrangements should be made for monitoring the levels of contamination of people, vehicles and goods moving out of areas with contamination, in order to control the spread of contamination and, as applicable, for the purposes of decontamination in accordance with the protection strategy (see clauses 3.1.27-3.1.31). These arrangements should include the use of pre-established operational criteria in Annex A and B of RPS G-3 Part 2 (ARPANSA 2019) in accordance with the protection strategy (see clause 3.1.28(d)) and should take into consideration that some vehicles and items potentially with contamination, as well as members of the public and emergency workers, might have left these areas before the establishment of contamination control points and boundaries.

3.2.79. Arrangements should be made for access control and enforcing of restrictions for areas in which evacuations and relocations would be carried out within emergency planning zones, the extended planning distance and the inner cordoned off area, in accordance with the protection strategy (see clauses 3.1.27 – 3.1.31). Returns to these areas for short periods of time should be



permitted if justified (e.g. to feed animals left behind) and provided that those individuals entering the area are:

- a. subject to controls and to dose assessment while in the area
- b. instructed on how to protect themselves
- c. briefed on the associated health hazards.

- 3.2.80. Arrangements should be made to test methods of decontamination before their general use and to assess their effectiveness in terms of dose reduction.
- 3.2.81. For a transnational emergency in category IV, arrangements should be made for taking early protective actions and other response actions as appropriate for areas beyond category V, including promptly conducting monitoring and assessment of contamination (a) of food, milk and drinking water and, as appropriate, of commodities other than food, and (b) of vehicles and cargoes that are likely to have contamination, with the aim of mitigating the consequences of a nuclear or radiological emergency and reassurance of the public. These arrangements should include the use of pre-established operational criteria in Annex A and B of RPS G-3 Part 2 (ARPANSA 2019) in accordance with the protection strategy (see clause 3.1.28(d)).
- 3.2.82. Monitoring in response to a nuclear or radiological emergency should be carried out on the basis of a strategy to be developed at the preparedness stage as part of the protection strategy. Arrangements should be made to adjust the monitoring in the emergency response on the basis of prevailing conditions.
- 3.2.83. Arrangements should be made to carry out retrospective assessment of exposure of members of the public in a nuclear or radiological emergency, and to make the results of these assessments publicly available. The assessments should be based on the best available information, should be put into perspective in terms of the associated health hazards (see clause 3.2.72) and should be promptly updated in the light of information that would yield substantially more accurate results.

## Managing radioactive waste in an emergency

*Radioactive waste should be managed safely and effectively in a nuclear or radiological emergency.*

- 3.2.84. The national policy and strategy for radioactive waste management in the context of the IAEA General Safety Requirements No. GSR Part 5, *Predisposal Management of Radioactive Waste* (IAEA 2009) should apply for radioactive waste generated in a nuclear or radiological emergency, with account taken of clauses 3.2.85 - 3.2.88.
- 3.2.85. The protection strategy (see clauses 3.1.27 - 3.1.31) should take into account radioactive waste that might arise from protective actions and other response actions that are to be taken.
- 3.2.86. Radioactive waste arising in a nuclear or radiological emergency, including radioactive waste arising from associated protective actions and other response actions taken, should be identified, characterised and categorised in due time and should be managed in a manner that

does not compromise the protection strategy, with account taken of prevailing conditions as they evolve.

- 3.2.87. Arrangements should be made for radioactive waste to be managed safely and effectively. These arrangements should include:
- a. a plan to characterise waste, including in situ measurements and analysis of samples
  - b. criteria for categorisation of waste
  - c. avoiding, to the extent possible, the mixing of waste of different categories
  - d. minimising the amount of material unduly declared as radioactive waste
  - e. a method for determining appropriate options for predisposal management of radioactive waste (including processing, storage and transport), with account taken of the interdependences between all steps as well as impacts on the anticipated end points (clearance, authorised discharge, reuse, recycling, disposal) (IAEA 2009, IAEA 2011d)
  - f. a method of identifying appropriate storage options and sites
  - g. consideration of non-radiological aspects of waste (e.g. chemical properties such as toxicity, and biological properties).
- 3.2.88. Consideration should be given to the management of human remains and animal remains with contamination as a result of a nuclear or radiological emergency, with due account taken of religious and cultural practices.

### **Mitigating non-radiological consequences of a nuclear or radiological emergency and of an emergency response**

*Arrangements should be in place for mitigation of non-radiological consequences of a nuclear or radiological emergency and of an emergency response.*

- 3.2.89. Non-radiological consequences of a nuclear or radiological emergency and of an emergency response should be taken into consideration when deciding on the protective actions and other response actions to be taken in the context of the protection strategy (see clauses 3.1.27 - 3.1.31).
- 3.2.90. Arrangements should be made for mitigating the non-radiological consequences of an emergency and those of an emergency response and for responding to public concern in a nuclear or radiological emergency. These arrangements should include arrangements for providing the people affected, with:
- a. information on any associated health hazards and clear instructions on any actions to be taken (see clauses 3.2.45 – 3.2.48 and clauses 3.2.69 – 3.2.75.)
  - b. medical and psychological counselling, as appropriate
  - c. adequate social support, as appropriate.

- 3.2.91. Arrangements should be made to mitigate the impacts on international trade of a nuclear or radiological emergency and associated protective actions, and other response actions, with account taken of the generic criteria in Annex B. These arrangements should provide for issuing information to the public and interested parties (such as importing countries) on controls put in place in relation to traded commodities, including food, and on vehicles and cargoes being shipped, and on any revisions of the relevant national criteria.
- 3.2.92. Arrangements should be put in place for any actions taken, beyond those emergency response actions that are warranted, by members of the public and by commercial, industrial, infrastructural or other governmental or non-governmental bodies to be, to the extent practicable, promptly identified and appropriately addressed. This should include the designation of organisation(s) with the responsibility for monitoring, identifying and addressing such actions.

### Requesting, providing and receiving international assistance for emergency preparedness and response

*Adequate arrangements should be in place to benefit from, and to contribute to, the provision of international assistance for preparedness and response for a nuclear or radiological emergency.*

- 3.2.93. Governments and international organisations should put in place and should maintain arrangements to respond in a timely manner to a request made by a country, in accordance with established mechanisms and respective mandates, for assistance in preparedness and response for a nuclear or radiological emergency.
- 3.2.94. Arrangements should be put in place and maintained for requesting and obtaining international assistance from countries or international organisations and for providing assistance to countries (either directly or through the IAEA) in preparedness and response for a nuclear or radiological emergency, on the basis of international instruments (e.g. the Assistance Convention (IAEA 1987)), bilateral agreements or other mechanisms. These arrangements should take due account of compatibility requirements for the capabilities to be obtained from and to be rendered to different countries so as to ensure the usefulness of these capabilities.

### Terminating a nuclear or radiological emergency

*Arrangements should be in place for the termination of a nuclear or radiological emergency, with account taken of the need for the resumption of social and economic activity.*

- 3.2.95. Adjustment of protective actions, other response actions and other arrangements that are aimed at enabling the termination of an emergency should be made by a formal process that includes consultation of interested parties.
- 3.2.96. Arrangements for communication with the public in a nuclear or radiological emergency (see clauses 3.2.69 – 3.2.75) should include arrangements for communication on the reasons for any adjustment of protective actions, other response actions and other arrangements aimed at

enabling the termination of the emergency. This should include providing the public with information on the need for any continuing protective actions following termination of the emergency and on any necessary modifications to their personal behaviour. Arrangements should be made during this period to closely monitor public opinion and the reaction in the news media in order to ensure that any concerns can be promptly addressed. These arrangements should ensure that any information provided to the public puts health hazards in perspective (see clauses 3.2.72).

- 3.2.97. The termination of a nuclear or radiological emergency should be based on a formal decision that is made public and should include prior consultation with interested parties, as appropriate.
- 3.2.98. Both radiological consequences and non-radiological consequences should be considered in deciding on the termination of an emergency as well as in the justification and optimisation of further protection strategies as necessary.
- 3.2.99. The transition to an existing exposure situation or to a planned exposure situation should be made in a coordinated and orderly manner, by making any necessary transfer of responsibilities and with the increased involvement of relevant authorities and interested parties.
- 3.2.100. As part of emergency preparedness, arrangements should be in place for the assurance of the termination of a nuclear or radiological emergency. The arrangements should take into account that the termination of an emergency might be at different times in different geographical areas. The planning process should include as appropriate:
  - a. the roles and functions of organisations
  - b. methods of transferring information
  - c. means for assessing radiological consequences and non-radiological consequences
  - d. conditions, criteria and objectives to be met for enabling the termination of a nuclear or radiological emergency (see Annex B)
  - e. a review of the hazard assessment and of the emergency arrangements
  - f. establishment of national guidelines for the termination of an emergency
  - g. arrangements for continued communication with the public, and for monitoring of public opinion and the reaction in the news media
  - h. arrangements for consultation of interested parties.
- 3.2.101. Once the emergency is terminated, all workers undertaking relevant work should be subject to the relevant requirements for occupational exposure in planned exposure situations (IAEA 2014), and individual monitoring, environmental monitoring and health surveillance should be conducted subject to the requirements for planned exposure situations or existing exposure situations, as appropriate (IAEA 2014).

## **Analysing the nuclear or radiological emergency and the emergency response**

*A nuclear or radiological emergency and the emergency response should be analysed in order to identify actions to be taken to avoid other emergencies and to improve emergency arrangements.*

- 3.2.102. Arrangements should be made to document, protect and preserve, in an emergency response, to the extent practicable, data and information important for an analysis of the nuclear or radiological emergency and the emergency response. Arrangements should be made to undertake a timely and comprehensive analysis of the nuclear or radiological emergency and the emergency response with the involvement of interested parties. These arrangements should give due consideration to the need for making contributions to relevant internationally coordinated analyses and for sharing the findings of the analysis with relevant response organisations. The analysis should give due consideration to:
- a. the reconstruction of the circumstances of the emergency
  - b. the root causes of the emergency
  - c. regulatory controls including regulations and regulatory oversight
  - d. general implications for safety, including the possible involvement of other sources or devices (including those in other countries)
  - e. general implications for nuclear security, as appropriate
  - f. necessary improvements to emergency arrangements
  - g. necessary improvements to regulatory control.
- 3.2.103. Arrangements should be made to enable comprehensive interviews on the circumstances of the nuclear or radiological emergency to be conducted with those involved.
- 3.2.104. Arrangements should be made to acquire (e.g. from the IAEA, from another country or from the manufacturer of relevant equipment) the expertise necessary to conduct an analysis of the circumstances of the nuclear or radiological emergency.
- 3.2.105. Arrangements should be made to take actions promptly on the basis of an analysis to avoid other emergencies, including provision of information to other operating organisations, as relevant, or to other countries, directly or through the IAEA.

### **3.3 Guidance for infrastructure**

#### **General**

- 3.3.1. This section establishes the requirements for infrastructural elements that are essential to providing the capability for fulfilling the requirements established in Section 3.2 in accordance with the hazard assessment and the protection strategy.

#### **Authorities for emergency preparedness and response**

*The relevant authorities for preparedness and response for a nuclear or radiological emergency should be clearly established.*

- 3.3.2. The authorities for developing, maintaining and regulating arrangements, both on-site and off-site, for preparedness and response for a nuclear or radiological emergency should be established by means of acts, legal codes or statutes.
- 3.3.3. All of the functions specified in Section 3.2 should be assigned to the appropriate operating organisations and to local, regional and national response organisations. The involvement of all these organisations in the performance of these functions, or in support of their performance, should be documented.<sup>36</sup> The documentation should specify their roles, functions, authorities and responsibilities in emergency preparedness and response and should assent to the authorities, roles and responsibilities of other response organisations. Conflicting or potentially conflicting and overlapping roles and responsibilities should be identified and conflicts should be resolved at the preparedness stage through the national coordinating mechanism (see clause 3.1.10).
- 3.3.4. The authority and responsibility for making decisions on response actions to be taken on-site and off-site (see clause 3.2.7) and the authority and responsibility for communication with the public should be clearly assigned for each phase of the response.
- 3.3.5. The emergency arrangements should include clear assignment of responsibilities and authorities, and should provide for coordination and for communication in all phases of the response. These arrangements should include:
- a. ensuring that for each response organisation a position in the response hierarchy has the authority and responsibility to direct and to coordinate its response actions
  - b. clearly assigning the authority and responsibility for the direction and coordination of the entire response (see clause 3.2.7) and for the prevention and resolution of conflicts between response organisations
  - c. assigning to an on-site position the authority and responsibility for notifying the appropriate response organisation(s) of an emergency and for taking immediate on-site actions
  - d. assigning to an on-site position the responsibility for directing the entire on-site emergency response (see clauses 3.2.2 and 3.2.7).

These arrangements should be such as to ensure that those personnel with authority and responsibility to perform critical response functions<sup>37</sup> in an emergency response are not assigned any other responsibilities in an emergency that would interfere with the prompt performance of the specified functions.

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<sup>36</sup> Typically, the involvement of operating organisations and local, regional and national response organisations is documented as part of the appropriate facility, local, regional and national emergency plans.

<sup>37</sup> Critical response functions are functions that must be performed promptly and correctly in order to classify, declare and notify an emergency, to activate an emergency response, to manage the response, to take mitigatory actions, to protect emergency workers and to take urgent protective actions on and off-site.

- 3.3.6. The arrangements for delegation and/or transfer of authority should be specified in the relevant emergency plans, together with arrangements for notifying all appropriate parties of the transfer.

### Organisation and staffing for emergency preparedness and response

*Arrangements should be made such that the overall organisation for preparedness and response for a nuclear or radiological emergency is clearly specified and staffed with sufficient personnel who are qualified and are assessed for their fitness for their intended duties.*

- 3.3.7. The organisational relationships for preparedness and response for a nuclear or radiological emergency and interfaces between all the response organisations should be established.
- 3.3.8. The positions responsible within each operating organisation and response organisation for performance of the response functions specified in Section 3.2 should be assigned in the emergency plans and procedures. The positions responsible in each operating organisation, in each response organisation and in the relevant authority for the performance of activities at the preparedness stage, in accordance with these requirements, should be assigned as part of the routine organisational structures and should be specified, as appropriate, in the emergency plans and procedures.
- 3.3.9. Personnel who are assigned to positions in all operating organisations and response organisations to perform the functions necessary to meet the requirements established in Section 3.2 should be qualified and should be assessed for their initial fitness and continuing fitness for their intended duties.
- 3.3.10. Appropriate numbers of suitably qualified personnel should be available at all times (including during 24 hour a day operations) so that appropriate positions can be promptly staffed as necessary following the declaration and notification of a nuclear or radiological emergency. Appropriate numbers of suitably qualified personnel should be available for the long term to staff the various positions necessary to take mitigatory actions, protective actions and other response actions.
- 3.3.11. For a site where multiple facilities in category I or II are collocated, an appropriate number of suitably qualified personnel should be available to manage an emergency response at all facilities if each of the facilities is under emergency conditions simultaneously (see clause 3.2.4).

### Coordination of emergency preparedness and response

*Arrangements should be in place for the coordination of preparedness and response for a nuclear or radiological emergency between the operating organisation and authorities at the local, regional and national levels, and, where appropriate, at the international level.*

- 3.3.12. Arrangements should be developed, as appropriate, for the coordination of emergency preparedness and response, and of protocols for operational interfaces between operating

organisations and authorities at the local, regional and national levels, including those organisations and authorities responsible for the response to conventional emergencies and to nuclear security events (see clauses 3.1.3, 3.1.10, 3.3.3 and clauses 3.2.1 - 3.2.10). The arrangements should be clearly documented and the documentation should be made available to all relevant parties. Arrangements should be put in place to ensure effective working relationships among these organisations, both at the preparedness stage and in an emergency.

- 3.3.13. When several different organisations of the country or of other countries are expected to have or to develop tools, procedures or criteria for use in the response to an emergency, arrangements for coordination should be put in place to improve the consistency of the assessments of the situation, including assessments of contamination, doses and radiation induced health effects and any other relevant assessments made in a nuclear or radiological emergency, so as not to give rise to confusion.
- 3.3.14. Arrangements should be made to coordinate with other countries in the event of a transnational emergency any protective actions and other response actions that are recommended to their citizens and to their embassies in order to either ensure that they are consistent with those recommended in other countries, or to provide an opportunity for them to explain to the public the basis for any differences (see clause 3.2.73).
- 3.3.15. Arrangements should be made to ensure that countries with areas in category V are provided with appropriate information for developing their own preparedness to respond to a transboundary emergency and that appropriate coordination across national borders is in place. These arrangements should include:
- a. agreements and protocols to provide information necessary to develop a coordinated means for notification, classification schemes and criteria for taking and for adjusting protective actions and other response actions
  - b. arrangements for communication with the public
  - c. arrangements for the exchange of information between decision making authorities.

## Plans and procedures for emergency response

*Plans and procedures necessary for effective response to a nuclear or radiological emergency should be established.*

- 3.3.16. Plans, procedures and other arrangements for effective emergency response, including coordinating mechanisms, letters of agreement or legal instruments, should be made for coordinating a national emergency response. The arrangements for a coordinated national emergency response:
- specify the organisation responsible for the development and maintenance of the arrangements
  - describe the responsibilities of operating organisations and other response organisations



- describe the coordination effected between these arrangements and the arrangements for response to a conventional emergency and to a nuclear security event.

Consideration should be given in these plans, procedures and other arrangements to the need to protect information that might be confidential.

3.3.17. Each response organisation should prepare an emergency plan or plans for coordinating and performing their assigned functions as specified in Section 3.2 and in accordance with the hazard assessment and the protection strategy. An emergency plan should be developed at the national level that integrates all relevant plans for emergency response in a coordinated manner and consistently with an all-hazards approach. Emergency plans should specify how responsibilities for managing operations in an emergency response are to be discharged on-site, off-site and across national borders, as appropriate. The emergency plans should be coordinated with other plans and procedures that may be implemented in a nuclear or radiological emergency, to ensure that the simultaneous implementation of the plans would not reduce their effectiveness or cause conflicts. Such other plans and procedures include:

- emergency plans for facilities in category I and for areas in category V
- security plans and contingency plans (IAEA 2011a, 2011b)
- procedures for the investigation of a nuclear security event, including identification, collection, packaging and transport of evidence contaminated with radionuclides, nuclear forensics and related activities (IAEA 2011c)
- evacuation plans
- plans for firefighting.

3.3.18. The appropriate responsible authorities should ensure that:

- a 'concept of operations'<sup>38</sup> for emergency response is developed at the beginning of the preparedness stage
- emergency plans and procedures are prepared and, as appropriate, approved for any facility or activity, area or location that could give rise to an emergency warranting protective actions and other response actions
- response organisations and operating organisations, as appropriate, are involved in the preparation of emergency plans and procedures, as appropriate
- account is taken in the content, features and extent of emergency plans of the results of any hazard assessment and any lessons from operating experience and from past emergencies, including conventional emergencies (see clauses 3.1.18 - 3.1.26)
- emergency plans and procedures are periodically reviewed and updated (see clauses 3.3.36 and 3.3.38).

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<sup>38</sup> A concept of operations is a brief description of an ideal response to a postulated nuclear or radiological emergency, used to ensure that all those personnel and organisations involved in the development of a capability for emergency response share a common understanding.

- 3.3.19. The operating organisation of a facility or for an activity in category I, II, III or IV should prepare an emergency plan. This emergency plan should be coordinated with those of all other bodies that have responsibilities in a nuclear or radiological emergency, including public authorities, and should be submitted to the relevant authority for approval.
- 3.3.20. The operating organisation and response organisations should develop the necessary procedures and analytical tools to be able to perform the functions specified in Section 3.2 for the goals of emergency response to be achieved and for the emergency response to be effective.
- 3.3.21. Procedures and analytical tools should be tested under simulated emergency conditions and should be validated prior to initial use. Any arrangements for the use of analytical tools early in an emergency response for supporting decision making on protective actions and other response actions should be made in due recognition of the limitations<sup>39</sup> of such analytical tools and in a way that would not reduce the effectiveness of response actions. These limitations should be made clear to, and should be recognised by, those responsible for decision making.

#### Logistical support and facilities for emergency response

*Adequate logistical support and facilities should be provided to enable emergency response functions to be performed effectively in a nuclear or radiological emergency.*

- 3.3.22. Adequate tools, instruments, supplies, equipment, communication systems, facilities and documentation (such as documentation of procedures, checklists, manuals, telephone numbers and email addresses) should be provided for performing the functions specified in Section 3.2. These items and facilities should be selected or designed to be operational under the conditions (such as radiological conditions, working conditions and environmental conditions) that could be encountered in the emergency response, and to be compatible with other procedures and equipment for the response (e.g. compatible with the communication frequencies used by other response organisations), as appropriate. These support items should be located or provided in a manner that allows their effective use under the emergency conditions postulated.
- 3.3.23. For facilities in categories I and II, as contingency measures, alternative supplies for taking on-site mitigatory actions, such as an alternative supply of water and an alternative electrical power supply, including any necessary equipment, should be ensured. This equipment should be located and maintained so that it can be functional and readily accessible when needed (see also SSR-2/1 (IAEA 2016d)).

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<sup>39</sup> An example of such limitations is that the timing and magnitude of radioactive releases in an emergency at a nuclear power plant that would warrant taking precautionary urgent protective actions and urgent protective actions off-site before, or shortly after, a radioactive release may not be predictable. In addition, the radioactive release could occur over several days, resulting in complex deposition patterns off-site.

- 3.3.24. Emergency response facilities or locations to support an emergency response under the full range of postulated hazardous conditions should be designated and should be assigned the following functions, as appropriate:
- a. receiving notifications and initiating the response
  - b. coordination and direction of on-site response actions
  - c. providing technical and operational support to those personnel performing tasks at a facility and those personnel responding off-site
  - d. direction of off-site response actions and coordination with on-site response actions
  - e. coordination of national response actions
  - f. coordination of communication with the public
  - g. coordination of monitoring, sampling and analysis
  - h. managing those people who have been evacuated (including reception, registration, monitoring and decontamination, as well as provision for meeting their personal needs, including for housing, food and sanitation)
  - i. managing the storage of necessary resources
  - j. providing individuals who have undergone exposure or contamination with appropriate medical attention including medical treatment.
- 3.3.25. For facilities in category I, emergency response facilities<sup>40</sup> separate from the control room and supplementary control room should be provided so that:
- a. technical support can be provided to the operating personnel in the control room in an emergency (from a technical support centre)
  - b. operational control by personnel performing tasks at or near the facility can be maintained (from an operational support centre)
  - c. the on-site emergency response is managed (from an emergency centre).

These emergency response facilities should operate as an integrated system in support of the emergency response, without conflicting with one another's functions, and should provide reasonable assurance of being operable and habitable under a range of postulated hazardous conditions, including conditions not considered in the design.

- 3.3.26. Arrangements should be made for performing appropriate and reliable analyses of samples<sup>41</sup> and measurements of internal contamination for the purposes of emergency response and of

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<sup>40</sup> Emergency response facilities may be collocated (i.e. these functions may be performed from a single emergency response facility or location) provided that it is ensured that they do not conflict with each other in performing their specified functions and provided that they are separated from the control rooms.

<sup>41</sup> Arrangements for analyses could include, for example, arrangements for performing analyses of environmental and biological samples as well as analyses of other samples taken from the facility for the purpose of assessing its operational status.

health screening, as appropriate. Such arrangements should include the designation of laboratories that would be operational under postulated emergency conditions.

- 3.3.27. Arrangements should be made to obtain appropriate support from organisations responsible for providing support in conventional emergencies for logistics and communication, for social welfare and in other areas.

### Training, drills and exercises for emergency preparedness and response

*Personnel relevant for emergency response should take part in regular training, drills and exercises to ensure that they are able to perform their assigned response functions effectively in a nuclear or radiological emergency.*

- 3.3.28. The operating organisation and response organisations should identify the knowledge, skills and abilities necessary to perform the functions specified in Section 3.2. The operating organisation and response organisations should make arrangements for the selection of personnel and for training to ensure that the personnel selected have the requisite knowledge, skills and abilities to perform their assigned response functions. The arrangements should include arrangements for continuing refresher training on an appropriate schedule and arrangements for ensuring that personnel assigned to positions with responsibilities in an emergency response undergo the specified training.
- 3.3.29. For facilities in category I, II or III, all personnel and all other persons on-site should be instructed in the arrangements for them to be notified of an emergency and of their actions if notified of an emergency.
- 3.3.30. Exercise programs should be developed and implemented to ensure that all specified functions required to be performed for emergency response, all organisational interfaces for facilities in category I, II or III, and the national level programs for category IV or V are tested at suitable intervals. These programs should include the participation in some exercises of, as appropriate and feasible, all the organisations concerned, people who are potentially affected, and representatives of news media. The exercises should be systematically evaluated (see clause 3.1.10(h)) and some exercises should be evaluated by the relevant authority. Programs should be subject to review and revision in the light of experience gained (see clauses 3.3.36 and 3.3.38).
- 3.3.31. The personnel responsible for critical response functions should participate in drills and exercises on a regular basis so as to ensure their ability to take their actions effectively.
- 3.3.32. Officials off-site who are responsible for making decisions on protective actions and other response actions should be trained and should regularly participate in exercises. Officials off-site who are responsible for communication with the public in a nuclear or radiological emergency should regularly participate in exercises.

- 3.3.33. The conduct of exercises should be evaluated against pre-established objectives of emergency response to demonstrate that identification, notification, activation and response actions can be performed effectively to achieve the goals of emergency response (see Section 2.2).

#### Quality management programme for emergency preparedness and response

*A programme should be established within an integrated management system to ensure the availability and reliability of all supplies, equipment, communication systems and facilities, plans, procedures and other arrangements necessary for effective response in a nuclear or radiological emergency.*

- 3.3.34. The operating organisation, as part of its management system (IAEA 2016b), and response organisations, as part of their emergency management system, should establish a program to ensure the availability and reliability of all supplies, equipment, communication systems and facilities, plans, procedures and other arrangements necessary to perform functions in a nuclear or radiological emergency as specified in Section 3.2 (see clause 3.3.22). The program should include arrangements for inventories, resupply, tests and calibrations, to ensure that these are continuously available and are functional for use in a nuclear or radiological emergency.
- 3.3.35. The program should also include periodic and independent appraisals against functions as specified in Section 3.2, including participation in international appraisals<sup>42</sup>.
- 3.3.36. Arrangements should be made to maintain, review and update emergency plans, procedures and other arrangements and to incorporate lessons from research, operating experience (such as in the response to emergencies) and emergency exercises.
- 3.3.37. The operating organisation and response organisations should establish and maintain adequate records in relation to both emergency arrangements and the response to a nuclear or radiological emergency, to include dose assessments, results of monitoring and inventory of radioactive waste managed, in order to allow for their review and evaluation. These records should also provide for the identification of those persons requiring longer term medical actions, as necessary, and should provide for the long term management of radioactive waste.
- 3.3.38. The operating organisation and response organisations should make arrangements to review and evaluate responses in actual events and in exercises, in order to record the areas in which improvements are necessary and to ensure that these improvements are made (see clauses 3.2.102 - 3.2.105).
- 3.3.39. Relevant international organisations should review and update their applicable standards and guidelines and their relevant arrangements in emergency preparedness and response on the basis of research and lessons from the response to actual emergencies and in emergency exercises.

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<sup>42</sup> Examples of international appraisals include those organised by the IAEA, such as Emergency Preparedness Review (EPREV) missions.

## Annex A: Guidance values for restricting exposure of emergency workers

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This Annex provides guidance values as a basis for operational guidance for restricting the exposure of emergency workers.

Table A.1 provides guidance values for restricting the exposure of emergency workers in an emergency response in terms of personal dose equivalent  $H_p(10)$  from external exposure to strongly penetrating radiation. The values for  $H_p(10)$  in Table A.1 assume that every effort has been made for protection against external exposure to weakly penetrating radiation and against exposure due to intakes or skin contamination.

The total effective dose and the relative biological effectiveness (RBE) weighted absorbed dose to a tissue or organ via all exposure pathways (i.e. both dose from external exposure and committed dose from intakes) need to be estimated as early as possible in a nuclear or radiological emergency. Table A.1 also provides guidance on the effective dose and the RBE weighted absorbed dose to a tissue or organ for consideration in restricting further exposure in the response to a nuclear or radiological emergency once these doses have been estimated.

Severe tissue reactions to a foetus could possibly occur following an equivalent dose to the foetus of greater than 100 mSv. Consequently, in the response to a nuclear or radiological emergency, female workers who are aware that they are pregnant or who might be pregnant need to be (a) informed of this risk and (b) excluded from taking actions that might result in an equivalent dose to the embryo and foetus exceeding 50 mSv for the full period of in utero development of the embryo and foetus.

**Table A.1:** Guidance values for restricting exposure of emergency workers

Tasks		Guidance value <sup>a</sup>		
		Hp(10) <sup>b</sup>	E <sup>c</sup>	AD <sub>T</sub> <sup>d</sup>
Lifesaving actions		<500 mSv	<500 mSv	$<\frac{1}{2}AD_T$ , Table B.1 <sup>e</sup>
		This value may be exceeded — with due consideration of the generic criteria in Table B.1 of Annex B — 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 these health risks		
Actions to prevent severe tissue reactions and actions to prevent the development of catastrophic conditions that could significantly affect people and the environment		<500 mSv	<500 mSv	$<\frac{1}{2}AD_T$ , Table B.1 <sup>e</sup>
Emergency workers implementing protective actions and other response actions <sup>f</sup>		<50 mSv	$E < 50 \text{ mSv}$	$<\frac{1}{10}AD_T$ , Table B.1 <sup>e</sup>
a	<p>These values for the following are set to be two to ten times lower than the generic criteria in Table B.1 of Annex B.</p> <p>The dose from external exposure to strongly penetrating radiation for Hp(10). Doses from external exposure to weakly penetrating radiation and from intake or skin contamination need to be prevented by all possible means. If this is not feasible, the effective dose and the RBE weighted absorbed dose to a tissue or organ have to be limited to minimise the health risk to the individual in line with the risk associated with the guidance values given here.</p> <p>The total effective dose E and the RBE weighted absorbed dose to a tissue or organ AD<sub>T</sub> via all exposure pathways (i.e. both dose from external exposure and committed dose from intakes) which are to be estimated as early as possible in order to enable any further exposure to be restricted as appropriate.</p>			
b	Personal dose equivalent $H_p(d)$ where $d = 10 \text{ mm}$ .			
c	Effective dose.			
d	RBE weighted absorbed dose to a tissue or organ.			
e	Values of RBE weighted absorbed dose to a tissue or organ given in Table B.1 of Annex B.			
f	See Table 4.1 of RPS G-3 Part 2 (ARPANSA 2019).			

## **Annex B:      Generic criteria for use in emergency preparedness and response**

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This annex provides generic criteria:

- a. for doses for which protective actions and other response actions are expected to be undertaken under any circumstances in a nuclear or radiological emergency to avoid or to minimise severe tissue reactions
- b. for doses for which protective actions and other response actions are expected to be taken, if they can be taken safely, in a nuclear or radiological emergency to reasonably reduce the risk of stochastic effects
- c. for doses for which restriction of international trade is warranted in a nuclear or radiological emergency, with due consideration of non-radiological consequences
- d. for doses for use as a target dose for the transition to an existing exposure situation.

Annex B includes examples of associated protective actions and other response actions. These generic criteria and associated protective actions and other response actions should be taken into account in the development of the protection strategy, including national generic criteria in accordance with clauses 3.1.27 - 3.1.31. If protective actions in the context of the protection strategy are to be taken when doses are below the generic criteria given in this Annex, careful consideration is necessary to ensure that such actions are justified (i.e. that they do more good than harm) and that they are optimised in accordance with clauses 3.1.27 - 3.1.31.



## **B.1 Generic criteria for doses received within a short period of time for which response actions are expected to be taken under any circumstances in an emergency response**

Table B.1 provides generic criteria for doses received within a short period of time for which protective actions and other response actions are expected to be taken under any circumstances in a nuclear or radiological emergency to avoid or to minimise severe tissue reactions.

**Table B.1:** Generic criteria for doses received within a short period of time for which protective actions and other response actions are expected to be taken under any circumstances in an emergency to avoid or to minimise severe tissue reactions.

Acute external exposure (<10 h)		
$AD_{\text{red marrow}}^a$	1 Gy	If the dose is projected:
$AD_{\text{fetus}}$	0.1 <sup>b</sup> Gy	Take precautionary urgent protective actions immediately (even under difficult conditions) to keep doses below the generic criteria
$AD_{\text{tissue}}^c$	25 Gy at 0.5 cm	Provide public information and warnings
$AD_{\text{skin}}^d$	10 Gy to 100 cm <sup>2</sup>	Carry out urgent decontamination
Acute internal exposure due to an acute intake ( $\Delta = 30 \text{ d}^e$ )		
$AD(\Delta)_{\text{red marrow}}$	0.2 Gy for radionuclides with atomic number $Z \geq 90^f$ 2 Gy for radionuclides with atomic number $Z \leq 89^f$	If the dose has been received: Perform immediate medical examination, medical consultation and indicated medical treatment
$AD(\Delta)_{\text{thyroid}}$	2 Gy	Carry out contamination control
$AD(\Delta)_{\text{lung}}^h$	30 Gy	Carry out immediate decorporation <sup>g</sup> (if applicable)
$AD(\Delta)_{\text{colon}}$	20 Gy	Conduct registration for longer term medical follow-up
$AD(\Delta')_{\text{fetus}}^i$	0.1 <sup>b</sup> Gy	Provide comprehensive psychological counselling
a	$AD_{\text{red marrow}}$ represents the average RBE weighted absorbed dose to internal tissues or organs (e.g. red marrow, lung, small intestine, gonads, thyroid) and to the lens of the eye from exposure in a uniform field of strongly penetrating radiation.	
B	At 0.1 Gy there would be only a very small probability of severe tissue reactions to the fetus and only during certain periods post-conception (e.g. between 8 and 15 weeks of in utero development), and only if the dose is received at high dose rates. During other periods post-conception and for lower dose rates, the fetus is less sensitive. There is a high probability of severe tissue reactions at 1 Gy. Therefore, 1 Gy is used as the generic criterion for doses to the fetus received within a short period of time: (i) in the hazard assessment (see clause 3.1.23), to identify facilities and activities, on-site areas, off-site areas and locations for which a nuclear or radiological emergency could warrant precautionary urgent protective actions to avoid or to minimise severe tissue reactions; (ii) for identifying situations in which exposure is dangerous to health; and (iii) for making arrangements (see clause 3.2.38) for applying decisions on urgent protective actions and other response actions to be taken off-site to avoid or to minimise the occurrence of severe tissue reactions (e.g. establishing a precautionary action zone).	
C	Dose delivered to 100 cm <sup>2</sup> at a depth of 0.5 cm under the body surface in tissue due to close contact with a radioactive source (e.g. source carried in the hand or pocket).	
d	The dose is to the 100 cm <sup>2</sup> dermis (skin structures at a depth of 40 mg/cm <sup>2</sup> (or 0.4 mm) below the surface).	
e	$AD(\Delta)$ is the RBE weighted absorbed dose delivered over a period of time $\Delta$ by the intake ( $I_{05}$ ) that will result in a severe deterministic effect in 5% of exposed individuals. This dose is calculated as described in Appendix I of <i>Dangerous Quantities of Radioactive Material (D-values)</i> IAEA 2006.	
f	Different generic criteria are used to take account of the significant difference in RBE weighted absorbed dose from exposure at the intake threshold values specific for these two groups of radionuclides.	
g	Decorporation is the action of the biological processes, facilitated by chemical or biological agents, by means of which incorporated radionuclides are removed from the human body. The generic criterion for decorporation is based on the projected dose without decorporation.	
h	For the purposes of these generic criteria, 'lung' means the alveolar–interstitial region of the respiratory tract.	
i	For this particular case, ' $\Delta$ ' refers to the period of in utero development of the embryo and foetus.	

## **B.2 Generic criteria for protective actions and other response actions to reduce the risk of stochastic effects**

Table B.2 provides generic criteria for taking protective actions and other response actions in a nuclear or radiological emergency to reduce the risk of stochastic effects.

**Table B.2:** Generic criteria for protective actions and other response actions in an emergency to reduce the risk of stochastic effects.

Generic criteria		Examples of protective actions and other response actions <sup>a</sup>
Projected dose that exceeds the following generic criteria: Take urgent protective actions and other response actions		
$H_{\text{thyroid}}$	30 mSv <sup>b</sup> in the first 7 days	Child and pregnant women iodine thyroid blocking <sup>c</sup>
$H_{\text{thyroid}}$	100 mSv <sup>b</sup> in the first 7 days	Adult iodine thyroid blocking <sup>c</sup>
$E^d$	50 mSv in the first 7 days	Evacuation
$E^d$	10 mSv in the first 7 days	Sheltering <sup>e</sup> ; prevention of inadvertent ingestion; restrictions on food, milk and drinking water <sup>g</sup> and restrictions on the food chain and water supply; restrictions on commodities other than food; contamination control; decontamination; registration; reassurance of the public
$H_{\text{fetus}}^f$	10 mSv in the first 7 days	
Projected dose that exceeds the following generic criteria: Take early protective actions and other response actions		
$E^d$	50 mSv in the first year	Temporary relocation
$E^d$	10 mSv in the first year	Prevention of inadvertent ingestion; restrictions on food, milk and drinking water <sup>g</sup> and restrictions on the food chain and water supply; restrictions on commodities other than food; contamination control; decontamination; registration; reassurance of the public
$H_{\text{fetus}}^f$	10 mSv for the full period of in utero development	
Dose that has been received and that exceeds the following generic criteria: Take longer term medical actions to detect and to effectively treat radiation induced health effects		
$E^d$	50 mSv in a month	Health screening based on equivalent doses to specific radiosensitive organs (as a basis for longer term medical follow-up) <sup>h</sup> , registration, counselling
$H_{\text{fetus}}^f$	50 mSv for the full period of in utero development	Counselling to allow informed decisions to be made in individual circumstances
a	These examples are neither exhaustive nor grouped in a mutually exclusive way.	
b	The equivalent dose to the thyroid ( $H_{\text{thyroid}}$ ) only due to exposure to radioiodine.	
c	This generic criterion applies only for administration of iodine thyroid blocking. For the thyroid, iodine thyroid blocking is an urgent protective action that is prescribed: (a) if exposure due to radioactive iodine is involved, (b) before or shortly after a release of radioactive iodine, and (c) within only a short period before or after the intake of radioactive iodine. A child is considered to be less than 18 years of age.	
d	Effective dose.	
e	As a less disruptive protective action, sheltering may be ordered at lower doses as long as justified and optimised in accordance with clauses 3.1.27 - 3.1.31 with due consideration of the reference level in clause 3.1.28(b).	
f	$H_{\text{fetus}}$ is the equivalent dose to the fetus, derived as the sum of the dose from external exposure and the maximum committed equivalent dose to any organ of the embryo or fetus from intake to the embryo or fetus for different chemical compounds and different times relative to conception.	
g	Restrictions on food, milk and drinking water using these generic criteria are to be applied before sampling and analysis of food, milk and drinking water are carried out. Such restrictions apply as long as replacements of food, milk and drinking water or other alternatives are available to ensure they would not result in severe malnutrition, dehydration or other severe health impacts.	
h	When results of the health screening indicate that the criteria in Table B.1 are exceeded, then appropriate medical attention on the basis of Appendix B (see Table B.1) is necessary.	

### **B.3 Generic criteria for food, milk and drinking water and other commodities to reduce the risk of stochastic effects**

Table B.3 provides generic criteria for taking protective actions and other response actions to reduce the risk of stochastic effects from the ingestion of food, milk and drinking water and from the use of other commodities in a nuclear or radiological emergency.

If restrictions on food, milk or drinking water would result in severe malnutrition or dehydration because replacements are not available, food, milk or drinking water with concentration levels of radionuclides that are projected to result in doses above the generic criteria given in Table B.3 may be consumed until replacements are available provided that this would not result in doses from all exposure pathways above the generic criteria given in Table B.2; otherwise, the people affected may be relocated.

**Table B.3:** Generic criteria for food, milk and drinking water and other commodities to reduce risk of stochastic effects.

Generic criteria		Examples of protective actions and other response actions
Projected dose from ingestion of food, milk and drinking water and from the use of other commodities that exceeds the following generic criteria:		
Take protective actions and other response actions		
$E^a$	10 mSv in the first year	Restrict consumption, distribution and sale of non-essential <sup>b</sup> food, milk and drinking water <sup>c</sup> and restrict the use and distribution of other commodities.  Replace essential food, milk and drinking water as soon as possible or relocate the people affected if replacements are not available.  Estimate the doses of those who might have consumed food, milk and drinking water or used other commodities to determine whether this may have resulted in doses warranting medical attention in accordance with Table B.2.
$H_{\text{fetus}}^d$	10 mSv for the full period of in utero development	
a	Effective dose.	
b	Restricting essential food, milk or drinking water could result in dehydration, severe malnutrition or other severe health impacts; therefore, essential food, milk and drinking water is to be restricted only if alternatives are available.	
c	These criteria for taking actions on food, milk and drinking water are applied once the sampling and analysis of food, milk and drinking water is carried out. This would also provide a basis for discontinuing restrictions imposed on food, milk and drinking water as a precaution on the basis of the generic criteria in Table B.2.	
d	$H_{\text{fetus}}$ is the equivalent dose to the fetus derived as the sum the dose from external exposure and the maximum committed equivalent dose to any organ from intake to the embryo or fetus for different chemical compounds and different times relative to conception.	

## **B.4 Generic criteria for vehicles, equipment and other items to reduce the risk of stochastic effects**

Table B.4 provides generic criteria for taking protective actions and other response actions to reduce the risk of stochastic effects arising from the use of vehicles, equipment and other items from an area affected by a nuclear or radiological emergency.

Restricting the use of vehicles, equipment and other items from an affected area could interfere with taking urgent protective actions and other response actions or with providing services essential to public health or well-being (e.g. restricting the use of vehicles for transferring individuals requiring critical medical treatment or preventing a ship or an aircraft that has left an affected area from reaching its final destination). Such vehicles, equipment and other items whose use would give rise to a projected dose to their users above the generic criteria given in Table B.4 may be used until replacements are available, provided that:

- a. their use will not result in doses from all exposure pathways that exceed the generic criteria given in Table B.2 for members of the public or the guidance values given in Annex A for restricting the exposure of emergency workers, or the restriction set in clause 3.2.57 for exposures of helpers in an emergency
- b. actions are taken to manage and control the exposure of the user as an emergency worker, a helper in an emergency or a member of the public, as appropriate.

**Table B.4: Generic criteria for vehicles, equipment and other items to reduce the risk of stochastic effects**

Generic criteria		Examples of protective actions and other response actions
Projected dose from the use of vehicles, equipment or other items from an affected area that exceed the following generic criteria:		
Take protective actions and other response actions		
$E^a$	10 mSv in the first year	Restrict non-essential use. Use essential vehicles, equipment and other items from an affected area until replacements are available provided that: (a) their use will not result in doses from all exposure pathways exceeding the generic criteria given in Table B.2 for a member of the public or the guidance values given in Annex A for restricting the exposure of emergency workers, or the restriction set in clause 3.2.57 for exposures of helpers in an emergency; and (b) actions are taken to control the dose to the user as an emergency worker, helper in an emergency or a member of the public, as appropriate. Estimate doses to those emergency workers, helpers in an emergency and members of the public who may have used a vehicle, equipment or other item from an affected area to determine whether this could have resulted in a dose warranting medical attention in accordance with Table B.2.
$H_{\text{fetus}}^c$	10 mSv for the full period of in utero development	
a	Effective dose.	
b	Restricting the use of vehicles, equipment and other items from an affected area could interfere with taking urgent protective actions and other response actions or with providing services essential to public health or well-being (e.g. restricting the use of vehicles for transferring individuals requiring critical medical treatment).	
c	$H_{\text{fetus}}$ is the equivalent dose to the fetus derived as the sum of the dose from external exposure and the maximum committed equivalent dose to any organ from intake to the embryo or fetus for different chemical compounds and different times relative to conception.	



## B.5 Generic criteria for food and other commodities traded internationally

Table B.5 provides generic criteria aimed at the effective implementation of response actions to reduce the non-radiological consequences of a nuclear or radiological emergency by providing a basis for the continuation or the resumption of international trade.

Values that exceed the generic criteria in Table B.5 may be acceptable under emergency (temporary) conditions.

The generic criteria for food traded internationally derive from the level used by the Joint FAO/WHO Codex Alimentarius Commission (FAO/WHO 2018). These generic criteria, and generic criteria for other commodities traded internationally that could contain radionuclides following a nuclear or radiological emergency, are established in Table B.2 for early protective actions and other response actions to ensure that doses to the public would be a small fraction of those for which actions are warranted to reduce the risk of stochastic effects.

For food traded internationally that could contain radionuclides following a nuclear or radiological emergency, the operational criteria (i.e. guideline levels) as published by the Joint FAO/WHO Codex Alimentarius Commission (FAO/WHO 2018) may ultimately be used (IAEA 2014).

If restricting trade in food and other commodities could result in severe health impacts or other detrimental effects in another country, then the food and other commodities that would give rise to a projected dose that exceeds the generic criteria in Table B.5 may be traded, if the trade is justified, until replacements are available, provided that:

- a. the trade is approved with the receiving country
- b. the trade will not result in doses that exceed the generic criteria for the public given in Table B.2 and Table B.3
- c. actions are taken to manage and control exposures during shipping
- d. actions are taken to control the consumption of food and use of other commodities and to reduce the exposure of members of the public.

**Table B.5: Generic criteria for food and other commodities traded internationally.**

Generic criteria		Examples of other response actions
Projected dose from food and other commodities that exceed the generic criteria: Take response actions to restrict international trade.		
$E^a$	1 mSv per year	Restrict non-essential <sup>b</sup> international trade. Trade essential food and other commodities until replacements are available if: (a) trade is approved with the receiving country; (b) trade will not result in doses to the public that exceed the generic criteria given in Table B.2 for all exposure pathways and in Table B.3 for the respective pathways; (c) actions are taken to manage and control the dose during shipping; and (d) actions are taken to control the consumption and use of food and other commodities and to reduce the exposure of members of the public.
$H_{\text{fetus}}^c$	1 mSv for the full period of in utero development	
a	Effective dose.	
b	Restricting the trade of essential commodities and food could result in severe health impacts or other detrimental conditions in another country.	
c	$H_{\text{fetus}}$ is the equivalent dose to the fetus derived as the sum of the dose from external exposure and the maximum committed equivalent dose to any organ from intake to the embryo or fetus for different chemical compounds and different times relative to conception.	

## B.6 Generic criteria for enabling a transition to an existing exposure situation

Generic criteria should be established in terms of the projected dose for the implementation of protective actions and other actions aimed at enabling the termination of a nuclear or radiological emergency and the subsequent transition to an existing exposure situation. These criteria are established as the generic criteria for the early protective actions and other response actions given in Table B.2<sup>43</sup> and are:

- a. an effective dose of 10 mSv per year
- b. an equivalent dose to a foetus of 10 mSv for the full period of in utero development.

The decision to terminate the nuclear or radiological emergency and the subsequent transition to an existing exposure situation is to be taken after:

- a. justified actions (see clause 3.1.29) have been taken to reach the generic criteria<sup>44</sup> for enabling the transition to an existing exposure situation and it has been confirmed that any further actions to reach these criteria would do more harm than good
- b. confirmation that the source of exposure is fully characterised for all members of the public living as normal in the area
- c. the situation with regard to exposure has been understood and has remained stable
- d. any restrictions on normal living conditions are limited and provisions are in place to confirm compliance with such restrictions
- e. confirmation that interested parties, including the public, have been consulted and are being kept informed about the basis for the adjustment of emergency response actions and for the transition, with the associated health hazards put into perspective (see clause 3.2.72).

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<sup>43</sup> Criteria established as the generic criteria for the early protective actions and other response actions given in Table B.2 are considered to be generically justified. This level is also consistent with the reference levels established in for existing exposure situations (ARPANSA 2017).

<sup>44</sup> Actions taken (see clause 3.1.29) to reach the generic criteria need to be justified and optimised in accordance with clauses 3.1.27 - 3.1.31. However, it may not be feasible to reach these criteria for enabling the transition to an existing exposure situation. If it is not feasible or justified to reach these generic criteria, the transition may still be possible as long as the generic criteria for early protective actions and other response actions given in Table B.2 are not exceeded.

## **Annex C: The Australian framework for preparedness and response applicable to radiation or nuclear events**

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Under Australian constitutional arrangements, the state and territory jurisdictions have primary responsibility for the protection of life, property and the environment within their jurisdiction.

### **C.1 Overview of the Australian prevention and preparedness**

State and Territory jurisdiction responsibilities for the protection of life, property and environment include prevention and preparedness activities to mitigate risk and the impact of crises.

The Australian Government provides:

- financial assistance to states and territories to support prevention and preparedness activities, including crisis management exercises
- national leadership and coordination on policy and capability through Council of Australian Government committees, such as the Australia-New Zealand Emergency Management Committee and the Australia-New Zealand Counter-Terrorism Committee.

Australian Commonwealth Government agencies (including ARPANSA) also develop national plans, conduct exercises, and assist in preparing for crises within Australia and overseas. The Australian Government Department of Foreign Affairs and Trade and the Department of Defence also manage a program to prepare for 'events' that may affect Australians and/or Australian interests overseas.

An inter-departmental committee, the Visiting Ships Panel (Nuclear) (VSP(N)), oversees the arrangements for visits to Australian ports by Nuclear Powered Warships (NPW).

### **C.2 Overview of the Australian crisis management framework**

All States and Territories have emergency management and other legislation that may be applied in the event of a radiation or nuclear event. This legislation is referred to in State and Territory plans and covers a range of functions, including health, law and order, energy supplies, transport, water and local government.

ARPANSA, as an Australian Government (Federal i.e. not state or territory government) agency, may be called on directly or indirectly to support state or territory emergency management. This may form part of a wider Australian Commonwealth Government involvement in any incident.

ARPANSA's contribution in the event of a radiation or nuclear event may include:

- location and characterisation of likely sources of radiological threat
- collection and monitoring of measurement data
- prediction of dispersion of radiological material
- technical analysis and assessment of simulated and actual data
- provision of expert advice including radiation protection and nuclear safety/security advice.

ARPANSA support to State and Territory governments would mainly be provided to the relevant radiation protection agency or regulator in that state or territory that holds primary responsibility under the relevant State or Territory legislation. ARPANSA support may be in the form of liaison officers, measurement services or technical product provided by electronic means.

### **C.3 State and Territory crisis management framework relationship with the Australian Government crisis management framework**

Commonwealth-level Australian Government responsibilities in a crisis include:

- providing support to a state or territory, where the response overwhelms resources and Australian Government coordinated assistance has been requested;
- jointly managing, with an affected state or territory, a crisis that has the potential to affect/has affected: more than one jurisdiction, the broader community or Australian Government areas of responsibility; or is of national consequence;
- taking primary responsibility for coordinating the response to a crisis that is not the responsibility of a state or territory (e.g. a crisis outside Australia that significantly affects Australians and/or Australian interests)
- providing financial assistance to the Australian community and states and territories for relief and recovery.

## Appendix 1: The ten principles of radiation risk management from the Fundamentals for Protection Against Ionising Radiation

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The following ten principles of radiation risk management are explained in detail in Section 4 of the Fundamentals for Protection Against Ionising Radiation (2014) (RPS F-1):

1. Clear division of responsibilities
  - i. *The prime responsibility for management of radiation risks must rest with the person or organisation responsible for facilities and activities that give rise to radiation risks.*
2. Legislative and regulatory framework
  - ii. *An effective framework including legislation, regulation and guidance to promote management of radiation risks, including an independent regulatory body, must be established and sustained.*
3. Leadership and management for safety
  - iii. *Effective leadership and management of radiation risks must be established and sustained in organisations concerned with, and facilities and activities that give rise to, radiation risks.*
4. Justification
  - iv. *Facilities and activities that give rise to radiation risks must yield an overall benefit.*
5. Optimisation of protection
  - v. *Protection must be optimised so that radiation risks are as low as reasonably achievable.*
6. Limitation of risks
  - vi. *Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm, and that the environment is protected.*
7. Protection of present and future generations
  - vii. *People and the environment, present and future, must be protected against radiation risks.*
8. Prevention of accidents and malicious acts
  - viii. *All practical efforts must be made to prevent and mitigate accidents, and acts with malicious intent, that may give rise to radiation risks.*
9. Emergency preparedness and response
  - ix. *Arrangements must be made for emergency preparedness and response for incidents, accidents and malicious acts that may give rise to radiation risks.*
10. Protective actions to reduce existing or unregulated radiation risks
  - x. *Protective actions to reduce existing or unregulated radiation risks must be justified and optimised.*

## Appendix 2: Derivation of emergency exposure guide clauses from GSR Part 7 requirements

Table App.1 cross-references each clause in Section 3 of this guide to the relevant requirement in GSR Part 7 (IAEA 2015).

**Table App.1: Clauses in Section 3 cross-referenced to the relevant requirement in GSR Part 7 (IAEA 2015).**

RPS G-3		IAEA GSR Part 7
Requirement	Clause(s)	Requirement
The emergency management system	3.1.1 - 3.1.4	Requirement 1
Roles and responsibilities in emergency preparedness and response	3.1.5 - 3.1.17	Requirement 2
Responsibilities of international organisations in emergency preparedness and response		Requirement 3
Hazard assessment	3.1.18 - 3.1.26	Requirement 4
Protection strategy for a nuclear or radiological emergency	3.1.27 - 3.1.31	Requirement 5
Managing operations in an emergency response	3.2.1 - 3.2.10	Requirement 6
Identifying and notifying a nuclear or radiological emergency and activating an emergency response	3.2.11 - 3.2.22	Requirement 7
Taking mitigatory actions	3.2.23 - 3.2.30	Requirement 8
Taking urgent protective actions and other response actions	3.2.31 - 3.2.44	Requirement 9
Providing instructions, warnings and relevant information to the public for emergency preparedness and response	3.2.45 - 3.2.48	Requirement 10
Protecting emergency workers and helpers in an emergency	3.2.49 - 3.2.61	Requirement 11
Managing the medical response in a nuclear or radiological emergency	3.2.62 - 3.2.68	Requirement 12
Communicating with the public throughout a nuclear or radiological emergency	3.2.69 - 3.2.75	Requirement 13

RPS G-3		IAEA GSR Part 7
Requirement	Clause(s)	Requirement
Taking early protective actions and other response actions	3.2.76 - 3.2.83	Requirement 14
Managing radioactive waste in a nuclear or radiological emergency	3.2.84 - 3.2.88	Requirement 15
Mitigating non-radiological consequences of a nuclear or radiological emergency and of an emergency response	3.2.89 - 3.2.92	Requirement 16
Requesting, providing and receiving international assistance for emergency preparedness and response	3.2.93 - 3.2.94	Requirement 17
Terminating a nuclear or radiological emergency	3.2.95 - 3.2.101	Requirement 18
Analysing the nuclear or radiological emergency and the emergency response	3.2.102 - 3.2.105	Requirement 19
Authorities for emergency preparedness and response	3.3.1 - 3.3.6	Requirement 20
Organisation and staffing for emergency preparedness and response	3.3.7 - 3.3.11	Requirement 21
Coordination of emergency preparedness and response	3.3.12 - 3.3.15	Requirement 22
Plans and procedures for emergency response	3.3.16 - 3.3.21	Requirement 23
Logistical support and facilities for emergency response	3.3.22 - 3.3.27	Requirement 24
Training, drills and exercises for emergency preparedness and response	3.3.28 - 3.3.33	Requirement 25
Quality management program for emergency preparedness and response	3.3.34 - 3.3.39	Requirement 26



## Glossary

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### Authorisation

The granting by a relevant regulatory authority of written permission for a Responsible Person to conduct specified activities.

### Control

The function or power or (usually as controls) means of directing, regulating or restraining.

*Regulatory control:* Any form of control or regulation applied to facilities and activities by a regulatory body for reasons relating to nuclear safety and radiation protection or to nuclear security.

*Emergency Management Incident Control:* In Australia, the overall direction of response activities in an emergency, operating horizontally across agencies. Authority for control is established in legislation or in an emergency response plan, and carries with it the responsibility for tasking other agencies in accordance with the needs of the situation.

### Deterministic effect

See 'tissue reactions'.

### Early protective actions

See 'protective actions'.

### Emergency

A non-routine situation (incident or accident) or event that necessitates prompt action, primarily to mitigate a hazard or adverse consequences for human health and safety, quality of life, property and the environment.

### Emergency action level (EAL)

A specific, predetermined criterion for observable conditions used to detect, recognise and determine the emergency class.

### Emergency arrangements

The integrated set of infrastructural elements, put in place at the preparedness stage, that are necessary to provide the capability for performing a specified function or task required in response to a nuclear or radiological emergency.

### Emergency classification

The process whereby an authorised official classifies an emergency in order to declare the applicable emergency class.

### Emergency exposure situation

A situation of exposure that arises as a result of an accident, a malicious act, or other unexpected event, and requires prompt action in order to avoid or to reduce adverse consequences.

### **Emergency plan**

A description of the objectives, policy and concept of operations for the response to an emergency and of the structure, authorities and responsibilities for a systematic, coordinated and effective response. The emergency plan serves as the basis for the development of other plans, procedures and checklists.

### **Emergency planning distance**

The extended planning distance (EPD) and the ingestion and commodities planning distance (ICPD).

### **Emergency planning zone**

The precautionary action zone (PAZ) and the urgent protective action planning zone (UPZ).

### **Emergency preparedness**

The capability to take actions that will effectively mitigate the consequences of an emergency for human health and safety, quality of life, property and the environment.

### **Emergency procedures**

A set of instructions describing in detail the actions to be taken by emergency workers in an emergency.

### **Emergency response**

The performance of actions to mitigate the consequences of an emergency for human health and safety, quality of life, property and the environment.

### **Emergency response action**

An action to be taken in response to a nuclear or radiological emergency to mitigate the consequences of an emergency for human health and safety, quality of life, property and the environment.

### **Emergency response facility or location**

A facility or location necessary for supporting an emergency response, for which specific functions are to be assigned at the preparedness stage, and which need to be usable under emergency conditions.

### **Emergency services**

The local off-site response organisations that are generally available and that perform emergency response functions. These may include police, firefighters and rescue brigades, ambulance services and control teams for hazardous materials.

### **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 organisations, 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.

### **Existing exposure situation**

A situation of exposure that already exists when a decision on the need for control needs to be taken. Existing exposure situations include exposure to natural background radiation that is amenable to control; exposure due to residual radioactive material that derives from past practices that were never subject to regulatory control; and exposure due to residual radioactive material deriving from a nuclear or radiological emergency after an emergency has been declared to be ended.

### **Extended planning distance (EPD)**

Area around a facility for which emergency arrangements are made to conduct monitoring following the declaration of a general emergency and to identify areas warranting emergency response actions to be taken off-site jurisdictions within a period following a significant radioactive release that would allow the risk of stochastic effects among members of the public to be effectively reduced.

### **Facilities and activities**

A general term encompassing nuclear facilities, uses of all sources of ionising radiation, all radioactive waste management activities, transport of radioactive material and any other practice or circumstances in which people may be subject to exposure to radiation from naturally occurring or artificial sources.

### **First responders**

The first members of an emergency service to respond at the site of an emergency.

### **Generic criteria**

Levels for the projected dose, or the dose that has been received, at which protective actions and other response actions are to be taken.

### **Graded approach**

An application of safety requirements that is commensurate with the characteristics of the facilities and activities or the source and with the magnitude and likelihood of the exposures.

### **Hazard assessment**

Assessment of hazards associated with facilities, activities or sources within or beyond the borders of a State in order to identify:

1. those events and the associated areas for which protective actions and other response actions may be required within the State
2. actions that would be effective in mitigating the consequences of such events.

### **Helper in an emergency**

Member of the public who willingly and voluntarily helps in the response to a nuclear or radiological emergency. Helpers in an emergency are to be made aware that they could be exposed to radiation while helping in response to a nuclear or radiological emergency.

### **Ingestion and commodities planning distance (ICPD)**

Area around a facility for which emergency arrangements are made to take effective emergency response actions following the declaration of a general emergency in order to reduce the risk of stochastic effects among members of the public and to mitigate non radiological consequences as a result of the distribution, sale and consumption of food, milk and drinking water and the use of commodities other than food that may have contamination from a significant radioactive release.

### **Inner cordoned off area**

An area established by first responders in an emergency around a potential radiation hazard, within which protective actions and other emergency response actions are taken to protect first responders and members of the public from possible exposure and contamination.

### **Justification**

The process of determining for an emergency exposure situation or an existing exposure situation whether a proposed protective action or remedial action is likely, overall, to be beneficial; i.e. whether the expected benefits to individuals and to society (including the reduction in radiation detriment) from introducing or continuing the protective action or remedial action outweigh the cost of such action and any harm or damage caused by the action.

### **Management system**

A set of interrelated or interacting elements (system) for establishing policies and objectives and enabling the objectives to be achieved in an efficient and effective manner.

### **Non-radiological consequences**

Adverse psychological, societal or economic consequences of a nuclear or radiological emergency or of an emergency response affecting human health and safety, quality of life, property and the environment.

### **Notification**

1. A report submitted promptly to a national or international authority providing details of an emergency or a possible emergency; for example, as required by the Convention on Early Notification of a Nuclear Accident.
2. A set of actions taken upon detection of emergency conditions with the purpose of alerting all organisations with responsibility for emergency response in the event of such conditions.

### **Notification point**

A designated organisation with which arrangements have been made to receive notification (meaning (2)) and to initiate promptly the predetermined actions to activate a part of the emergency response.

## **Notifying State**

The Country that is responsible for notifying (see notification meaning (1)) potentially affected Countries and the IAEA of an event of actual, potential or perceived radiological significance for other States. This includes:

1. The Country that has jurisdiction or control over the facility or activity (including space objects) in accordance with Article 1 of the Convention on Early Notification of a Nuclear Accident
2. The Country that initially detects or discovers evidence of a transnational emergency, for example by: detecting significant increases in atmospheric radiation levels of unknown origin; detecting contamination in transboundary shipments; discovering a dangerous source that may have originated in another Country; or diagnosing clinical symptoms that may have resulted from exposure outside the Country.

## **Nuclear or radiological emergency**

An emergency in which there is, or is perceived to be, a hazard due to:

1. the energy resulting from a nuclear chain reaction or from the decay of the products of a chain reaction
2. radiation exposure.

## **Nuclear material**

Includes plutonium (except that with isotopic concentration exceeding 80% in plutonium-238); uranium-233; uranium enriched in the isotope 235 or 233; uranium containing the mixture of isotopes as occurring in nature other than in the form of ore or ore residue; depleted uranium; thorium; any material containing one or more of the foregoing. For the purposes of IAEA safeguards agreements, see the Commonwealth Nuclear Non-Proliferation (Safeguards) Act 1987.

## **Nuclear security**

The prevention and detection of, and response to, criminal or intentional unauthorised acts involving nuclear material, other radioactive material, associated facilities or associated activities.

## **Nuclear security event**

An event that has potential or actual implications for nuclear security that must be addressed.<sup>4</sup>

## **Off-site jurisdiction**

Any entity that has a defined emergency management role or responsibility beyond the site boundary or cordon of an emergency.

## **Off-site (area)**

See 'site (area)'.

## **On-site (area)**

See 'site (area)'.

### **Operating personnel**

Individual workers engaged in the operation of an authorised facility or the conduct of an authorised activity.

### **Operating organisation**

Any organisation or person applying for authorisation or authorised to operate an authorised facility or to conduct an authorised activity and responsible for its safety.

### **Operational criteria**

Values of measurable quantities or observable conditions (i.e. observables) to be used in the response to a nuclear or radiological emergency in order to determine the need for appropriate protective actions and other response actions.

### **Operational intervention level (OIL)**

A set level of a measurable quantity that corresponds to a generic criterion.

### **Optimisation (of protection and safety)**

The process of determining what level of protection and safety would result in the magnitude of individual doses, the number of individuals (workers and members of the public) subject to exposure and the likelihood of exposure being 'as low as reasonably achievable, economic and social factors being taken into account' (ALARA).

### **Planned exposure situation**

The situation of exposure that arises from the planned operation of a source or from a planned activity that results in an exposure due to a source. Since provision for protection and safety can be made before embarking on the activity concerned, associated exposures and their probabilities of occurrence can be restricted from the outset. The primary means of controlling exposure in planned exposure situations is by good design of installations, equipment and operating procedures. In planned exposure situations, a certain level of exposure is expected to occur.

### **Precautionary action zone (PAZ)**

An area around a facility for which emergency arrangements have been made to take urgent protective actions in the event of a nuclear or radiological emergency to avoid or to minimise severe tissue reactions off-site jurisdictions. Protective actions within this area are to be taken before or shortly after a release of radioactive material or an exposure, on the basis of prevailing conditions at the facility.

### **Preparedness stage**

The stage or phase at which arrangements for an effective emergency response are established prior to a nuclear or radiological emergency.

### **Projected dose**

The dose that would be expected to be received if planned protective actions were not taken.

## Protective action

An action for the purposes of avoiding or reducing doses that might otherwise be received in an emergency exposure situation or an existing exposure situation.

*Early protective action:* A protective action in the event of a nuclear or radiological emergency that can be implemented within days to weeks and still be effective.

*Mitigatory action:* Immediate action by the operator or other party:

1. to reduce the potential for conditions to develop that would result in exposure or a release of radioactive material requiring emergency response actions on-site or off-site or
2. to mitigate source conditions that may result in exposure or a release of radioactive material requiring emergency response actions on-site or off-site.

*Urgent protective action:* A protective action in the event of a nuclear or radiological emergency which must be taken promptly (usually within hours to a day) in order to be effective, and the effectiveness of which will be markedly reduced if it is delayed.

Urgent protective actions include iodine thyroid blocking, evacuation, short term sheltering, actions to reduce inadvertent ingestion, decontamination of individuals and prevention of ingestion of food, milk or drinking water possibly with contamination.

*Precautionary urgent protective action:* Is an urgent protective action taken before or shortly after a release of radioactive material, or an exposure, on the basis of the prevailing conditions to avoid or to minimise severe tissue reactions.

## Reference level

For an emergency exposure situation or an existing exposure situation, the level of dose, risk or activity concentration above which it is not appropriate to plan to allow exposures to occur and below which optimisation of protection and safety would continue to be implemented.

## Regulatory body

The radiation protection authority or authorities designated, or otherwise recognised, for regulatory purposes in connection with protection and safety relating to applications of ionising radiation. A list of relevant regulatory authorities in Australia can be found on ARPANSA's website at [www.arpansa.gov.au/Regulation/Regulators](http://www.arpansa.gov.au/Regulation/Regulators).

## Residual dose

The dose expected to be incurred after protective actions have been terminated (or after a decision has been taken not to take protective actions). Residual dose applies for an existing exposure situation or an emergency exposure situation.

## Response organisation

An organisation designated or recognised by a State as being responsible for managing or implementing any aspect of an emergency response. This also includes those organisations or services necessary to support the management and/or conduct of an emergency response, such as meteorological services.

## Response Time Objectives

A set of pre-determined actions to be performed within set time-frames in order to achieve the goals of emergency response. RTOs should be incorporated during field exercises in order to validate the performance of preparedness arrangements.

## Site area

A geographical area that contains an authorised facility, authorised activity or source, and within which the management of the authorised facility or authorised activity or first responders may directly initiate emergency response actions.

This is typically the area within the security perimeter fence or other designated property marker. It may also be the controlled area around a radiography source or an inner cordoned off area established by first responders around a suspected hazard.

*On-site (area):* (Area) within the site area.

*Off-site (area):* (Area) outside the site area.

## Source

1. Anything that may cause radiation exposure — such as by emitting ionising radiation or by releasing radioactive substances or radioactive material — and can be treated as a single entity for purposes of protection and safety.
2. Radioactive material used as a source of radiation.

*Dangerous source:* A source that could, if not under control, give rise to exposure sufficient to cause severe tissue reactions. This categorisation is used for determining the need for emergency arrangements and is not to be confused with categorisations of sources for other purposes.

*Radioactive source:* A source containing radioactive material that is used as a source of radiation.

## Special facility

A facility for which predetermined facility specific actions need to be taken if urgent protective actions are ordered in its locality in the event of a nuclear or radiological emergency.

## Special population group

Members of the public for whom special arrangements are necessary in order for effective protective actions to be taken in the event of a nuclear or radiological emergency. Examples include persons with disabilities, hospital patients and prisoners.

## Stochastic effect

A radiation induced health effect, the probability of occurrence of which is greater for a higher radiation dose and the severity of which (if it occurs) is independent of dose. Stochastic effects may be somatic effects or hereditary effects, and generally occur without a threshold level of dose. Examples include solid cancers and leukaemia.



### **Tissue reaction**

Harmful reaction to radiation in a population of cells (tissue) where a threshold dose has to be exceeded for it to be expressed in a clinically relevant form, and where the severity of harm increases with the dose.

Often used as synonymous to 'deterministic effects'. Tissue reactions is the preferred term as the effect is susceptible to a range of modifiers, i.e. is not strictly predetermined.

### **Transient population group**

Those members of the public who are residing for a short period of time (days to weeks) in a location (such as a camping ground) that can be identified in advance. This does not include members of the public who may be travelling through an area.

### **Transnational emergency**

A nuclear or radiological emergency of actual, potential or perceived radiological significance for more than one Country.

This may include:

1. a significant transboundary release of radioactive material (however, a transnational emergency does not necessarily imply a significant transboundary release of radioactive material)
2. a general emergency at a facility or other event that could result in a significant transboundary release (atmospheric or aquatic) of radioactive material
3. discovery of the loss or illicit removal of a dangerous source that has been transported across, or is suspected of having been transported across, a national border
4. an emergency resulting in significant disruption to international trade or travel
5. an emergency warranting the taking of protective actions for foreign nationals or embassies in the State in which it occurs
6. an emergency resulting in or potentially resulting in severe tissue reactions and involving a fault and/or problem (such as in equipment or software) that could have serious implications for safety internationally
7. an emergency resulting in or potentially resulting in great concern among the population of more than one Country owing to the actual or perceived radiological hazard
8. Space-Debris Re-entry events are usually considered as transnational emergencies due to the significant speed of re-entry vehicles, the potential for release of radioactivity across vast distances into the atmosphere, and their unpredictable terminal landing sites.

*Significant transboundary release:* A release of radioactive material to the environment that may result in doses or levels of contamination beyond national borders from the release which exceed generic criteria for protective actions and other response actions, including food restrictions and restrictions on trade.

### **Urgent protective action**

See 'protective action'.

### **Urgent protective action planning zone (UPZ)**

An area around a facility for which arrangements have been made to take urgent protective actions in the event of a nuclear or radiological emergency to avert doses off-site in accordance with international safety standards. Protective actions within this area are to be taken on the basis of environmental monitoring or, as appropriate, prevailing conditions at the facility.

### **Warning point**

A designated organisation to act as a point of contact that is staffed or able to be alerted at all times for promptly responding to, or initiating a response to, an incoming notification, warning message, request for assistance or request for verification of a message, as appropriate, from the IAEA.

### **Worker**

Any person who works, whether full time, part time or temporarily, for an employer and who has recognised rights and duties in relation to occupational radiation protection.

## References

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