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No. GS-G-2.1



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ARRANGEMENTS FOR PREPAREDNESS FOR A NUCLEAR OR RADIOLOGICAL EMERGENCY

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IAEA SAFETY STANDARDS SERIES No. GS-G-2.1

ARRANGEMENTS FOR PREPAREDNESS FOR A NUCLEAR OR RADIOLOGICAL EMERGENCY

SAFETY GUIDE

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INTERNATIONAL ATOMIC ENERGY AGENCY
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FOREWORD

by Mohamed ElBaradei
Director General

The IAEA's Statute authorizes the Agency to establish safety standards to protect health and minimize danger to life and property — standards which the IAEA must use in its own operations, and which a State can apply by means of its regulatory provisions for nuclear and radiation safety. A comprehensive body of safety standards under regular review, together with the IAEA's assistance in their application, has become a key element in a global safety regime.

In the mid-1990s, a major overhaul of the IAEA's safety standards programme was initiated, with a revised oversight committee structure and a systematic approach to updating the entire corpus of standards. The new standards that have resulted are of a high calibre and reflect best practices in Member States. With the assistance of the Commission on Safety Standards, the IAEA is working to promote the global acceptance and use of its safety standards.

Safety standards are only effective, however, if they are properly applied in practice. The IAEA's safety services — which range in scope from engineering safety, operational safety, and radiation, transport and waste safety to regulatory matters and safety culture in organizations — assist Member States in applying the standards and appraise their effectiveness. These safety services enable valuable insights to be shared and I continue to urge all Member States to make use of them.

Regulating nuclear and radiation safety is a national responsibility, and many Member States have decided to adopt the IAEA's safety standards for use in their national regulations. For the Contracting Parties to the various international safety conventions, IAEA standards provide a consistent, reliable means of ensuring the effective fulfilment of obligations under the conventions. The standards are also applied by designers, manufacturers and operators around the world to enhance nuclear and radiation safety in power generation, medicine, industry, agriculture, research and education.

The IAEA takes seriously the enduring challenge for users and regulators everywhere: that of ensuring a high level of safety in the use of nuclear materials and radiation sources around the world. Their continuing utilization for the benefit of humankind must be managed in a safe manner, and the IAEA safety standards are designed to facilitate the achievement of that goal.

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PREFACE

In March 2002, the IAEA's Board of Governors approved a Safety Requirements publication, Preparedness and Response for a Nuclear or Radiological Emergency, jointly sponsored by seven international organizations, which established the requirements for an adequate level of preparedness for and for response to a nuclear or radiological emergency in any State. The IAEA General Conference, in resolution GC(46)/RES/9, encouraged Member States "to implement, if necessary, instruments for improving their own preparedness and response capabilities for nuclear and radiological incidents and accidents, including their arrangements for responding to acts involving the malicious use of nuclear or radioactive material and to threats of such acts", and has further encouraged them to "implement the Safety Requirements for Preparedness and Response to a Nuclear or Radiological Emergency".

The Convention on Early Notification of a Nuclear Accident ('Early Notification Convention') and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency ('Assistance Convention') adopted in 1986 place specific obligations on the Parties and on the IAEA. Under Article 5a (ii) of the Assistance Convention, one function of the IAEA is to collect and disseminate to States Parties and Member States information concerning methodologies, techniques and available results of research relating to response to such emergencies.

This Safety Guide is intended to assist Member States in the application of the Safety Requirements publication on Preparedness and Response for a Nuclear or Radiological Emergency, Safety Standards Series No. GS-R-2, and to help in fulfilling the IAEA's obligations under the Assistance Convention. In fulfilling its functions under the Assistance Convention and Early Notification Convention, the IAEA works together with other international organizations within an Inter-Agency Committee for Response to Nuclear Accidents (IACRNA). IACRNA has cooperated in the establishment of common requirements for preparedness and response for a nuclear or radiological emergency. Six members of IACRNA co-sponsored the development of Safety Standards Series No. GS-R-2. The Food and Agriculture Organization of the United Nations (FAO), the International Labour Office (ILO), the Pan American Health Organization (PAHO), the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) and the World Health Organization (WHO) are joint sponsors of this Safety Guide.

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1. INTRODUCTION

BACKGROUND

1.1. Under Article 5(a)(ii) of the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (the ‘Assistance Convention’) [1], one function of the IAEA is to collect and disseminate to States Parties and Member States information concerning methodologies, techniques and available results of research relating to response to such emergencies.

1.2. In March 2002, the IAEA’s Board of Governors approved a Safety Requirements publication, Preparedness and Response for a Nuclear or Radiological Emergency, issued as Safety Standards Series No. GS-R-2 [2], jointly sponsored by seven international organizations, which established the requirements for an adequate level of preparedness for and for response to a nuclear or radiological emergency in any State. The IAEA General Conference in resolution GC(46)/RES/9 encouraged Member States “to implement, if necessary, instruments for improving their own preparedness and response capabilities for nuclear and radiological incidents and accidents, including their arrangements for responding to acts involving the malicious use of nuclear or radioactive material and to threats of such acts” and has further encouraged them to “implement the Safety Requirements for Preparedness and Response to a Nuclear or Radiological Emergency”.

This Safety Guide is not a standalone text. It should be used in conjunction with Ref. [2], referred to in this text as ‘the Requirements’.

OBJECTIVE

1.3. The primary objectives of this Safety Guide are:

- To provide guidance on those selected elements of the Requirements [2] for which guidance has been requested by Member States and for which there is an international consensus on the means to meet these requirements;
- To describe appropriate responses to a range of emergencies;
- To provide background information, where appropriate, on the past experience that provided a basis for the Requirements, thus helping the

user to better implement arrangements that address the underlying issues.

SCOPE

1.4. The guidance presented in this Safety Guide concerns emergency preparedness for a nuclear or radiological emergency. The range of possible nuclear or radiological emergencies of concern is enormous, extending from a general emergency at a nuclear power plant to emergencies involving lost, stolen or found radioactive material. The guidance presented in this Safety Guide is applicable to the entire range of emergencies, concentrated on the general aspects of emergency preparedness.

1.5. Clearly, this Safety Guide cannot take all State specific, site specific or emergency specific factors into account. Planners should remain flexible in their use of the guidance and should adapt it to take account of local sociopolitical, economic and other factors.

1.6. This Safety Guide does not provide detailed guidance on all the arrangements or operational criteria necessary to respond effectively to a nuclear or radiological emergency. The IAEA has published more detailed information on developing and maintaining an effective emergency response capability. Reference [3] provides an overview of this information. Guidance on preparing for emergency response to transport accidents involving radioactive material is provided in Ref. [4].

1.7. This Safety Guide does not provide guidance on the tactical or investigative response to terrorist or other criminal acts. It does address the coordination of such a response with the response to deal with actual or to anticipate potential radiological consequences.

STRUCTURE

1.8. This Safety Guide is divided into six sections. Section 2 provides guidance on basic concepts that must be understood to apply the guidance. Sections 3, 4 and 5 provide guidance on how to meet the requirements in the corresponding sections of the Requirements [2]. Section 6 discusses the concept of operations, describing in general terms how the response should proceed for different types of emergency. The Safety Guide also contains eight

appendices and an annex which provide further elaboration and clarification. Recommendations expressed as ‘should’ statements carry the implication that it is necessary to take the measures recommended or equivalent alternative measures to comply with the Requirements. Requirements quoted directly from Ref. [2] are expressed as ‘shall’ statements.

2. BASIC CONCEPTS

TYPES OF EMERGENCY

2.1. The approaches for developing the capability to respond to a nuclear or radiological emergency differ depending on the characteristics of the emergency. Consequently, it is convenient to divide the guidance for emergency preparedness and response into two classes:

- (a) Nuclear emergencies. These are categorized in threat category I, II or III¹, depending on their on-site and off-site threats. Nuclear emergencies may occur at:
 - Large irradiation facilities (e.g. industrial irradiators);
 - Nuclear reactors (research reactors, ship reactors and power reactors);
 - Storage facilities for large quantities of spent fuel or liquid or gaseous radioactive material;
 - Fuel cycle facilities (e.g. fuel processing plants);
 - Industrial facilities (e.g. facilities for manufacturing radiopharmaceuticals);
 - Research or medical facilities with large fixed sources (e.g. teletherapy facilities).
- (b) Radiological emergencies. These are categorized in threat category IV. They can occur anywhere and so this guidance is applicable to all States. Radiological emergencies include:

¹ The threat categories are discussed in paras 2.19 and 2.20.

- Uncontrolled (abandoned, lost, stolen or found) dangerous sources;²
- Misuse of industrial and medical dangerous sources (e.g. of those used in radiography);
- Public exposures and contamination from unknown origins;
- Re-entry of a satellite containing radioactive material;
- Serious overexposures;³
- Malicious threats and/or acts;
- Transport emergencies.

RADIATION INDUCED HEALTH EFFECTS

2.2. The Requirements [2] (para. 2.3) present the following practical goals of emergency response in relation to radiation induced health effects:

- “— To prevent the occurrence of [severe] deterministic health effects⁴ in workers and the public;
- To render first aid and to manage the treatment of radiation injuries;
- To prevent, to the extent practicable, the occurrence of stochastic health effects in the population.”

2.3. This section reviews the important aspects of radiation induced health effects that may result from a nuclear or radiological emergency. Reference [5] provides a further discussion of these health effects.

Deterministic effects

2.4. One of the primary objectives of the response to an emergency is to prevent the occurrence of deterministic effects. A deterministic effect of radiation is one for which generally a threshold level of dose exists, below which there is no effect and above which the severity of the effect increases

² A dangerous source is a source that could, if not under control, give rise to exposure sufficient to cause severe deterministic health effects. This categorization is used for determining the need for emergency response arrangements and is not to be confused with categorizations of sources for other purposes. Dangerous sources are discussed further in Appendix III.

³ A serious overexposure is one that can result in severe deterministic health effects.

⁴ ‘Severe deterministic effect’ is defined in the Glossary under ‘deterministic effect’.

with the dose received. The threshold differs for different organs and for different effects. A deterministic effect is described as ‘severe’ if it is fatal or life threatening or results in a permanent injury that reduces quality of life. The thresholds for severe deterministic effects are — except for doses to the foetus — one or more grays (Gy) from radiation at high dose rates (thousands to millions of times the normal radiation doses due to background levels of radiation) delivered over a short period of time. Keeping the doses below these thresholds will prevent deterministic effects.

2.5. Radiological emergencies in the past have resulted in severe deterministic effects, including fatalities and very serious injuries, among the public [6–12]. Severe deterministic effects have also occurred in patients owing to accidental medical overexposure [13, 14].

2.6. Severe deterministic effects have occurred among workers and responders in emergencies at facilities in threat categories I, II and III [15–18]. Severe deterministic effects could also result off a site owing to a release of large amounts of radioactive material from facilities in threat category I. This threat is most probably limited to large reactors⁵ and facilities where there are large quantities of volatile radioactive material, such as facilities for reprocessing fuel waste.

Stochastic effects

2.7. For a stochastic health effect of radiation, the probability of its occurrence increases with increasing dose, and the severity of the effect (if it occurs) is independent of dose. Stochastic effects are assumed to occur without a threshold level of dose and they include cancers (e.g. thyroid cancer and leukaemia) and hereditary effects.

2.8. Only the exposure of many tens of thousands of people to whole body doses in the range of 100–200 mSv [15] or of many tens of thousands of children to thyroid doses of the order of 50 mSv [19] (i.e. at dose rates thousands of times higher than those due to background levels of radiation) could result in a detectable increase in the incidence of cancer among those population groups

⁵ In the Chernobyl accident, dose rates off the site were higher than 1 Gy/h from the deposition of radioactive material, which is sufficient to cause severe deterministic health effects within a few hours [15]. Fortunately, these dose rates occurred only in uninhabited areas.

exposed. Even emergencies that have led to the exposure of very large groups of people (e.g. the Chernobyl accident) who received doses well above those due to background levels of radiation have not resulted in a detectable increase in the incidence of solid cancers among those exposed.⁶

2.9. Typically, following a nuclear or radiological emergency a number of people (not all of whom may be experts) will make estimates of a radiation induced increase to be expected in the incidence of cancers and other effects (e.g. birth defects) that may appear among those population groups who were exposed to radiation as a result of the emergency. Such stochastic health effects would not be individually attributable to radiation exposure (as they could not be distinguished from health effects with other causes). Estimates of consequences for a population may be made on the basis of the collective radiation dose (i.e. the sum total of all individual doses in an exposed population, expressed in man-sieverts) and levels of radiation health risks derived from observations made on exposed population groups who received high radiation doses (e.g. survivors of the atomic bombing in Japan). However, health consequences to be expected are generally estimated for people who have received only low radiation doses. In estimating such health consequences certain assumptions have to be made because of scientific uncertainties concerning the biological effects of radiation exposure at low doses and low dose rates. For the purposes of the system of radiation protection the assumption is made that there is no threshold level of radiation dose below which there is no associated radiation risk. This is only an assumption, however; data on radiation health risks that are yielded by studying the effects of exposure at high doses are not directly applicable for low dose exposure. Moreover, the very small projected increases in the incidence of cancers among those people exposed with such low levels of dose would in any case be undetectable epidemiologically against the fluctuations in the spontaneous incidence. Incautious estimates of the health effects of low dose exposures have

⁶ As of 2000 no excess solid cancers had been observed among the approximately 200 000 people who performed recovery operations within the 30 km zone in 1986–1987 where the highest doses were received following the Chernobyl accident [15]. However, a major increase was detected in the incidence of thyroid cancer among those persons who had received radiation doses as a foetus or child following the Chernobyl accident. This detectable increase in incidence in this population group was due to a very large release of radioiodine, resulting in high thyroid doses in hundreds of thousands of children (primarily due to the consumption of contaminated milk and leafy vegetables). This radiation induced rise in cancer incidence was easily detected epidemiologically because of the very low spontaneous rate of thyroid cancers among the children.

led to what many consider is an exaggerated view on the part of the public of the risks associated with radiation, and consequently in inappropriate and, in some cases, counterproductive and harmful ‘protective’ actions being taken by the public and by officials. Risks of stochastic effects occurring as a result of low radiation doses (e.g. lower than 100 mSv) that are quantified for the purposes of radiation protection should therefore be interpreted for and communicated to the public with great caution, if at all. Any such quantification should be accompanied by a plain language explanation that makes it clear that, for such low doses, any radiation induced increase in the incidence of health effects in a population would be inherently very difficult, if not impossible, to detect. This plain language explanation should also discuss the risks and consequences of any actions taken to reduce the risks associated with exposure. If others (e.g. official or unofficial parties within or outside the State) make such estimates, consideration should be given to providing a clear explanation that puts these estimates in perspective.

2.10. One of the important goals of emergency preparedness is to prevent, to the extent practicable, the occurrence of stochastic effects. Since it is assumed that any dose, no matter how small, can increase the risk of occurrence of a stochastic effect, it would be impracticable and probably harmful to attempt to reduce the dose, and thus its associated risk, resulting from an emergency to near zero. In fact, some actions taken to reduce the risk of stochastic effects (e.g. relocation from an area with insignificant levels of contamination) may do more harm than good. The difficulty lies in determining what is practicable and reasonable. To address this issue, international standards provide generic intervention and action levels at which various protective measures would be justified on radiation protection grounds [2]. Taking protective action at levels significantly below these levels could do more harm than good.

Special concern

2.11. One special concern is radiation exposure of the embryo or foetus (exposure in utero). The health effects of radiation exposure in utero may include both deterministic effects (e.g. a reduction in average intelligence quotient among an exposed group) and stochastic effects expressed in the child after birth (e.g. radiation induced cancers). As with the general population, only the exposure of a large number of pregnant women to doses many times those due to normal background levels of radiation could possibly give rise to a detectable increase in stochastic effects among children exposed in utero.⁶ During the period of 8–25 weeks after conception, foetal doses in excess of about 100 mGy may result in a verifiable decrease of intelligence quotient [20].

This would correspond to dose rates a thousand or more times those due to normal background levels. However, doses sufficient to result in deterministic effects in a child born following in utero exposure, as a consequence of a nuclear or radiological emergency, have not been reported.⁷

EXPOSURE PATHWAYS

2.12. The ways in which people can be exposed to radiation are referred to as exposure pathways and include:

- External exposure from contact with or being in proximity to a source of radiation (e.g. a source, a plume containing radioactive material or ground contamination);
- Ingestion (e.g. of contaminated food, milk or water, inadvertent ingestion of contamination on hands);
- Inhalation from a plume or due to the resuspension of deposited radioactive material;
- Contamination of skin and clothing.

2.13. For radiological emergencies that have involved uncontrolled dangerous sources in the public domain, historically the most important pathways of exposure have been external exposure and inadvertent ingestion. Severe deterministic effects have resulted from unshielded dangerous sources being carried (e.g. by hand or in pockets) or taken home [9–12, 21].⁸ In one instance, individuals who were not aware of the hazard removed a dangerous amount of radioactive material from its container and scattered this material. This led to the contamination of large and complex areas in a city, and at least one victim inadvertently ingested an amount of this material with fatal consequences [6]. In these emergencies, the most important means of movement of the radioactive material was human activity.

⁷ Studies on adverse consequences relating to the Chernobyl accident have been performed in those areas close to the plant where the doses were highest. “So far, no increase in birth defects, congenital malformations, stillbirths, or premature births could be linked to radiation exposure caused by the [Chernobyl] accident” [15].

⁸ In one emergency, a family member picked up a tiny, shiny cylinder (a lost radiography source) and took it home. This resulted in the deaths of eight family members and relatives in the following three months [21].

2.14. Workers in irradiation facilities (threat category III) have received lethal exposures from being near extremely dangerous unshielded sources⁹ [16, 17], in one case for less than a minute [22]. Workers have also received fatal doses almost instantaneously from being near an accidental criticality event in a fuel cycle facility [18].

2.15. For radiological emergencies an airborne release of radioactive material is of concern primarily if a dangerous source containing dispersible material is in a fire or explosion. The distance at which such a release is hazardous is typically limited to less than a few hundred metres, but this depends on many factors such as the size of the source, the amount of material dispersed into the air, its dilution, the movement of the plume and the size and nature of the particles.¹⁰ It may be that none of these factors is known with any certainty during an emergency.

2.16. For airborne releases from facilities the significant pathways of exposure for the public are mainly:

- External gamma radiation from the plume, called cloud shine;
- External gamma radiation from radioactive material deposited on the ground, called ground shine;
- Inhalation of radioactive material contained in the plume;¹¹
- Ingestion of contaminated food, milk or water;
- To a lesser extent, deposition of radioactive material on the skin.

2.17. The pattern of the radioactive material deposited following an airborne radioactive release is very complex, as was seen following the Chernobyl [15, 23] and Tomsok [24] accidents. For facilities in threat category I, airborne releases have been postulated (e.g. for large reactors [25]) or have actually occurred (i.e. in the Chernobyl accident [15]) that would result or have resulted in doses sufficient to cause severe or even fatal deterministic effects within a few hours to persons off the site. For some facilities in threat categories I and II, airborne releases have been postulated or have actually occurred [25, 26] that would result or have resulted in doses over several days sufficient to warrant

⁹ See Table 9 for the D values of different radionuclides.

¹⁰ Appendix III provides a plain language explanation of the possible impacts of emergencies involving dangerous sources.

¹¹ Resuspension could be an important pathway of exposure if the deposited material contains significant amounts of alpha emitters (e.g. Pu).

the implementation of urgent protective measures to prevent severe deterministic effects or reasonably to reduce the risk of stochastic effects.

2.18. There may also be emergencies at some threat category II facilities that involve unshielded criticalities and that would result in off-site doses (without a significant airborne release¹²) sufficient to warrant the implementation of urgent protective actions within a distance of several hundred metres.

THREAT CATEGORIES

2.19. The Requirements [2] and the guidance in this publication are often specified for the threat categories summarized in Table 1. Threat categories I, II and III represent decreasing levels of threat at major facilities and therefore correspond to decreasing stringency of requirements for emergency preparedness and response. Facilities in threat categories I and II warrant extensive on-site and off-site arrangements for emergency preparedness. For facilities in threat category III the radiation related threat is limited to the site or to areas on the site (e.g. treatment rooms or laboratories), but arrangements to inform and reassure the public in the event of an emergency are still warranted.

2.20. Threat category IV includes radiological emergencies that could occur anywhere unexpectedly and applies always in all jurisdictions, possibly together with other threat categories. Threat category IV includes emergencies involving the types of event listed in Table 2.

2.21. These threat categories apply both to facilities or practices and to governmental jurisdictions for which various levels of preparedness are warranted. Section 3 provides guidance on determining threat categories and Appendix I gives examples of threat categories for different practices.

¹² Criticality accidents cannot produce sufficient amounts of fission products to result in a significant airborne radioactive release; however, the energy produced could result in an airborne release of other hazardous material that may be present at the time of the criticality.

TABLE 1. FIVE CATEGORIES OF NUCLEAR AND RADIATION RELATED THREATS FOR THE PURPOSES OF THE REQUIREMENTS (taken directly from Ref. [2])

Threat category	Description
I	Facilities, such as nuclear power plants, for which on-site events ^a (including very low probability events) are postulated that could give rise to severe deterministic health effects ^b off the site, or for which such events have occurred in similar facilities.
II	Facilities, such as some types of research reactors, for which on-site events ^a are postulated that could give rise to doses to people off the site that warrant urgent protective action in accordance with international standards ^c , or for which such events have occurred in similar facilities. Threat category II (as opposed to threat category I) does not include facilities for which on-site events (including very low probability events) are postulated that could give rise to severe deterministic health effects off the site, or for which such events have occurred in similar facilities.
III	Facilities, such as industrial irradiation facilities, for which on-site events are postulated that could give rise to doses that warrant or contamination that warrants urgent protective action on the site, or for which such events have occurred in similar facilities. Threat category III (as opposed to threat category II) does not include facilities for which events are postulated that could warrant urgent protective action off the site, or for which such events have occurred in similar facilities.
IV	Activities that could give rise to a nuclear or radiological emergency that could warrant urgent protective action in an unforeseeable location. These include non-authorized activities such as activities relating to dangerous sources obtained illicitly. They also include transport and authorized activities involving mobile dangerous sources such as industrial radiography ^d sources, nuclear powered satellites or radiothermal generators. Threat category IV represents the minimum level of threat, which is assumed to apply for all States and jurisdictions.

TABLE 1. FIVE CATEGORIES OF NUCLEAR AND RADIATION RELATED THREATS FOR THE PURPOSES OF THE REQUIREMENTS (taken directly from Ref. [2]) (cont.)

Threat category	Description
V	Activities not normally involving sources of ionizing radiation, but which yield products with a significant likelihood ^e of becoming contaminated, as a result of events at facilities in threat category I or II, including such facilities in other States, to levels necessitating prompt restrictions on products in accordance with international standards.
^a Such on-site events would be events involving an atmospheric or aquatic release of radioactive material or external exposure (e.g. due to a loss of shielding or a criticality event) that originates from a location on the site. ^b Doses in excess of those for which intervention is expected to be undertaken under any circumstances (Refs [2, 5]). See the Glossary under ‘deterministic effect’. ^c See Annex III of Ref. [2]. ^d For the purposes of this Safety Guide a mobile source is a source, such as a radiography camera, that is authorized to be used under the control of the operator at any location. ^e Contingent on the occurrence of a significant release of radioactive material from a facility in threat category I or II.	

AREAS AND ZONES

2.22. The Requirements [2] establish numerous requirements relating to generic areas: on the site (on-site) and off the site (off-site). In addition, the Requirements [2] establish requirements (para. 4.48) for two off-site emergency zones: the precautionary action zone (PAZ) and the urgent protective action planning zone (UPZ). Finally, the Requirements [2] establish requirements (para. 4.89) for areas in threat category V.

On-site area

2.23. The on-site area is the area under the control of the operator or first responders.

2.24. For facilities in threat category I, II or III, the on-site area is the area surrounding the facility within the security perimeter, fence or other designated property marker that is under the immediate control of the facility operator.

TABLE 2. TYPES OF EVENT ASSOCIATED WITH RADIOLOGICAL EMERGENCIES

— Detection of medical symptoms of radiation exposure due to unknown sources
— Lost dangerous source
— Theft of a dangerous source
— Found dangerous source
— Recovery of an uncontrolled dangerous source
— Radiography: disconnected or damaged source
— Radiography: source in a fire
— Damage to a fixed dangerous sealed source (e.g. as used in gauges)
— Public contamination and/or exposure (including that caused intentionally)
— Re-entry of a satellite containing radioactive material
— Accident with a nuclear weapon
— Transport emergency
— Emergency in radiology or nuclear medicine
— Emergency in radiotherapy
— A serious overexposure
— Credible or confirmed terrorist threats
— Non-credible terrorist threats
— An explosive radiological dispersal device
— Intentional contamination of water supply
— Intentional contamination of food and/or other products
— Detection of elevated radiation levels (in air, water, food or other products)
— Notification of a transnational emergency by the IAEA or any State

2.25. For licensed practices using radiography sources or other dangerous sources in threat category IV this is the area under the control of the operator.

2.26. For radiological emergencies involving transport, uncontrolled sources or localized contamination the first responders should establish a security perimeter containing the inner and outer cordoned areas to define the on-site area [27]. This is shown in Fig. 1. Appendix II provides suggested sizes for the inner cordoned area for various radiological emergencies.

Off-site area

2.27. The off-site area is the area beyond that area under the control of the facility, operator or first responders.

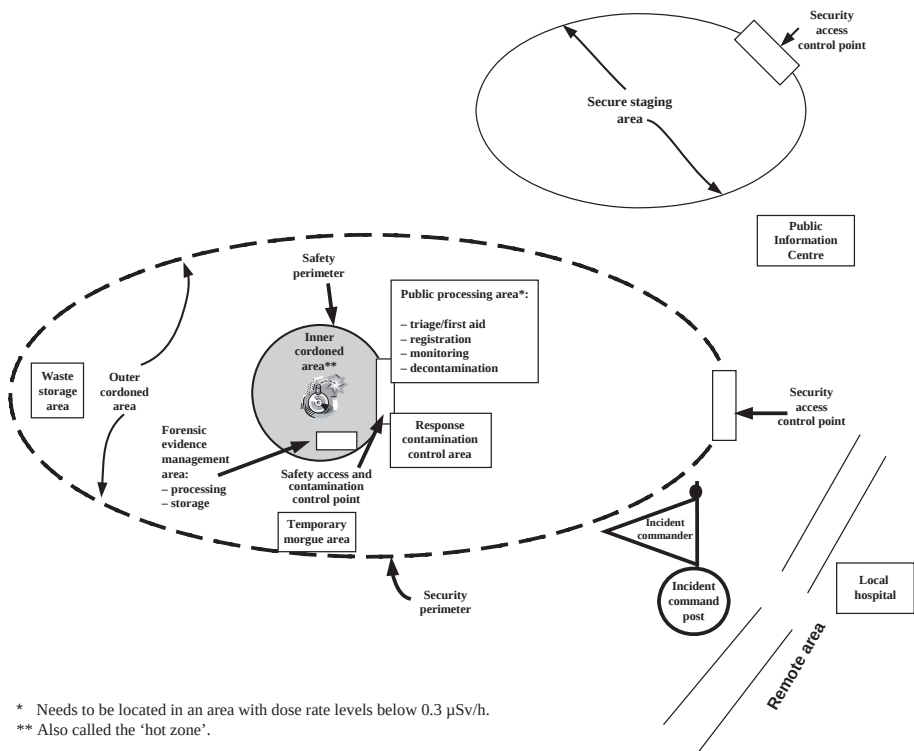


FIG. 1. Areas established by first responders (Appendix VIII provides a description of some of the facilities and locations shown).

2.28. The Requirements [2] (para. 4.48) require that, for facilities in threat category I or II, arrangements be made for effectively making and implementing decisions on urgent protective actions to be taken off the site within:

- “(i) A precautionary action zone, for facilities in threat category I, for which arrangements shall be made with the goal of taking precautionary urgent protective action, before a release of radioactive material occurs or shortly after a release of radioactive material begins, on the basis of conditions at the facility (such as the emergency classification) in order to reduce substantially the risk of severe deterministic health effects.
- “(ii) An urgent protective action planning zone, for facilities in threat category I or II, for which arrangements shall be made for urgent

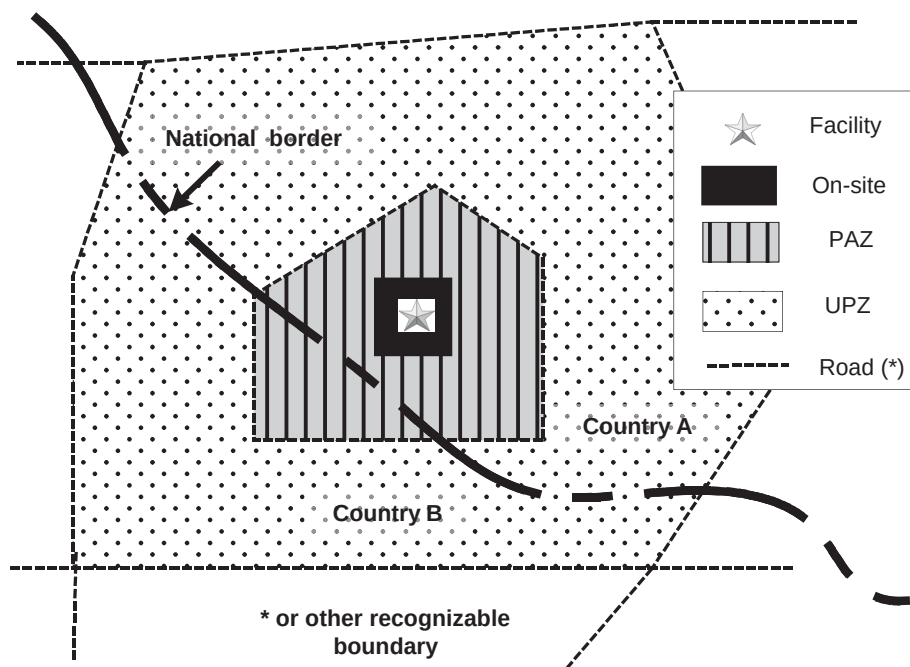


FIG. 2. Emergency zones.

protective action to be taken promptly, in order to avert dose off the site in accordance with international standards.”

2.29. The PAZ and UPZ should be roughly circular areas around the facility, and their boundaries should be defined, where appropriate, by local landmarks (e.g. roads or rivers) to allow easy identification during a response, as illustrated in Fig. 2. It should be noted that the zones should not stop at national borders. The size of the PAZ and the UPZ should be in accordance with the guidance provided in Appendix II.

2.30. The Requirements [2] (para. 4.89) establish requirements for areas with activities in threat category V. Threat category V includes activities that might yield products with a significant likelihood of becoming contaminated, as a result of events at facilities in threat category I or II, to levels necessitating prompt restrictions on products in accordance with international standards.

3. GENERAL REQUIREMENTS

BASIC RESPONSIBILITIES

3.1. The Requirements [2] require (para. 3.3) that legislation be adopted to clearly allocate responsibilities for preparedness and response for a nuclear or radiological emergency and for meeting the Requirements.

3.2. Responsibilities for emergency preparedness and response are typically assigned at three levels: operator, off-site and international. Table 3 summarizes the emergency preparedness arrangements that should be the responsibility of the operator and off-site officials.

Operator level

3.3. The operator may be:

- The staff and operating organization of a facility in threat category I, II or III;
- A designated and qualified individual who is authorized to operate equipment containing dangerous sources (threat category IV); such devices are found in:
 - Radiotherapy [28];
 - Industrial radiography;
 - Well logging;
- Those responsible for the on-scene operation of a facility where uncontrolled dangerous sources may be encountered; such facilities include:
 - Border crossings, airports and seaports;
 - Scrap metal dealers and processors.

3.4. The assignment of responsibilities for response to emergencies in transport is discussed in Ref. [4].

3.5. The operator should be responsible, as appropriate, for:

- Identifying and/or detecting an emergency or hazard (e.g. dangerous sources);
- Taking immediate action to mitigate the consequences of the emergency;

TABLE 3. EMERGENCY PREPAREDNESS ARRANGEMENTS BY THREAT CATEGORY

Threat categories I and II	
Operator	Off-site officials responsible for response within the emergency zones
Arrangements to promptly: classify an emergency; protect those on the site and on-site emergency workers; mitigate the consequences of the emergency; notify and recommend protective actions for the public to off-site officials; obtain off-site assistance; conduct environmental monitoring near the facility; and assist off-site officials in keeping the public informed.	Arrangements to promptly: implement urgent protective action within the emergency zones; conduct environmental monitoring; control consumption of contaminated food; provide emergency services to the facility; provide medical treatment for individuals who have been contaminated or overexposed and register them for long term medical follow-up on the basis of predetermined criteria; tell the public and media in plain language of the risks and of the actions they should take; respond to inappropriate public reactions; report transnational emergencies to the IAEA; respond to IAEA notifications; and request IAEA assistance when needed.
Threat category III	
Operator	Off-site officials (near the facility)
Arrangements to promptly: classify an emergency; protect those on the site and on-site emergency workers; inform off-site officials; obtain off-site assistance; ensure that there are no off-site risks; and assist off-site officials in keeping the public informed.	Arrangements to promptly: provide emergency services; protect emergency workers; provide medical treatment to those contaminated or overexposed and register them for long term medical follow-up on the basis of predetermined criteria; confirm there are no off-site impacts; inform the public and media in plain language of the risks and of the actions they should take; respond to inappropriate public reactions; report transnational emergencies to the IAEA; respond to IAEA notifications; and request IAEA assistance when needed.

IAEA

TABLE 3. EMERGENCY PREPAREDNESS ARRANGEMENTS BY THREAT CATEGORY (cont.)

Threat category IV	
Operator (dangerous source)	Off-site officials (national level)
Arrangements to promptly: recognize an emergency; take action to protect people nearby; mitigate the consequences of the emergency; inform off-site officials of the risks; and provide technical assistance to off-site officials if needed.	Arrangements to: inform as part of an ongoing programme medical practitioners, scrap metal dealers and border crossing officials of the recognition and response to a radiological emergency; promptly make decisions on protective actions in accordance with international standards; provide local officials with assistance in assessing and responding to radiological conditions; provide medical treatment to those contaminated or overexposed and register them for long term medical follow-up on the basis of predetermined criteria; inform the public and media in plain language of the risks and of the actions they should take; respond to inappropriate public reactions; report transnational emergencies to the IAEA; respond to IAEA notifications; and request IAEA assistance when needed.
Threat category V	
Farmers and food production processors	Off-site officials
Arrangements to respond promptly to official instructions to protect food and water supplies and to control potentially contaminated food and water.	Arrangements to issue instructions to protect food and water supplies and to control potentially contaminated food and water and products, in accordance with international standards.

- Protecting individuals on the site and within the area controlled by the operator;
- Declaring the class of the emergency (if appropriate);
- Notifying off-site officials and possibly providing them with recommendations on protective actions and technical assistance;
- Establishing ongoing communication with off-site officials;

- Assisting the off-site officials in keeping the public informed and countering incorrect information and inappropriate public reactions;
- Providing, if possible, initial radiological monitoring and technical advice.

Off-site level

3.6. The off-site level consists of organizations that will perform the response actions carried out off the site, and should include:

- Local officials.
 - For facilities in threat category I, II or III, local officials are the government and support agencies responsible for providing immediate support to the operator and prompt protection of the public in the emergency zones;
 - For a radiological emergency in the public domain, local officials are the emergency services responding at the scene. These include the police, firefighting and civil emergency services or medical personnel, and they may be the first to learn of an emergency.
- Medical practitioners. They should be able to recognize radiation induced injuries and notify the appropriate officials.
- National and regional officials. These are the governmental agencies responsible for planning and response at the national (or regional) level and also non-governmental organizations (NGOs). These agencies should be responsible for providing technical assistance to local responders and for implementing protective actions and other actions that do not need to be implemented urgently to be effective. At the national level, preparations should be made to respond to radiological emergencies that can occur anywhere unexpectedly. These preparations should be designed to support local officials in dealing with these emergencies.
- Officials in all States should be responsible for the implementation of protective actions within the emergency zones of a facility in threat category I or II.

International level

3.7. The international level consists of organizations responsible for providing international assistance as described in the Joint Radiation Emergency Management Plan of the International Organizations [29]. It includes:

- IAEA implementation of the Convention on Early Notification of a Nuclear Accident (‘Notification Convention’) and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (‘Assistance Convention’) [1], and para. 4.15 of the Requirements [2]. The Parties to the Notification Convention commit themselves to informing forthwith those States that may be affected by a significant transboundary release and the IAEA and to meeting the international requirements [2]. States adopting the Conventions must notify States and the IAEA of a transnational emergency. These notifications can be made directly or through the IAEA. However, areas in States with territory within the emergency zones should be notified promptly and directly and not through the IAEA. Under the Assistance Convention, States commit themselves to facilitating prompt assistance in the event of an accident. The IAEA, with the help of Member States and other international organizations, has provided assistance in emergencies under the Assistance Convention, including conducting environmental monitoring, making aerial surveys, providing medical consultation and treatment, assisting with source recovery and assisting with media relations.
- Organizations, such as the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), the World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO), that can provide technical, humanitarian or medical assistance in the event of an emergency.

National coordinating authority

3.8. The Requirements [2] require (para. 3.4) that an existing governmental body or organization be established or identified to act as a national coordinating authority whose function, among others, is to coordinate the threat assessment¹³ for threats within the State and to ensure that the functions and responsibilities of operators and response organizations are clearly assigned and are understood by all response organizations.

3.9. The national coordinating authority should be an existing ministry or a standing committee with representatives of all national organizations that play a major part in the response to a nuclear or radiological emergency. This

¹³ The term ‘threat assessment’ does not imply that any threat, in the sense of an intention and capability to cause harm, has been made in relation to such facilities, activities or sources.

authority should have the ability to coordinate the response preparations for all the national organizations with roles in preparation for, or response to, nuclear or radiological emergencies, conventional emergencies or criminal activities (e.g. terrorist attacks or threats).

3.10. The national coordinating authority should ensure that a threat assessment (see paras 3.24–3.31) is conducted periodically to identify any new practice or event that could necessitate an emergency response. This should include the exchange of information with nearby States.

3.11. The national coordinating authority should determine which tasks each organization plans to perform during an emergency, whether it is actually responsible for them and whether it has adequate resources and capabilities to perform them. The findings should then be assessed at the national and local levels to identify gaps, overlaps and conflicts. The national coordinating authority should resolve any conflicts and incompatible arrangements between the various participating organizations.

3.12. The national coordinating authority should ensure that organizations that perform tasks (conventional, radiological or law enforcement) that are critical to a successful response have agreed to their assigned responsibilities as defined in the concept of operations (see Section 6). Reference [3] provides a list of tasks that are critical for a successful response.

3.13. The national coordinating authority should coordinate the development of the national all-hazards response plan or the national radiation emergency plan and should foster the implementation by other States of measures designed to fulfil the relevant international obligations¹⁴ in accordance with the Requirements [2] (para. 3.5). (In this context, a ‘radiation emergency’ means the same as a ‘nuclear or radiological emergency’.)

3.14. The individual groups to which roles and responsibilities are assigned should make a commitment to develop the necessary response capability.

3.15. Within the national coordinating body, a single overall national radiation emergency planning coordinator should be designated to guide the preparedness process.

¹⁴ For example, to notify promptly those States with territory within the emergency zones in the event of a general emergency.

3.16. The coordinator should have in-depth technical and operational knowledge of emergency preparedness and response issues and should have sufficient decision making authority to ensure an effective coordination process. The coordinator should be provided with sufficient staff and resources for the long term to develop and maintain the response capability once it has been established. This should include a multi-year budget.

Integrated planning (all hazards approach)

3.17. A nuclear or radiological emergency may be caused by or may involve different types of hazards, including natural (e.g. storms), technological (e.g. nuclear power generation) or criminal and malicious activity (e.g. theft, sabotage, terrorist attacks). The response to each of these hazards would probably involve different response organizations with their own response terminology, cultures and plans.

3.18. Consequently, the Requirements [2] (para. 3.11) require that the national coordinating authority and the response organizations ensure that the arrangements for response to a nuclear or radiological emergency are coordinated with the arrangements for response to conventional emergencies.

3.19. The planning and preparations for response to a nuclear or radiological emergency should be integrated with the planning for response to hazards of all types and should fully involve the national or local organizations responsible for response to conventional emergencies such as those due to fires, floods, earthquakes, tsunamis or storms. Since an emergency may involve criminal activity such as terrorism or theft, preparations should also involve law enforcement agencies.

3.20. Consequently, the Requirements [2] (para. 3.12) require that “All organizations that may be involved in the response to a nuclear or radiological emergency shall ensure that appropriate management arrangements are adopted to meet the timescales for response throughout the emergency. Where appropriate, the management system shall be consistent with that used by other response organizations in order to ensure a timely, effective and coordinated response.”

3.21. The preparation (planning) for response to all hazards should be structured into a coherent and interlocking system (Fig. 3). At the top level

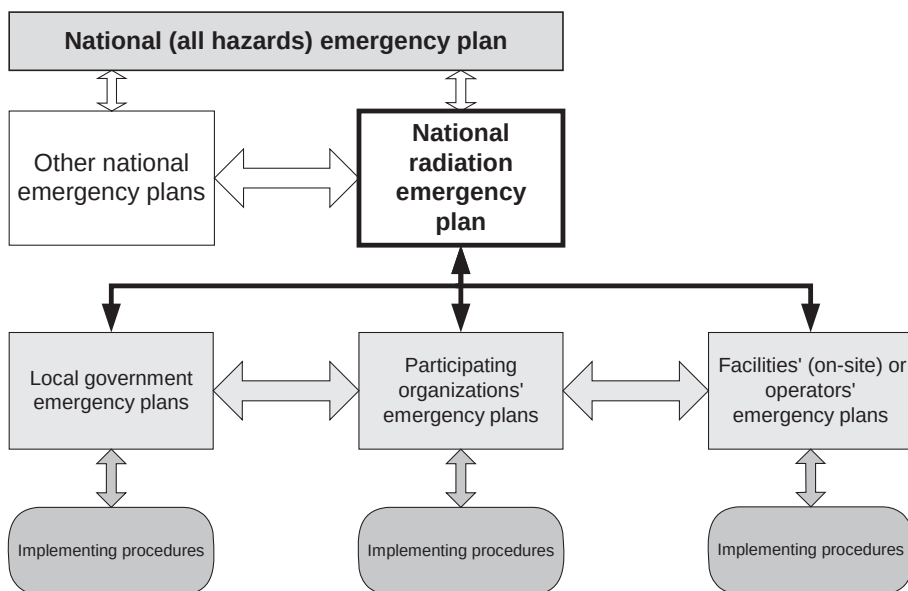


FIG. 3. Integrated planning concept.

should be a national emergency plan for an integrated response to any combination of hazards. The national radiation emergency plan may be a part of this all hazards plan. If there is no national all hazards plan, the national radiation emergency plan should provide for integration with the responses of other organizations during emergencies involving a combination of actual and perceived radiation hazards. The national radiation emergency plan should describe the concepts of operations, and roles and responsibilities of all the responding organizations, and their relationships with each other, summarizing more detailed plans and ensuring that all the other planning is integrated and compatible. In particular, the national radiation emergency plan should provide sufficient detail to ensure that the plans for the functional areas that are performed by personnel drawn from different ministries or organizations can function effectively. This could be accomplished by attaching to the national radiation emergency plan detailed functional plans for operations such as incident command, radiological monitoring and assessment, medical response and public affairs.

3.22. The next level should contain the plans developed by individual agencies, governmental jurisdictions and facilities or operators. The final level should represent the procedures (e.g. implementing instructions and operating procedures) and resources that will be used during an emergency to carry out the plans. Reference [3] outlines the various levels of plans and procedures.

3.23. To optimize the use of resources and the effectiveness of the response, response plans should be highly coordinated and consolidated. Planning should not be done by one organization or agency without consultation with the others. Responsibilities should be assigned jointly with the participation of all concerned parties.

THREAT ASSESSMENTS

3.24. The Requirements [2] (paras 3.13–3.20) require that operators, the national coordinating authority and other appropriate organizations periodically conduct a threat assessment for the threats posed by facilities, sources, practices, on-site areas, off-site areas and locations to determine which threat categories apply. Moreover, these bodies are required to identify facilities, sources, practices, on-site areas, off-site areas or locations for which nuclear or radiological emergencies¹⁵ could warrant (Ref. [2], para. 3.17):

- “Precautionary urgent protective action to prevent severe deterministic health effects by keeping doses below those for which intervention would be expected to be undertaken under any circumstances;¹⁶
- “Urgent protective action to prevent stochastic effects to the extent practicable by averting doses, in accordance with international standards;¹⁷
- “Agricultural countermeasures, countermeasures to ingestion and longer term protective measures, in compliance with international standards¹⁷; or
- “Protection for the workers responding (undertaking an intervention), in accordance with international standards.¹⁸”

3.25. The threat assessment should include the exchange of information with any nearby States whose territory may fall within the PAZ or UPZ (see paras 2.28–2.30 and Appendix II) of a facility located within the territory of the State performing the threat assessment.

3.26. The threat assessment should also identify:

¹⁵ Including events with a very low estimated probability of occurrence.

¹⁶ Annex II of Ref. [2].

¹⁷ Annex III of Ref. [2].

¹⁸ Annex I of Ref. [2].

- Significant non-radiation-related threats (e.g. UF_6 or other hazardous chemical releases) to individuals on and off the site who are associated with the facility;
- The operators of dangerous sources (threat category IV in Tables 1 and 4);
- The threat category of the jurisdictions within the State, on the basis of Table 5.

3.27. Operators of facilities in threat categories I, II and III and operators using dangerous sources should perform threat assessments to identify emergencies that could warrant the implementation of protective actions on or off the site. This threat assessment should be reviewed and revised periodically to take into account emergencies in similar facilities, in particular if there have been changes to on-site operations or off-site conditions that could have an impact on the preparations for emergency response.

3.28. A minimum level of threat (threat category IV in Table 1) should be assumed to exist for all jurisdictions. States should therefore assess their vulnerability to emergencies that can occur anywhere. This threat assessment should include:

- Types of shipments of radioactive material that have passed through the State and their main routes and focal points (e.g. distribution centres);
- Uses of dangerous sources (e.g. medical or industrial);
- Locations where spent and/or recovered dangerous sources are stored;
- Locations at which there is a significant probability of encountering an uncontrolled dangerous source that has been stored, lost, abandoned, stolen or illicitly transported. These should include scrap metal processing facilities, national border crossing points, seaports and airports.

3.29. Appendix I provides the typical threat categories for practices and Appendix III provides a method for determining whether a quantity of radioactive material should be considered a dangerous source.

3.30. The threat category of off-site jurisdictions should be consistent with their responsibilities in the response to an emergency, as shown in Table 5 and as illustrated in Fig. 4. Different threat categories may be applicable for a governmental jurisdiction (local or national): while typically only one threat

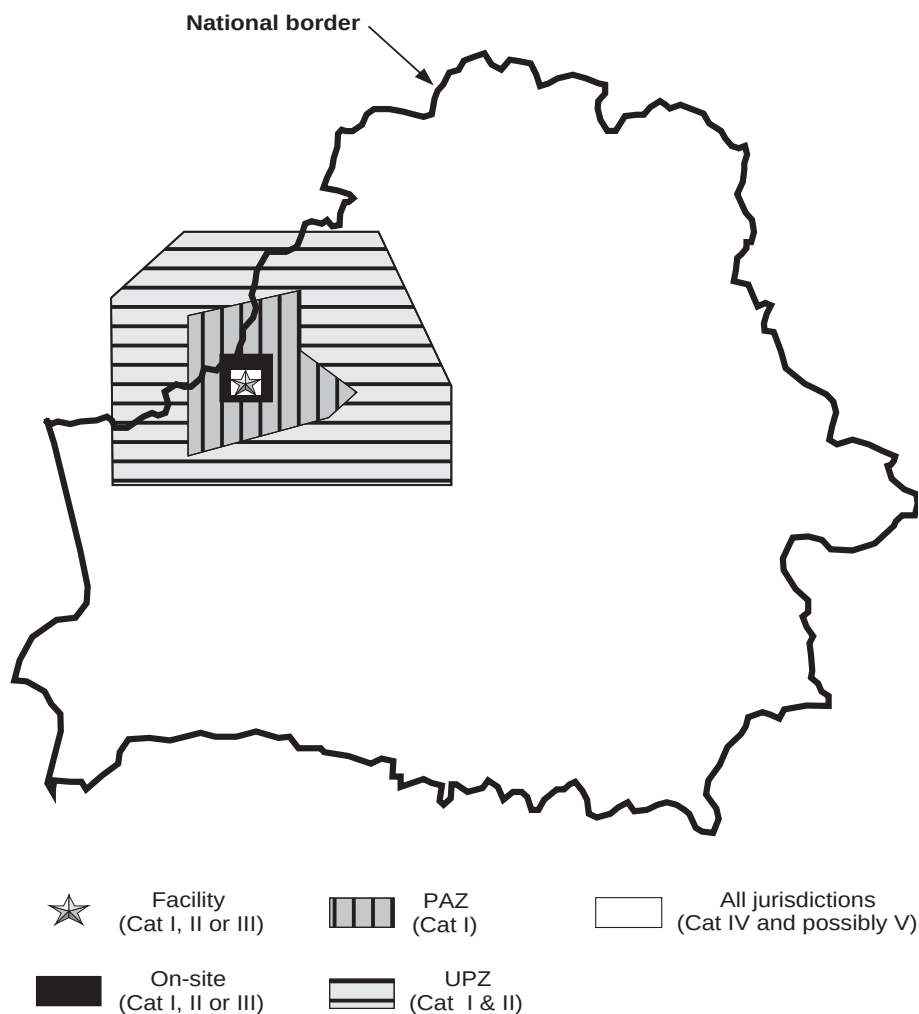


FIG. 4. Emergency zones and areas, and application of threat categories (this figure is not to scale).

category can apply to a facility and on-site area, all jurisdictions, as a minimum, fall within threat category IV.

3.31. The results of this analysis should be documented and included in the national all hazards plan or national radiation emergency plan (see paras 3.21–3.23) with a list and a map that show the threat categories of the facilities and their local jurisdictions. The results of the threat analysis should be used to implement a graded approach to emergency preparedness arrangements commensurate with the potential magnitude and the nature of the hazard.

TABLE 4. SUGGESTED CRITERIA FOR DETERMINING EMERGENCY THREAT CATEGORIES FOR FACILITIES AND PRACTICES

Threat category	Criteria ^a
I	Facilities for which emergencies have been postulated that could result in severe deterministic health effects off the site, including: • Reactors with power levels greater than 100 MW(th) (power, nuclear ship and research reactors);^b • Facilities and/or locations containing recently discharged irradiated reactor fuel with a total of more than about 0.1 EBq of ¹³⁷Cs (equivalent to the inventory in a 3000 MW(th) reactor core); • Facilities with inventories of dispersible radioactive material sufficient to result in severe deterministic effects off the site.^c
II	Facilities for which emergencies have been postulated that could result in doses warranting urgent protective action being taken off the site, including: • Reactors with power levels greater than 2 MW(th) and less than or equal to 100 MW(th) (power reactors, nuclear ship and research reactors); • Facilities and/or locations containing recently discharged irradiated reactor fuel requiring active cooling; • Facilities with potential for an uncontrolled criticality within 0.5 km of the off-site boundary; • Facilities with inventories of dispersible radioactive material sufficient to result in doses warranting urgent protective action being taken off the site.^d
III	Facilities for which emergencies have been postulated that could result in doses warranting urgent protective action being taken on the site, including: • Facilities with the potential, if shielding is lost, for causing direct external dose rates of more than 100 mGy/h at 1 m; • Facilities with potential for an uncontrolled criticality more than 0.5 km from the off-site boundary; • Reactors with power levels of less than or equal to 2 MW(th); • Facilities with inventories of radioactive material sufficient to result in doses warranting urgent protective action being taken on the site.^e -----

TABLE 4. SUGGESTED CRITERIA FOR DETERMINING EMERGENCY THREAT CATEGORIES FOR FACILITIES AND PRACTICES (cont.)

Threat category	Criteria ^a
IV	Practices involving mobile dangerous sources, including: • A mobile source with: (i) potential, if shielding is lost, for causing direct external (shine) dose rates of more than 1 mGy/h at 1 m, or (ii) dangerous sources according to Appendix III; • Satellites containing dangerous sources according to Appendix III; • Transport of quantities of radioactive material that would be dangerous sources according to Appendix III if not controlled. Facilities/locations at which there is a significant probability of encountering an uncontrolled dangerous source, such as: • Large scrap metal processing facilities; • National border crossing points, seaports and airports.

^a Site specific analysis can be performed to determine the appropriate threat category.

^b This is on the assumption that the reactor has been operating at this power level sufficiently long to build up the ¹³¹I inventory close to 10 PBq/MW(th). For research reactors, owing to the great variety in their design and operation, a facility specific analysis should be performed to determine whether there could be sufficient inventory and energy to result in a significant airborne release off the site.

^c Inventories 10 000 times the A/D₂ value calculated in Appendix III may place a facility in threat category I if it is assumed that 10% of the inventory could be released to the atmosphere in a single event.

^d Inventories 100 times the A/D₂ value calculated in Appendix III may place a facility in threat category II if it is assumed that 10% of the inventory could be released to the atmosphere in a single event.

^e Inventories 0.01 times the A/D₂ value calculated in Appendix III may place a facility in threat category III if it is assumed that 10% of the inventory could be released in a single event into a room from which people can be evacuated within a few minutes.

TABLE 5. EMERGENCY THREAT CATEGORIES FOR GOVERNMENT JURISDICTIONS

Threat category	Local preparedness is warranted for jurisdictions	National preparedness is warranted for States
I	With responsibility for urgent protective actions within the PAZ and UPZ of a threat category I facility	With territory within the PAZ or UPZ of a threat category I facility
II	With responsibility for urgent protective actions within the UPZ of a threat category II facility	With territory within the UPZ of a threat category II facility
III	With responsibility for providing emergency services to a threat category III facility, including firefighting, police and medical services	Containing a threat category III facility
IV	Applies to all jurisdictions	Applies to all jurisdictions
V	With farming or food production processing facilities and/or responsibility for taking local action for agricultural and ingestion control	With territory that may warrant control of potentially contaminated food and/or water and products in the event of an emergency at a threat category I or II facility, including those located in other States

4. FUNCTIONAL REQUIREMENTS

IDENTIFYING, NOTIFYING AND ACTIVATING

4.1. The severity of nuclear emergencies has not always been initially recognized or comprehended by facility operators even when there were indisputable indications of the severity of the event [18, 30]. In some nuclear emergencies it has taken considerable time (hours to days) to select and implement various response actions, including urgent protective action for the public. In addition, in several emergencies it took considerable time to coordinate the response and this, in many cases, severely degraded the effectiveness of the on-site and off-site response. These failures have been attributed to the following: (1) emergency arrangements that did not address the full range of postulated emergencies; (2) procedures that lacked

predetermined criteria as a basis for determining the severity of the event and making decisions about the response; (3) an absence of emergency arrangements (e.g. provision for prompt decision making) that could enable a coordinated response on and off the site within minutes to hours.

4.2. Consequently, the Requirements [2] (para. 4.19) require the operator of a facility or practice in threat category I, II, III or IV to make arrangements for the prompt identification of an actual or potential nuclear or radiological emergency and determination of the appropriate level of response. Furthermore, the Requirements [2] (para. 4.20) require that the criteria for classification be “predefined emergency action levels (EALs) that relate to abnormal conditions for the facility or practice concerned, security related concerns, releases of radioactive material, environmental measurements and other observable indications.” The Requirements [2] (para. 4.25) also require that declaration of a particular class of emergency “shall promptly initiate the appropriate level of co-ordinated and preplanned emergency response on and off the site. The responsibilities and initial response actions of all response organizations shall be defined for each class of emergency.”

4.3. The classification system and the immediate actions that should be taken by on-site and off-site response organizations immediately upon declaration of the level of emergency should be in accordance with the guidance in Appendix IV.

4.4. The emergency action levels should be based on the consideration of the full range of postulated emergencies, including those of very low estimated probability of occurrence (see para. 3.15 of Ref. [2]).

4.5. The emergency action levels should include, to the extent possible, symptomatic thresholds that will allow the operator, on the basis of information readily available during the emergency, promptly to declare, with a minimum of effort, the appropriate levels of emergency. The emergency action levels for reactor emergencies should be in accordance with Ref. [31].

4.6. Standardized national guidance on the response at the local (first responders) and national level that encompasses the types of radiological emergency listed in Table 2 should be developed and made available, with training, to the appropriate response organizations. This guidance should be consistent with the concepts of operation discussed in Section 6. The action guides in Ref. [3] (Appendix 7) could provide a basis for the response actions

for most of the types of emergency listed in Table 2; Ref. [4] should be used for emergencies involving transport.

International Nuclear Event Scale (INES)

4.7. The Requirements [2] (footnote 27) point out that the emergency response classification system should not be confused with the International Nuclear Event Scale (INES). The INES is used for communicating to the public the severity or estimated severity of an event and cannot be used as the basis for emergency response actions.

4.8. The Requirements [2] require (para. 4.20) that “It shall be ensured that the process of rating the event on the joint IAEA and OECD/NEA International Nuclear Event Scale (INES) does not delay classification or other response actions.”

4.9. Experience has shown that in the early phase of an emergency its nature and its potential consequences may not be fully understood. Any INES rating made during this phase may be subject to change as more information becomes available. While an emergency is developing, no final rating should be assigned. Early announcement of the rating may help the public to understand the significance of the event only if the situation is clear and a provisional INES rating can genuinely be established.

4.10. If an INES rating is requested and sufficient information is available, the best estimate for a provisional rating should be given. If there is insufficient information to define a rating plus or minus one level, it should be stated in a broader communication on the emergency that there is not yet enough information available to provide an INES rating.

TAKING URGENT PROTECTIVE ACTIONS AND ASSESSING THE INITIAL PHASE

4.11. The Requirements [2] require (para. 4.42) that “Urgent protective action, in accordance with international standards¹⁹, shall be taken to prevent to the extent practicable the occurrence of severe deterministic health effects and to avert doses.”

¹⁹ See Annexes II and III of Ref. [2].

4.12. The Requirements [2] define an urgent protective action as “A protective action in the event of an emergency which must be taken promptly (normally within hours) in order to be effective, and the effectiveness of which will be markedly reduced if it is delayed.”

4.13. The urgent protective actions and countermeasures should include the following, which are further described in Appendix V:

- For radiological emergencies, isolation of a contaminated area or radioactive source;
- Prevention of inadvertent ingestion;
- Evacuation;
- Sheltering;
- Respiratory protection and protection of skin and eyes;
- Decontamination of individuals;
- Prophylaxis with stable iodine;
- Protection of the food supply and prevention of the consumption of significantly contaminated foodstuffs and water;
- Management of the medical response;
- Protection of international trade.

4.14. International standards²⁰ have been established for determining whether and when evacuation, shelter, relocation and food restrictions are justified. However, these standards cannot be used directly during an emergency since they are not specified in terms of quantities that are directly measurable in a facility or in the environment.

4.15. Consequently, the Requirements [2] (para. 4.71) require that “arrangements shall be made for promptly assessing the results of environmental monitoring and monitoring for contamination on people in order to decide on or to adapt urgent protective actions to protect workers and the public, including the application of operational intervention levels (OILs) with arrangements to revise the OILs as appropriate to take into account the conditions prevailing during the emergency.”

²⁰ For facilities it may be possible for the criteria for decisions on protective actions to be established at the time of the emergency, provided that there is a high degree of assurance that they can be established and implemented immediately upon the receipt of field monitoring results.

4.16. All States should develop default OILs (see footnote 20) in advance, as part of the preparedness process, for determining whether and when exposure rates or contamination levels warrant taking protective action and other countermeasures in the event of a nuclear or radiological emergency. OILs should be developed for:

- The isolation of a contaminated area or dangerous source;
- Evacuation or substantial shelter;
- Stable iodine prophylaxis;
- Decontamination of people;
- Decontamination or control of vital equipment, vehicles and personal property;
- Immediate medical treatment;
- Long term medical monitoring;
- Countermeasures against excessive doses from ingestion;
- Control of international trade, goods and products.

4.17. OILs should be developed for radioactive releases and/or direct exposures resulting from emergencies involving facilities in threat categories I, II and III and for radiological emergencies, by using realistic assumptions and including arrangements to revise the OILs as appropriate to take into account the conditions prevailing during the emergency.

4.18. The default OILs for the dose rates from deposition resulting from a nuclear reactor emergency, which are used to make decisions concerning evacuation and substantial shelter, and the arrangements for their revision, should be consistent with Ref. [31].

4.19. The OILs for the isolation of a contaminated area or dangerous source should be consistent with Appendix II, Table 7.

4.20. For most radiological emergencies, first responders should initiate the initial urgent protective action. Often, the first responders will not have radiological monitoring equipment and they may have misconceptions about the risks, which may compromise the initial response.²¹

²¹ For example, in some emergencies first responders have been reluctant to perform life saving actions or to treat victims because of indications that radioactive material was present.

4.21. Consequently, the Requirements [2] (para. 4.47) require that “First responders shall be informed that, in the event of an immediate threat to life (such as a fire), they should not delay any action to save human life or prevent serious injury for the reason that signs or placards indicate the possible presence of radioactive material.”

4.22. For the emergencies listed in Table 2, the initial actions to be taken by first responders should be predetermined and communicated to the first responders. In general, the actions should be initiated on the basis of information and conditions that are observable by the first responder at the scene.

4.23. Emergencies have been postulated or have occurred at facilities in threat category I for which urgent protective measures should be taken off the site within the PAZ before or shortly after a radioactive release if they are to be effective. The effectiveness of protective actions in these cases can best be ensured by taking the actions upon the detection of dangerous conditions in the facility and not awaiting a release or environmental monitoring results. Emergencies have also been postulated or have occurred at facilities in threat categories I and II for which urgent protective measures should be promptly taken within the UPZ on the basis of the results of radiological monitoring off the site.

4.24. During general emergencies at facilities in threat categories I and II it has taken many hours or days to decide on and to implement urgent protective actions for the public.²² Subsequent analysis showed that, even with the delays, inappropriate protective action had been taken. This occurred because no arrangements for making decisions promptly were in place²³ for these low probability emergencies.

4.25. Consequently, the Requirements [2] (para. 4.48) require that “For facilities in threat category I or II arrangements shall be made for effectively

²² After the Chernobyl accident, imposition of restrictions on the consumption of contaminated milk was delayed for several days. This delay probably resulted in several thousand avoidable cases of thyroid cancer among children.

²³ In most cases, a meeting was held to decide what to do and who should do it. In addition, the decision makers were untrained (often they were too busy to attend training courses or exercises). In one case, a regulatory body interfered in the process for making decisions on protective actions even though it had no designated role in this area.

making and implementing decisions on urgent protective actions to be taken off the site. This capability shall make use of existing public infrastructure²⁴ to limit the occurrence of severe deterministic health effects and to avert doses, in accordance with international standards (Ref. [2], Annexes II and III), for the full range of possible emergencies²⁵ at those facilities.”

4.26. For facilities in threat categories I and II these arrangements should include provisions for promptly taking urgent protective actions off the site upon the declaration of an emergency, in accordance with Appendix VII and based on OILs for environmental measurements. The arrangements should be based on site specific analysis to best ensure that severe deterministic effects will be prevented and that other justified actions taken will be in accordance with international standards. These arrangements should be established with the goal of meeting the time objectives in Appendix VI.

4.27. The decision support systems, including those using computer models, may not be able to predict the size and timing of a radioactive release (the source term), the movements of plumes, deposition levels or resulting doses sufficiently quickly or accurately during an emergency that they could provide the sole basis for deciding on initial urgent protective actions. This is particularly true for emergencies for which protective actions must be initiated before or shortly after a release to be effective or for which a release is by an unmonitored pathway. Consequently, for such emergencies, immediate protective actions should be implemented out to a predetermined distance from the facility in all directions when severe conditions are detected in the facility. The protective actions and the distance should be determined in advance and should be consistent with Appendix II, or should be determined on the basis of site specific analysis.

4.28. Emergencies have occurred in facilities in threat categories I, II and III that have resulted in hazardous conditions on the site.

4.29. Consequently, the Requirements [2] (para. 4.51) require that, for these facilities, specific arrangements be in place to effectively implement urgent protective action for the people on the site. These arrangements should apply to all people in areas controlled by the operator, such as visitors or others (e.g. construction workers, fishermen).

²⁴ Such infrastructure includes, for example, buildings and transport networks.

²⁵ The full range of possible emergencies includes those of very low probability.

4.30. In an emergency, public officials will make recommendations with regard to what protective actions the public should take. It may be that neither these officials nor the public understand the principles or terminology of radiation protection. The arrangements for taking protective action should therefore include a plain language explanation of how the protective actions would ensure the safety of the public.

4.31. Inconsistencies between measures taken by different States may be difficult to explain and may possibly result in a loss of trust in officials on the part of the public. Consequently, the arrangements should include a means to ensure that the recommended countermeasures or actions are coherent among States or that any differences can readily be explained to the public to allow the public and decision makers to make informed decisions.

KEEPING THE PUBLIC INFORMED

4.32. It has often been stated that the public panicked during a nuclear or radiological emergency when they expressed concern or did not follow official recommendations. However, subsequent investigations have found that in some emergencies the public received, apparently from official sources, the news media and other people, confusing and inconsistent information concerning the risks of exposure and the appropriate actions to be taken to reduce the risks. In many cases the confusion was partly the result of attempts by local officials, national officials and the operator, without prior coordination, to address the news media from different locations (e.g. the national capital, the regional capital, the location of the emergency) [32]. Under these circumstances, the public did what they felt was appropriate to protect themselves, their families and their interests. This often resulted in the public taking actions that did not appear to follow official recommendations or that were later found to be inappropriate and, in some cases, harmful (see para. 4.52), and which resulted in severe adverse economic and psychological consequences.

4.33. The severity of the non-radiological effects may depend in part on how well the following questions from the public are answered:

- Is the situation safe?
- How do I keep my family and myself safe and how do I protect my interests?