Version 8

Dated: 2021-04-06

Arrangements for Preparedness and Response for a Nuclear or Radiological Emergency

Jointly sponsored by the
XXX

General Safety Guide
No. GSG-XX

Draft DS504

Status: STEP 6 – draft approved by the Coordination Committee

Action: Review by safety standards committees

IAEA
International Atomic Energy Agency

CONTENTS

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 nuclear accidents or radiological emergencies".

1.2. In March 2015 the IAEA's Board of Governors approved a Safety Requirements publication, IAEA Safety Standards Series No. GSR Part 7, Preparedness and Response for a Nuclear or Radiological Emergency, which was jointly sponsored by 13 international organizations. GSR Part 7 [2] establishes requirements for an adequate level of preparedness for and response to a nuclear or radiological emergency, irrespective of the initiator of the emergency.

1.3. Fulfilment of the requirements given in GSR Part 7 [2] is intended to contribute to the harmonization worldwide of arrangements for preparedness and response for a nuclear or radiological emergency. Consistent application of the guidance in this Safety Guide will facilitate harmonized implementation of the requirements in GSR Part 7 [2] among Member States.

OBJECTIVE

1.4. The objective of this Safety Guide is to provide guidance and recommendations to Member States on arrangements for preparedness and response for a nuclear or radiological emergency, irrespective of its initiator, in support of the following requirements of GSR Part 7 [2][1]:

— Requirements 1, 2 and 4 of the General Requirements;

— Requirements 6, 7, 9, 14, 17, and 19 of the Functional Requirements; and

— Requirements 20 to 26 of the Requirements for Infrastructure.

1.5. Considering that GSR Part 7 [2] elaborates further the requirements for emergency exposure situation provided in the GSR Part 3 [12] this Safety Guide also covers all those relevant requirements of the GSR Part 3 that are under the scope of this document.

1.6. This Safety Guide also provides descriptions of appropriate responses to a range of postulated nuclear or radiological emergencies for the different emergency preparedness categories.

1.7. This Safety Guide should be used in conjunction with GSR Part 7 [2], with due account to be taken of the recommendations provided in IAEA Safety Standards Series No. GSG-2, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency [3], IAEA Safety Standards Series No. GSG-11, Arrangements for the Termination of a Nuclear or Radiological Emergency [4] and IAEA Safety Standards Series No. GSG-14, Arrangements for Communication with the Public in Preparedness and Response for a Nuclear or Radiological Emergency [5].

[1] The remaining requirements of GSR Part 7 are not addressed in this Safety Guide because they are or will be covered in other IAEA publications. **Annex IV** provides a list of references that elaborates more on specific requirements not covered by this Safety Guide.

SCOPE

1.8. The guidance presented in this Safety Guide concerns emergency preparedness and response for a nuclear or radiological emergency, irrespective of its cause.

1.9. The guidance presented in this Safety Guide is applicable to the entire range of emergencies, concentrated on the general aspects of emergency preparedness and response and thus, it necessitates the application of a graded approach[2] in their implementation. The range of possible nuclear or radiological emergencies of concern is enormous, extending from emergencies involving lost, stolen or found radioactive source to a general emergency at a nuclear power plant, or a combination of events (such as with natural disasters or pandemics). In the context of this Safety Guide, the following distinction is made on the basis of the definition of a nuclear or radiological emergency[3]:

- Nuclear emergency: An emergency involving nuclear chain reaction and its products (such as a general emergency at a nuclear power plant or an emergency involving a spent fuel storage facility or a fuel cycle facility, or transportation of spent fuel); and
- Radiological emergency: An emergency involving exposure to ionizing radiation except exposure arising from the nuclear chain reaction and its products (such as an emergency involving dangerous quantities of radioactive material used in medicine and industry or arising from medical accidental overexposures).

1.10. Clearly, this Safety Guide cannot take all State specific, site specific or emergency specific factors into account. Emergency planners should remain flexible in the use of the guidance and should adapt it to take account of local socio-political, economic and other factors.

1.11. This Safety Guide does not provide guidance or recommendations on meeting the requirements established in GSR Part 7 [2] in relation to protection strategy and criteria for use in preparedness and response for a nuclear or radiological emergency, arrangements for the termination of a nuclear or radiological emergency, public communication, protection of emergency workers and helpers, radioactive waste management following an emergency and mitigating non-radiological consequences; guidance relevant to these areas can be found in GSG-2 [3], GSG-11 [4] and GSG-14 [5], GSG-7 [6].

1.12. Both GSR Part 7 [2] and GSR Part 3 [12], in Requirements 5 and 44 respectively, require establishment of justified and optimised protection strategy that shall be implemented safely and effectively through the implementation of emergency arrangements that inter alia includes promptly taking urgent protective actions, early protective actions and other response actions to minimise health consequences of emergency. This publication doesn't elaborate further on the above-mentioned requirements.

1.13. This Safety Guide does not provide recommendations on taking site specific mitigatory actions as well as on medical preparedness and response for a nuclear or radiological emergency. Practical guidance on medical preparedness and response can be found in Ref. [7].

1.14. This Safety Guide does not provide guidance on response measures related to nuclear security to be implemented to counter an attempted or actual malicious act involving (or targeted at) nuclear or

[2] For a system of control, such as a regulatory system or a safety system, a process or method in which the stringency of the control measures and conditions to be applied is commensurate, to the extent practicable, with the likelihood and possible consequences of, and the level of risk associated with, a loss of control.

[3] In the context of this Safety Guide the term 'emergency' is used for conciseness of the document and is intended to mean a nuclear and radiological emergency, unless otherwise specified.

radiological materials, as well as it doesn't address response measures and activities carried out in the context of investigation into the circumstances surrounding a nuclear security event such as interdiction, identification, collection, packaging and transport of evidences contaminated with radionuclides, and nuclear forensics and related actions; guidance on this can be found within Nuclear Security Series publications [8, 9, 10]. However, this Safety Guide does address the coordination and integration of such response measures with the emergency response.

1.15. Terms are used in this Safety Guide as defined in GSR Part 7 [2] and the IAEA Safety Glossary [11].

STRUCTURE

1.16. This Safety Guide is divided into five sections. Sections 2, 3 and 4 provide guidance on how to meet selected requirements from the General Requirements, Functional Requirements and Requirements for Infrastructure from GSR Part 7 [2], respectively. Section 5 discusses the concept of operations, describing in general terms how the response should proceed for different types of emergencies. The Safety Guide also contains ten appendices and four annexes. Appendix I provides list of functions and responsibilities of operating organizations in preparedness and response to nuclear or radiological emergency. Appendix II elaborates on the concept of dangerous sources and use of D-values, as well as some guidance on how to communicate and instruct the public in the event of radiological emergency with potential contamination. Appendix III lists typical emergency preparedness categories for specific practices. Appendix IV provides an overview of emergency classes for all five emergency preparedness categories with description of response actions to be taken on-site and off-site. Appendix V recommends response time objectives for implementing selected critical response functions or tasks during the emergency. Appendix VI suggests the approximate radii of the inner cordoned off area depending on observed emergency conditions and sizes of emergency planning zones and emergency planning distances. Appendix VII gives a list of recommended emergency response facilities or locations for different emergency preparedness categories. Appendix VIII provides guidance on generic content that should be included in emergency plans and procedures. Appendix IX elaborates on training and exercise programmes for different roles and emergency preparedness categories. Appendix X gives recommendations on urgent protective actions. Annexes provide further elaboration and clarification on sizes of emergency planning zones, radiation induced health effects and exposure pathways, key protective actions and other response actions to be taken in the event of a nuclear or radiological emergency, and lists existing technical guidance that address in more details specific requirements of GSR Part 7 [2] not included in this safety guide.

2. GENERAL REQUIREMENTS

GENERAL

2.1. The five General Requirements contained in GSR Part 7 [2] cover the basic processes needed to achieve an adequate and coherent emergency preparedness and response framework for nuclear or radiological emergencies. This section covers the three general requirements that are addressed in this Safety Guide: establishing and maintaining an emergency management system, assigning roles and responsibilities in emergency preparedness and response, and conducting hazard assessments. These requirements are all fundamental for formulating an emergency preparedness and response framework that matches the needs of any State or its jurisdictions.

2.2. Preparation for and response to nuclear or radiological emergencies can be complex, and typically involves the government of a State and a variety of different national, regional, local and on-site organizations. These can include one or several governmental ministries or authorities, for example, national authorities responsible for radiation safety, food safety, agriculture, fisheries, forestry, health and welfare, law enforcement, nuclear security, medical and rescue services, and other, as appropriate. Many of these national authorities have jurisdiction over or connections to the associated services at the regional[4] or local level, most obvious are the medical and rescue services, and the law enforcement agencies. On-site organizations are typically the operators for facilities or activities that are classified according to the emergency preparedness categories. In addition, the relevant organizations planning for and responding to nuclear or radiological emergencies can be different for different categories of emergencies and can also be the same organizations that would be involved in responding to other types of emergencies.

2.3. To deal with this complexity, the government is required to ensure that roles and responsibilities for both the preparedness and response phases of nuclear or radiological emergencies are clearly specified and assigned at all levels in advance, including assigning roles and responsibilities amongst government officials [2]. The government is also required to ensure that an emergency management system is in place to provide adequate arrangements for the relevant organizations responsible during the entire chain of processes that make up the preparedness and response phases for nuclear or radiological emergencies [2]. Fundamental to this is first identifying, to the extent possible, hazards that exist in a State or its jurisdictions and that could cause nuclear or radiological emergencies, that could impair emergency response capabilities, or that could affect wide areas and categorizing those hazards. Assessment of the hazards elucidates the possible consequences that could occur.

2.4. Identifying and categorising the hazards associated with nuclear or radiological emergencies provides the basis for using a graded approach in establishing an emergency management system and associated emergency plans. Assessing the consequences of the identified hazards leads to the preparation of emergency arrangements for a response to an emergency that are commensurate with the type of hazards and possible consequences that exist in a State and its jurisdictions.

2.5. Integrating the emergency management system for nuclear or radiological emergencies into a State's all-hazards emergency management system allows for the identification of organizations or resources that can be part of a response to different types of emergencies in an all-hazards approach. The all-hazards approach focuses on capacities and capabilities that are critical to preparedness for a range of different emergencies or disasters and incorporates these in the State's all-hazards emergency management system, ensuring the capacity to address a broad range of related emergencies from a common pool of resources.

2.6. A successful, efficient and effective response would be difficult without an emergency management system, emergency plans that include clear allocation of roles and responsibilities, emergency procedures that give the detailed operation steps for the emergency plans, and identification, categorization and assessment of the possible hazards. The ultimate responsibility for making these arrangements lies with the government of any State that has activities that could cause nuclear or radiological emergencies; how the government organises this responsibility is up to each individual State.

[4] In the context of this Safety Guide the term 'regional' is used to refer to territories within the borders of one country.

EMERGENCY MANAGEMENT SYSTEM

Requirement 1 of GSR Part 7 [2]:

"The government shall ensure that an integrated and coordinated emergency management system for preparedness and response for a nuclear or radiological emergency is established and maintained."

2.7. A successfully managed system for emergency preparedness and response for nuclear or radiological emergencies is key to a successful response and the first of the general and overarching requirements in GSR Part 7. The term management system is defined in both GSR Part 7 and GSR Part 3 [2, 12].

2.8. The emergency management system should include an overarching set of arrangements at the national level. It should also contain individual arrangements for each of the organisations that work together to coherently achieve the goals of emergency preparedness and response as outlined in GSR Part 7, para 3.2., and any other pre-defined goals that may have been specified by a State or its jurisdictions. *FIG. 1* shows schematic overview of the nuclear and radiological emergency management system with examples of its possible elements.

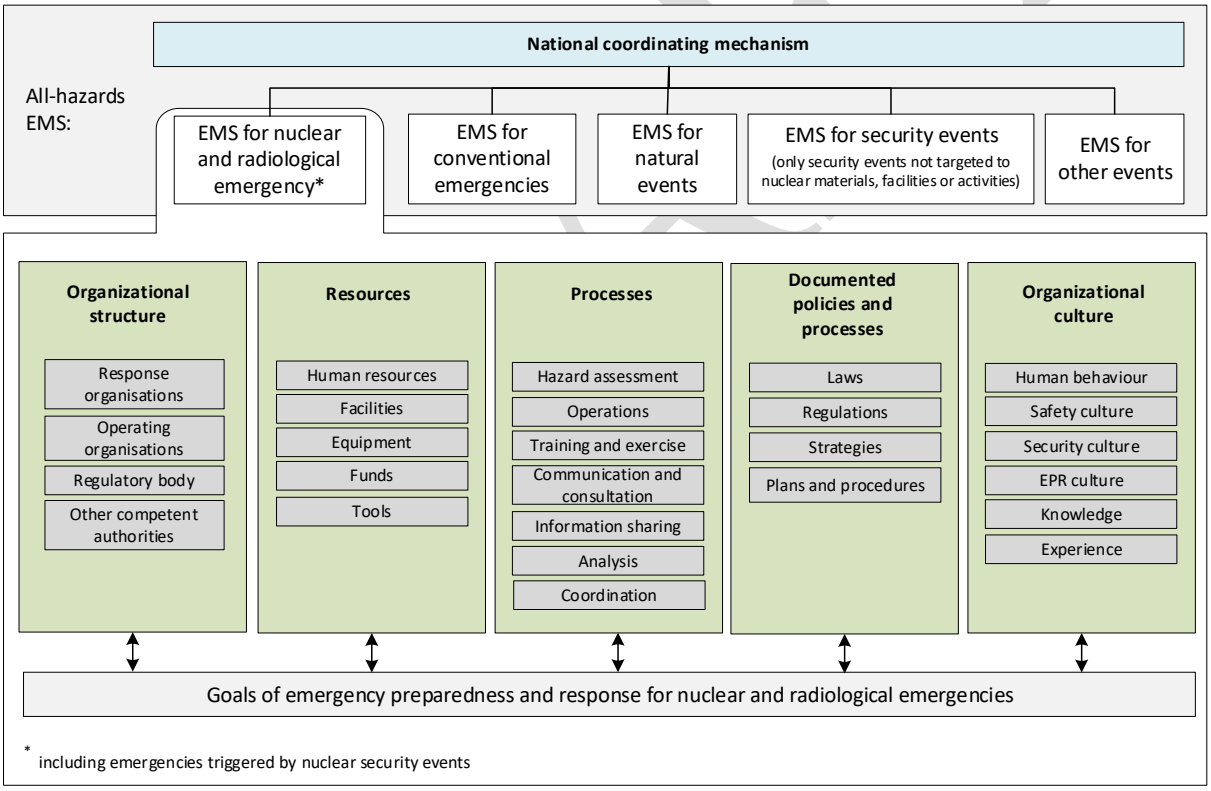


FIG. 1. Schematic overview of a nuclear and radiological emergency management system

2.9. States and their jurisdictions should identify, and document all relevant elements to be included in their emergency management system for nuclear or radiological emergencies. *FIG. 2* provides an overview of essential documents that together with other elements constitute an emergency management system.

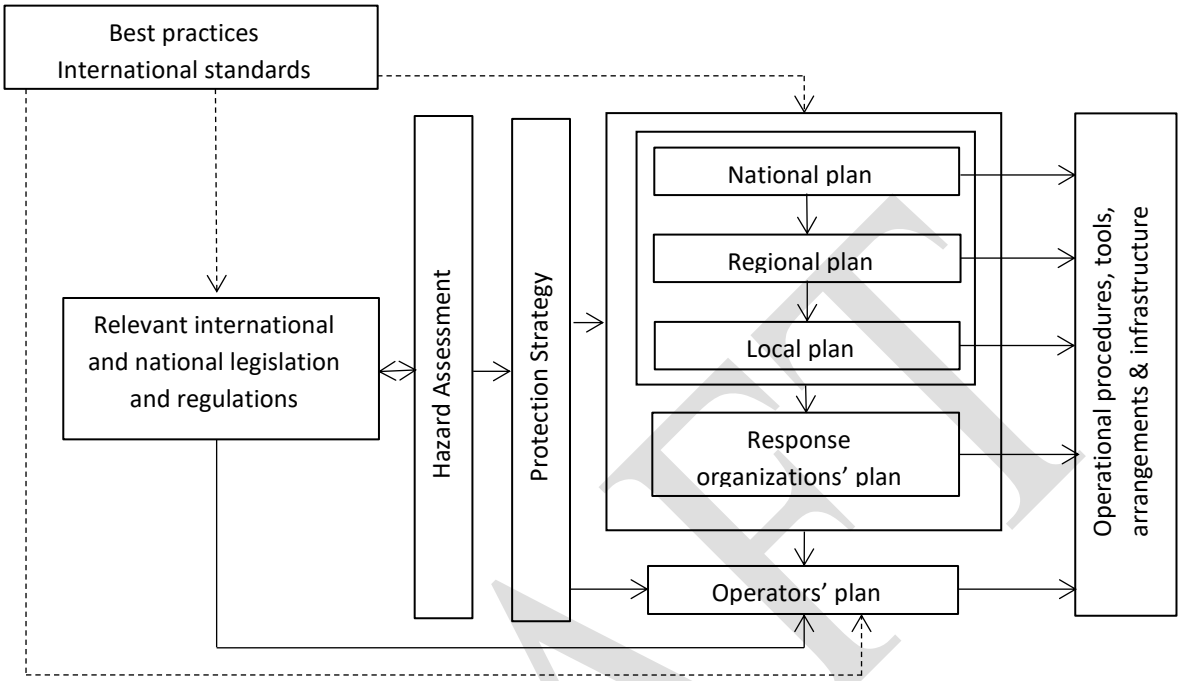


FIG. 2. Essential documents of emergency management system

2.10. Paragraph 4.5 of GSR Part 3 [12] includes essential elements to be covered by the emergency management system at all levels (i.e. on-site, local, regional, national, international), as appropriate:

(a) Hazard assessment;

(b) Development and exercising of emergency plans and emergency procedures;

(c) Clear allocation of responsibilities to persons and organizations having roles in the arrangements for emergency preparedness and response;

(d) Arrangements for efficient and effective cooperation and coordination among organizations;

(e) Reliable communication, including public information;

(f) Optimized protection strategies for the implementation and the termination of measures for the protection of members of the public who could be subject to exposure in an emergency, including relevant considerations for protection of the environment;

(g) Arrangements for the protection of emergency workers and helpers;

(h) Education and training, including training in radiation protection, of all persons involved in emergency response and exercising of emergency plans and emergency procedures;

(i) Preparations for the transition from emergency exposure situation to an existing exposure situation;

(j) Arrangements for the medical response and the public health response in an emergency;

(k) Provision for individual monitoring and environmental monitoring and for dose assessment;

(l) Involvement of relevant parties and interested parties.

2.11. When establishing the emergency management system for preparedness and response for nuclear and radiological emergency, account should be taken of the following examples, which may also need to be managed but are not included in the list of essential elements in para 2.10: policy making; formulating and developing organizational structures on each level; continuous development of leadership; human performance and safety culture; development of contingency plans to cover failure of response element; planning of and coordinating analyses and measurement/monitoring procedures; obtaining and assigning resources, including human resources and equipment; decision making, and other elements that need coordination on the site and at the local, regional, national and international levels.

2.12. The exact composition of elements to be covered by an emergency management system for nuclear and radiological emergency will vary from one State to another and will depend on (1) identified hazards and scenarios of concern (2) geographical location of an emergency (3) stage (i.e. preparedness or response) and emergency phase (i.e. urgent response, early response or transition phase). It can also vary from the organisational perspective, with emphasis either on the facility, local, regional, national or international level. Because of the time, location and scenario-dependent dynamics associated with an emergency, any overarching structure for organizing emergency preparedness and response for nuclear or radiological emergencies should have an effective emergency management system that integrates the elements to be managed into a single dynamic system that keeps it coherent, effective and focused on achieving the goals of emergency response. The structure of the emergency management system should be flexible enough to be able to handle unexpected events.

2.13. Since the categorization and assessment of identified hazards provides the foundation for using the graded approach to formulate an emergency management system for nuclear or radiological emergencies that is commensurate with the types of hazards identified, States should complete their hazard identification and categorization as a first step before establishing the emergency management system. The exact make-up of a State's emergency management system is dependent on the specific needs according to the hazards identified and assessed by a State and its jurisdictions. Thus, the results of the identification, categorization and assessment of hazards should guide the development and implementation of the appropriate elements in the emergency management system during the preparedness stage. This will enable an effective emergency response to reasonably foreseeable events, including very low probability events and events combined with other emergencies such as natural disasters, disease outbreaks, or security events[5]. More guidance on hazard assessment is provided in paras 2.72 – 2.108.

2.14. Before detailed planning for emergency preparedness and response can begin, development of the emergency management system and its elements should be performed in conjunction with the development of roles and responsibilities that are needed for both the preparedness and response. Both the establishment of the emergency management system and the assignment of roles and responsibilities should be based on the results of hazard assessment.

[5] In the context of this Safety Guide it includes only conventional security events (i.e. events involving criminal or illegal activities in which the target is not related to nuclear or radioactive materials, as well as to nuclear and radiological facilities or activities.
Response to nuclear security events which may trigger nuclear or radiological emergencies are covered within the response to nuclear or radiological emergencies.

2.15. The government should ensure that the information from the hazard assessments is used by all relevant response organizations to help assess what resources are needed to prepare for a response and determine what would be an adequate level of these identified resources. All hazards that can cause or influence nuclear or radiological emergencies identified in the hazard assessment should be considered. Managing these needs should be incorporated into the elements of the emergency management system. In addition to assessing what resources are required and would be adequate for dealing with the radiological consequences of a nuclear or radiological emergency, the government should also ensure that a similar assessment considering the non-radiological consequences of a nuclear or radiological emergency is made. Different expertise may be needed to assess different aspects of an emergency, but they should all be synthesised into one plan by whoever is responsible.

2.16. The emergency management system for nuclear or radiological emergencies should be documented and integrated into the State's all-hazards emergency management system. The capacities and capabilities identified in the all-hazards approach that are relevant for a response to a nuclear or radiological emergency should be incorporated in the emergency management system for nuclear or radiological emergencies.

2.17. Nuclear or radiological emergencies can be caused by or otherwise combined with other types of conventional emergencies (e.g. earthquake, flood, tsunami, pandemic) or security events (Ref. [13]). Such combination of events may affect the response to these emergencies. Often the same response organizations will have the responsibility for responding to different types of emergencies irrespective of whether they occur as a standalone emergency or combined with a nuclear or radiological emergency. This should be considered in the integration of nuclear or radiological emergencies in the all hazard approach. The arrangements and means for setting the priorities necessary to handle and coordinate more complex or combined emergencies[6] should be incorporated in the State's all-hazards emergency management system.

2.18. Because the timescale for any response is usually challenging, management arrangements including plans for coordinated decision-making procedures should be established and adopted during the preparedness stage. This should include the integration of the individual plans (for decision making) of the different on-site, local, regional and national emergency-related organizations and, if relevant, international organizations, into a single coordinated structure in the State's emergency management system for nuclear or radiological emergencies.

2.19. Any organization or entity within a State that has an interface with the international community is responsible for ensuring compliance with any international emergency arrangements and should ensure that its plans and procedures are consistent with any related plans and procedures in the national emergency plan, and are coordinated with any related tasks that could be occurring simultaneously in an emergency response. If more than one international arrangement requires the same information communicated during an emergency, procedures for simultaneously sending the same information to different sources should be considered to be established and arranged. All functions in the response organization that assume interaction with international community need to be coordinated through the national coordinating mechanism within the emergency management system.

2.20. The IAEA Safety Standards Series No. GSR Part 2, Leadership and Management for Safety [14] should be used as a reference for understanding the need for and function of a management system

[6] Combined emergency is a nuclear or radiological emergency combined with other incidents or emergencies, i.e. a nuclear or radiological emergency initiated and/or affected by conventional emergencies, natural events and/or security events.

that supports safety, with direct relevance for the emergency management system for nuclear or radiological emergencies. In addition, the IAEA Safety Standards Series No. GS-G-3.1 "Application of the Management System for Facilities and Activities" [15] gives guidance on establishing, implementing, assessing and continually improving a management system. The Safety Guide was written for the management of facilities and activities although the generic guidance given is applicable to and should be used as an aid in the development of an emergency management system for nuclear or radiological emergencies.

2.21. An effective emergency management system is also dependent on the impact that human behavioural issues have on emergency. This has been demonstrated in the analyses of recent emergencies, including the 2011 accident at the Fukushima Daiichi nuclear power facility in Japan [16]. As a result of that need a report has been developed and published on leadership, human performance and internal communication in nuclear emergencies [17]. Because of the demonstrated importance of human behavioural issues on the response to a nuclear or radiological emergency, the report [17] should be studied and the lessons learned applied in the continual development of an emergency management system.

ROLES AND RESPONSIBILITIES IN EMERGENCY PREPAREDNESS AND RESPONSE

General

Requirement 2 of GSR Part 7 [2]:

"The government shall make provisions to ensure that roles and responsibilities for preparedness and response for a nuclear or radiological emergency are clearly specified and clearly assigned."

2.22. Roles and responsibilities for both the preparedness and response should be firmly established, assigned, and accepted by all relevant participants during the preparedness stage. The objectives of clearly specifying and clearly assigning roles and responsibilities for both the preparedness and response phases of a nuclear or radiological emergency are to help ensure that emergency preparedness plans and arrangements are (a) efficiently and effectively developed and (b) all involved participants understand their roles and responsibilities.

2.23. The preparedness process involves a number of different types of government agencies and regulatory body[7], response organizations, and operators, many of which also need to be involved in any subsequent response to a particular nuclear or radiological emergency. Many of these agencies, organizations and operators may also have roles and responsibilities in handling other types of emergencies with other types of hazards than those identified for nuclear or radiological emergencies. Any conflicts in these roles and responsibilities that could affect the ability to carry out the necessary work needed in preparedness and response for a nuclear or radiological emergency should be taken into account and resolved during the process of assigning roles and responsibilities.

2.24. The government should ensure that the actions necessary to respond to the consequences of potential accidents identified from the hazard assessment is used as appropriate by the operating organisations, regulatory body and response organisations to identify, clearly specify and assign the

[7] Throughout the text the words "regulatory body" means the designated regulatory body or any other relevant governmental body or organization that the State has assigned the responsibility being discussed.

necessary roles and responsibilities that are needed during all parts of the preparedness and response phases.

2.25. The competence and capability of each organisation should be taken account when assigning roles and responsibilities, to ensure the correct human resources and competence exist for fulfilling the responsibilities assigned. These organizations can be nuclear safety and radiation protection agencies, health protection agencies, emergency management and rescue services agencies, regional and local authorities, customs agencies, operating organizations, or others as is relevant for the State or Jurisdiction. Which organizations are relevant should result from the categorisation of each hazard.

2.26. The government is required to ensure that legislation is adopted and regulations established so that preparedness for and response to a nuclear or radiological emergency can be governed at all levels ([2], paragraph 4.5). Accountabilities and responsibilities should be clearly defined at all levels, from the operating organisation, local, regional, national and if relevant international levels (regarding interactions with international organisations or other States). Accountability and responsibility for specific actions or arrangements in emergency preparedness and response should be clearly understood by the relevant assigned organizations. National requirements should state through adopting legislation how and to whom the responsibilities for emergency response are assigned.

2.27. The responsibility for regulating the emergency preparedness and response arrangements of the operating organizations should be clearly and unambiguously assigned to the relevant authority, or other organization as decided by the government (i.e. regulatory body). If more than one organization share the regulatory authority with respect to operating organizations then the regulatory responsibilities should be clearly assigned and the regulatory functions should be effectively coordinated to avoid any overlap and gaps.

2.28. In general, when similar or related functions are undertaken by different organizations involved in preparedness and response, responsibilities and interfaces should be clearly understood by all involved organizations.

2.29. The regulatory body, or other organization as decided by the government, should develop or adopt regulations addressing the need to clearly understand and allocate roles and responsibilities in the on-site response organization.

2.30. Clear responsibilities should be assigned for at least the following critical functions, as relevant:

- identifying and notifying an emergency and activating on-site and off-site emergency response;
- declaration of the emergency class;
- directing the on-site response;
- directing the off-site response;
- protecting emergency workers and helpers;
- protecting the public and implementing variety of protective actions and other response actions;
- directing health and rescue services;
- coordination between response organisations;
- monitoring (e.g. environment, public, source);

- waste management;
- assessment and prognosis;
- public communication;
- communication with interested parties;
- international communication;
- declaring the termination of the emergency;
- analysing the emergency and emergency response.

2.31. The government should ensure that responsibility is assigned to the appropriate authority for consideration of its citizens and/or embassies that are in another State that could experience a nuclear or radiological emergency, including what information or resources are needed to assist the embassies to prepare for any possible response phase. ([2], paragraphs 4.8. and 5.48.)

2.32. The government is required to ensure that arrangements are in place for governing the provision of compensation of victims for damage due to a nuclear or radiological emergency, see paragraph 4.6 in [2]. The government should assign accountability and responsibility for addressing this aspect to an appropriate organization. If other approaches already exist in the all-hazard emergency management system for providing compensation to victims of, for example, natural or other disasters, the government should consider using the existing national and international liability regime and the arrangements established under them for a nuclear or radiological emergency. This is elaborated upon in paragraphs 4.208. – 4.212. in Ref. [4].

2.33. The roles and responsibilities should include a clear path or chain of command for decision-making during a response and clear allocation of authority for making different types of decisions. Experiences from past emergencies have shown that clear leadership during an emergency is crucial to achieving the goals of emergency response. The government is thus required to ensure that response organizations, operating organizations and the regulatory body have and maintain leadership capabilities that can be demonstrated both during preparedness and response. These leadership capabilities should be developed through an on-going education and development program. The program should include exercises that clearly challenge the different leadership roles, and the results of these exercises should be used in the further development of the various leadership roles. The government should serve as an example of clear leadership by providing sufficient resources and ensuring adequate status to the State's nuclear or radiological emergency programme.

2.34. The government may assign the regulatory body with additional roles and responsibilities in emergency preparedness and response in addition to the responsibilities for regulation, such as provision of advice to the government, establishing a response capability with specified responsibilities and/or provision of expert services. Examples of the latter could be services for radiation monitoring, dose and consequences assessment, risk assessment, or public information and information exchange. Assigning additional roles and responsibilities to the regulatory body as part of the national emergency preparedness and response framework should only be made provided that:

- they do not create any conflict of interest with the regulatory body's function as a regulator;
- they do not constrain the resources available to the regulatory body that are needed to be an effective regulator of the operator's emergency preparedness and response arrangements. This applies to the resources necessary for the regulatory body to regulate all facilities and activities that fall under its jurisdiction.

Regulatory body

2.35. The regulatory body is required to establish or adopt regulations and guides for specifying the scope of the arrangements needed for preparedness and response to a nuclear or radiological emergency for facilities and activities that are under the responsibility of an operating organization. The regulatory body is also required to ensure that emergency arrangements are established, as applicable or necessary, before any source is brought to a facility site and that complete emergency arrangements are in place and exercised before operation of the facility or activity begins.

2.36. The regulatory body should verify compliance of the operator's on-site arrangements with the regulatory requirements before commencement of operation of any proposed facility or activity, and regularly during the lifetime of the facility or activity. The verification program should include components that check and approve the effectiveness of the operator's emergency response plan. The verification program should also check the on-site emergency arrangements of the operator to ensure that they are integrated with the arrangements of other response organizations. The verification program should check the on-site arrangements with regards to contingency plans and security plans in the context of Refs [18] and [19], respectively.

2.37. The regulatory body should prepare and establish processes and documents (e.g. checklists, codes of conduct or other helpful tools) that support an inspection process to review and assess the operator's emergency plans. The processes and documents established by the regulatory body should be formulated with the goal of being able to determine compliance of the operator's emergency plans with the regulatory requirements, and support a decision to approve the operator's plans. If checklists are used, they should include all parts of the regulatory requirements.

2.38. Regular inspections should start with the commissioning of the facility or activity and should be conducted by the regulatory body focusing on the emergency preparedness and response arrangements of operating organizations.

2.39. The regulatory body should establish an education programme for inspectors. The program should aim at ensuring effective verification of compliance with the regulations for emergency preparedness and response. The following aspects should be included, at least and as appropriate, in designing the educational program for inspectors: in depth education on the meaning and implications of all regulations that are related to governing emergency preparedness and response; review of other regulations governing the relevant facility or activity; interview techniques; education on human and organisational factors, including safety culture issues as related to inspections; safety issues during inspections; and documenting, reporting on and the procedure for writing an official compliance or non-compliance report after an inspection.

2.40. The regulations and guides established by the regulatory body[8] for the operating organizations should require of the operating organizations, at least, the list of functions as outlined in **Appendix I**. The regulatory body should ensure, through inspections, that the operating organization has the resources, methods and infrastructure to carry out the list of required functions.

2.41. The extent of the operating organization's responsibility and mandate regarding decision making during an emergency response should be made clear to the operating organization through regulations and guides. The regulatory body is required to ensure that sufficient authority is given to the operating organization on the site to promptly take necessary actions to mitigate any on-site and, if

[8] (or any other body assigned by the government that has the authority to issue regulations and guides)

relevant, off-site consequences [2], and therefore regulatory body should not requiring the operating organization to request approval in the course of implementing such mitigatory actions on the site during an emergency. Example of such action taken by the operating organisation can be a justifiable controlled discharge of radioactive material to the environment in order to minimize radiological consequences. These actions should be subject to discussion and approval at the preparedness stage when the regulatory body approves the operator's emergency plan.

2.42. The regulatory body should establish regulations to ensure that the operating organisation a clear periodically review and, when necessary, revise their emergency arrangements. The revision may be required 1) prior to any planned changes in the facility or activity, if the planned changes could affect the consequences and associated mitigatory actions and other response actions that have been identified through previous hazard assessment, or 2) when new information becomes available that provides insights into, and/or questions the adequacy of the existing arrangements.

2.43. The regulatory body should have a plan to observe suitable and sufficient exercises conducted by the operating organisation to confirm that the response to an emergency will be effective.

Operating organisation

2.44. The definition for operating organization provided in Refs [2, 11] should be considered as guidance when identifying the operating organisations in the State and assigning roles and responsibilities. Examples of who the operator may be are the operating organization of a facility in emergency preparedness category I, II or III; an individual who is authorized to operate equipment containing dangerous sources, such as in radiotherapy or industrial radiography, or carrier of radioactive source (both are emergency preparedness category IV). It should be noted that although those responsible for the on-site operation of a facility where uncontrolled dangerous sources may be encountered such as national border crossing points, airports, seaports, scrap metal dealers and processors are recognized as operators in the general meaning of this term and required having some limited emergency preparedness and response arrangements, such facilities and locations should not be treated as operating organisation in the meaning presented in the IAEA Safety Glossary as they generally don't apply for or are authorised by the regulatory body to undertake activities in relation to the detected sources of ionising radiation.

2.45. The operating organization is required to "establish and maintain arrangements for on-site preparedness and response for a nuclear or radiological emergency for facilities or activities under its responsibility" [2] and thus, the operator should prepare for, at least, the relevant requirements listed in **Appendix I**.

2.46. The operating organization should ensure that their on-site arrangements for preparedness and response to a nuclear or radiological emergency comply with regulatory requirements and demonstrate this in their authorisation documentation, which should include their emergency plan. The operating organization should consider when planning what support can be needed from the off-site, and should cooperate with off-site authorities or response organizations to coordinate response arrangements in case of an emergency with off-site consequences.

2.47. Appropriate and challenging exercises should be used as part of demonstrating compliance of the operating organization's emergency arrangements with regulations and guides issued by the regulatory body.

Off-site response organizations

2.48. Off-site response organizations typically include a variety of different national, regional and local organizations (e.g., authorities or organizations responsible for radiation safety, emergency management, food safety, agriculture, fisheries, forestry, health and welfare, law enforcement, border patrol, nuclear security, intelligence, medical and rescue services). These types of organisations should be considered when roles and responsibilities are assigned. Consideration should be given to which organizations have sufficient resources and competence for the various tasks associated with the assigned roles and responsibilities and can give the required support in a timely manner.

2.49. National, regional or local plans should be implemented by the designated responsible officials at each level. Responsibilities can also be assigned to non-governmental organizations.

2.50. The government should ensure that responsibilities have been assigned to the appropriate officials to respond to emergencies that can occur anywhere unexpectedly, for example, emergencies with transport, orphan sources, or malicious acts using or targeted to nuclear or radioactive materials, facilities or associated activities. These responsibilities should be designed to include support to the local efforts (e.g., local officials, emergency response organizations) in dealing with these emergencies.

2.51. The operator should be capable of planning the response to an emergency on the site. However, consideration during planning should be given to what type of support would be needed and could be provided to the operator by the off-site response organisations and agencies. Off-site response organizations should be assigned responsibilities for performing specific functions that are either not part of, or are in support of, the responsibility of the operating organization. In addition, the relevant off-site response organizations can be different for different types of nuclear or radiological emergencies. The designated off-site organisations or agencies should understand the totality of the support that will be required to provide the on-site response.

2.52. The off-site response organizations should develop appropriate emergency arrangements (e.g. plans, procedures, resources, training and exercise programmes) to fulfil their assigned roles and responsibilities. They should cooperate and work together with other relevant organizations, including the operating organizations, and should participate in joint exercises to promote coordination and effectiveness.

National coordinating mechanism (NCM)

2.53. Paragraph 4.10 of GSR Part 7 [2] requires the government to establish a national coordination mechanism, an essential instruments of the emergency management system to be used at the preparedness stage, to ensure that all emergency arrangements established at the preparedness stage by operating organisations, regulatory body and response organisations at all levels are coordinated, compatible and integrated in order to ensure effective and efficient emergency response. Same paragraph lists the main functions of the national coordinating mechanism:

> "(a) To ensure that roles and responsibilities are clearly specified and are understood by operating organizations, response organizations and the regulatory body …;
>
> (b) To coordinate the hazard assessment within the State … and periodic reviews of the assessed hazards…;

(c) To coordinate and ensure consistency between the emergency arrangements of the various response organizations, operating organizations and the regulatory body 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 States and of international organizations;

(d) To ensure consistency among requirements for emergency arrangements, contingency plans and security plans of operating organizations specified by the regulatory body and by other competent authorities with responsibilities for regulating nuclear security, as relevant, and to ensure that these arrangements and plans are integrated …;

(e) To ensure that appropriate emergency arrangements are in place, both on the site and off the site, as appropriate, in relation to facilities and activities under regulatory control, both within the State and, as relevant, beyond its borders, and also for sources that are not under regulatory control;

(f) To coordinate arrangements made for enforcing compliance with the national requirements for emergency preparedness and response as established by legislation and regulations …;

(g) To coordinate a subsequent analysis of an emergency, including analysis of the emergency response …;

(h) To ensure that appropriate and coordinated programmes of training and exercises are in place and implemented, and that training and exercises are systematically evaluated;

(i) To coordinate effective communication with the public in preparedness for a nuclear or radiological emergency."

2.54. Additional functions may include (1) to coordinate the development of a comprehensive protection strategy for a nuclear or radiological emergency; and (2) to monitor the adequacy of established emergency arrangements to implement the protection strategy.

2.55. The government should ensure that all elements of the emergency management system are covered in the functional duties of the NCM.

2.56. National coordinating mechanism is a preparedness effort and should not be used as a coordination tool during the response when this function is fulfilled by the operation of the unified command and control system (UCCS).

2.57. The government should determine the most effective way of establishing this coordinating mechanism. For example, States with large and diverse nuclear and radiological programmes could allocate this responsibility to either an existing or newly formed committee or body, whilst those with a very limited programme may allocate the responsibility to an existing authority. It is also possible that same body serves as an NCM for several functions or different bodies are assigned for specific tasks.

2.58. National coordinating mechanism should be applied at all levels. It should be given adequate authority for initiating and completing its functions as elaborated above. The government should ensure that the NCM understands 1) the functions to be undertaken; 2) what are existing limitations associated with the functions; and 3) which specific expertise can be called upon, if necessary, to understand and/or assist in completing the functions. Examples of expertise the NCM should consider in completing its functions are in the following areas: organizational structure and emergency

management; all-hazards approach; national legislation and regulations; hazard assessments and graded approach; protection strategy; radiation protection and radiation measurement techniques; relevant medical skills; rescue services, customs and/or law enforcement; nuclear security; radioactive waste management; relevant assessment and analysis techniques; training and exercises; and public communication; international arrangements.

2.59. Because nuclear or radiological emergencies encompass a range of scenarios with different characteristics, the NCM should have the flexibility to include members from different organizations that are relevant for different scenarios, or for different emergency preparedness categories. It should have a dynamic character, and be able to change the composition of participants relevant to different specific tasks, scenarios or emergency preparedness categories.

2.60. The NCM should have the authority to coordinate the emergency preparedness arrangements of all the involved organizations and authorities included in an all-hazards approach.

2.61. The NCM should have identified means for checking that roles and responsibilities are clearly specified and understood by operating organizations, response organizations and the regulatory body (for example, signed and approved emergency plan or successfully implemented exercise).

2.62. The NCM should have means for identifying and ensuring resolution of any conflicts and incompatible arrangements, gaps or overlaps, that may exist between the various participating organizations and their roles and responsibilities, and should have the authority to resolve them.

2.63. The 'concept of operations' (see Section 5) should be used as an aid in understanding and allocating responsibilities. Reference [20] provides a list of tasks that are critical for a successful response.

2.64. In coordinating the hazard assessment for nuclear or radiological emergencies, including periodic reviews of the assessed hazards, the NCM should have a mechanism for assuring that the hazard assessment has identified all consequences that may need to be managed, and actions taken, thereby leading to confirmation that all necessary organisations for which co-ordination is needed have been identified.

2.65. The NCM should be provided with sufficient resources and should ideally include a multi-year commitment to ensure stability in planning and the ongoing need to keep plans coordinated and up-to-date.

Integrated planning (all-hazards approach)

2.66. A nuclear or radiological emergency may be caused by or may involve different types of hazards, including natural (e.g., storms or other extreme weather conditions, pandemic), technological (e.g., nuclear power generation), human error (e.g., unintended possession of a strong radioactive source) or criminal and malicious activity (e.g., theft, sabotage, terrorist attacks). The response to emergencies caused by each of these hazards can involve different response organizations with their own terminology, cultures and plans. Consequently, the paragraph 4.10(c) of GSR Part 7 [2] require that the NCM ensures that the arrangements for response to a nuclear or radiological emergency are coordinated and consistent at all levels. This includes coordination of the planning for response to emergencies, irrespective whether the cause of the emergency is nuclear safety or nuclear security related, or combinations of these with conventional emergencies and, as appropriate, other States and international organizations under the all-hazards approach.

2.67. 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, or pandemic/disease outbreak. Since an emergency may involve criminal activity such as terrorism or theft, preparations should also involve law enforcement agencies.

2.68. The preparation and planning for response to all hazards should be structured into a coherent and interlocking system, an example is given in *FIG. 3*. At the top level (level 1) should be a national all-hazards emergency plan, for an integrated and coordinated response to any combination of hazards. The national nuclear and radiological emergency plan (level 2) may be a part of this all-hazards plan. If there is no national all-hazards emergency plan, the national nuclear and radiological emergency plan should provide for integration with the responses of other organizations during emergencies involving a combination of actual or perceived nuclear or radiological hazards with other non-nuclear hazards.

2.69. The national nuclear and radiological 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 nuclear and radiological 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 should be accomplished by attaching to the national nuclear and radiological emergency plan strategies for operations such as radiological monitoring and consequences assessment, medical response, public affairs and public communications.

2.70. The next level (level 3) should contain the plans developed by individual response organisations, governmental jurisdictions and operators. The final level (level 4) 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 [20] outlines the various levels of plans and procedures.

2.71. To optimize the use of resources and the effectiveness of the response, response plans should be highly coordinated and consolidated. Planning done by any one organization or agency should be done in consultation with the relevant interested parties.

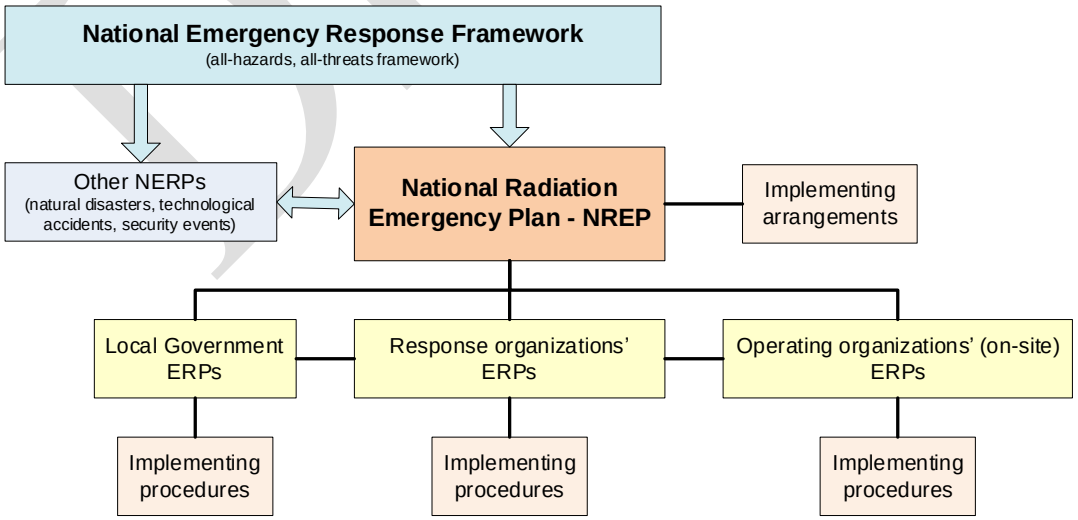


FIG. 3. Example of an integrated planning concept

HAZARD ASSESSMENT

General

Requirement 4 of GSR Part 7 [2]:

"The government shall ensure that a hazard assessment is performed to provide a basis for a graded approach in preparedness and response for a nuclear or radiological emergency."

2.72. This section provides guidance and recommendations to assist Member States in addressing the challenges associated with performing hazard assessments, assigning emergency preparedness categories and applying the graded approach in preparedness for nuclear and radiological emergencies. Emergency preparedness categories are used as a structure to group facilities, activities, sources, acts, and areas based on the assessed hazards and the level of emergency preparedness and response warranted.

2.73. According to GSR Part 7 [2] graded approach requires that emergency arrangements are commensurate with the hazards associated with facilities and activities and the potential consequences of a nuclear or radiological emergency should it occur. It is thus the results of the hazard assessments that define the consequences that need to be taken into account when designing and preparing appropriate emergency response arrangements.

2.74. Emergency preparedness categories offered by GSR Part 7 [2] are structured using a graded approach, both as a function of the severity of radiological consequences for categories I to III, and as a function of the types of emergencies that can occur. The requirements of GSR Part 7 [2] are also structured so that the nature of the conditions defining each emergency preparedness category determines which of the safety requirements apply to each category. Annex 1 in GSR Part 7 [2] assists by providing a table showing which paragraphs in the requirements are applicable to each emergency preparedness category and should be used to assist States in fulfilling the requirements.

2.75. For facilities like nuclear installations some components of the studies performed during the site characterisation like those related to the evaluation of natural and human induced external hazards (e.g. seismic, volcanic, meteorological, hydrological), evaluation of population density and distribution, analysis on feasibility of emergency response action, should be utilised when performing hazard assessment. The following Refs [21, 22, 23, 24, 25, 26] provide further guidance on this.

Hazard assessments

2.76. Requirement 4 of GSR Part 7 [2] requires that hazard assessments be performed for all identified hazards in a State and its jurisdictions. The government is responsible for allocating the responsibility for performing hazard assessments, which typically is assigned to the operating organizations or to appropriate competent authority like regulatory body (i.e. national hazard assessment), and/or to response organizations (e.g. first responders). The involvement of the national coordinating mechanism is also required to ensure that the hazard assessments are coordinated and periodically reviewed.

2.77. Hazard assessments provide the basis for emergency preparedness and response and should be periodically reviewed and updated. The stages of the assessment process can be briefly summarized as:

a. identify and characterise postulated emergency situations,

b. evaluate the associated nuclear or radiological inventory and potential releases,

c. assess the distribution of radioactive and any other materials released (including dispersion and deposition processes), when appropriate;

d. assess the radiological consequences associated with the release or exposures and characterise the effects associated with the source or release, including, e.g., distribution or dose rates, as appropriate to the hazard;

e. assess the non-radiological consequences associated with the hazard;

f. identify and assess the effectiveness and consequences of protective actions that may need to be taken.

These stages are discussed in the following paragraphs. See also Ref. [27] document for more technical information on this subject.

2.78. In designing and creating an adequate emergency preparedness and response framework, States are required[9] to identify and characterize all existing hazards that could lead to a nuclear or radiological emergency within the limits of uncertainties and available information. This first stage in the hazard assessment should identify all facilities, activities, as well as dangerous sources, locations and conditions that could cause nuclear or radiological emergencies within the State that warrant protective actions and other response actions.

2.79. This identification and characterization stage should include the full range of possible events, such as those addressed in para. 4.20 of the GSR Part 7 [2]:

- Events with a very low estimated probability of occurrence and events not considered in the design of a facility;
- Events involving a combination of a nuclear or radiological emergency with a conventional emergency such as an earthquake, a volcanic eruption, a tropical cyclone, severe weather, a tsunami, a disease outbreak or pandemic, an aircraft crash or civil disturbances that may affect wide areas and/or impair capabilities to provide support in the emergency response;
- Events that could affect several facilities or activities simultaneously, and
- Events at facilities in other States or events involving activities in other States.

Some of these scenarios involve non-radiological emergencies. Thus, coordination and cooperation with non-radiological hazard assessments performed at other appropriate government agencies, operator or responding organizations should be a part of this process.

2.80. This means that any hazard that has the potential to impair or diminish the ability to protect human life, health, property and the environment in the event of a nuclear or radiological emergency should be identified, including worst case scenarios. It is also required that the process of identifying hazards includes cooperation with those responsible for nuclear security risks to ensure all hazards are identified and preparations, and any ensuing response, can be coordinated.

2.81. After identification of the hazards, an assessment of the radiological consequences that any hazard and associated relevant scenarios could produce is required to be performed in order to determine whether and to what extent an identified hazard warrants protective or other response

[9] This requirement is carried out through those government bodies or appropriate organizations that the government has assigned the responsibility for performing hazard assessments.

actions. The assessment should also determine if each hazard could lead to needs for communicating with the public when an event occurs but no radiological consequences warranting protective actions or other response actions exist.

2.82. An evaluation of the inventory or possible releases should be performed, which includes the radionuclide mix and the nature of any chemical or other hazards. This should include an assessment of the inventory of the release or source, including the chemical composition and total activity and the proportion of the inventory and the radionuclide composition that could be released under defined emergency conditions. Because this is specialized information that depends on the nature of the event and the specific facility or source, interaction with experts outside the emergency preparedness and response community should be arranged. For example, this should include, as relevant, interaction with experts involved in research into fundamental chemical and physical processes. Consideration should be given to 1) radionuclides present or released from the source including decay products, nuclear reaction products and activation products, and 2) chemical and other hazards. This evaluation of the inventory or releases should result in an assessment of the radionuclide mixes expected to be released from the source, which may be significant contributors of the dose to the public and/or workers; or relevant to the instrument response and thus choice of measurement instruments.

2.83. Next, an assessment of the transport to individuals of the distribution of radioactive materials, and any other materials released from the radioactive source, should be performed. This stage of the hazard assessment includes the dispersion and deposition processes. The transport should be divided into two stages. The first is the transport from the source to the environment, i.e., to the atmosphere, water or objects through, as appropriate, a facility or source specific structure, such as nuclear power plant containment or the housing of a radioactive source. The second stage is the transport from the environment to the public, for example, through atmospheric dispersion and deposition or through movement of water to the public. If the scenario being assessed includes a sealed source or sources, any method for transport of the contents in the sealed source, such as broken or compromised source containment, to the environment or the public should be considered.

2.84. The transport from the source to the environment may be direct; in which case the radionuclide mix determined in the para. 2.82 would not be significantly changed. This would occur if the transport went through a direct containment bypass in an NPP, or through a breach of a sealed source. The transport from the source to the environment may also be indirect, where the radionuclide mix would be affected by a specific structure before getting into the environment. The relevance of these two transport mechanisms for transporting the source to the environment should be determined and the consequences assessed. In both the direct or indirect transport scenarios, radioactive decay should be taken into account in assessing the radionuclide mix.

2.85. The type of facility or source specific structure and the accident conditions impact the radionuclide mix that results from an indirect release. The following factors should be considered when determining the possible impact of the radionuclide mix during an indirect release.

− The behaviour of the source within the facility or source specific structure during the progression of the accident should be considered. Examples of what is meant by the source behaviour are core/concrete interactions or whether there could occur in- or ex-vessel melting.

− The retention of any released mixes in the containment or source specific structure could affect the radionuclide mix and should be considered.

− Any mitigatory actions, such as water sprays or chemical reactors, which are implemented within the facility or source specific structure, should be considered.

− Release pathways within the facility or source specific structures such as filters or water pools

should be considered.

− Any other facility or source specific effects should be identified and the effect on the radionuclide mix should be assessed.

2.86. The next stage of the hazard assessment should be assessing the radiological exposure associated with the release as characterized in the stages described above. Assessing the radiological exposure involves characterizing the temporal variation and spatial distribution of the released material and the exposure scenarios and pathways for each postulated emergency. Using information on the characterization of the area and population, the projected doses to people on-site and off-site (as appropriate) should be assessed. This should be assessed in the absence of protective actions in order to determine which protective actions are appropriate. The following factors should be considered: the relevant exposure pathways, the application of the representative person concept[10] and procedures for calculation of doses. With regard to concurrent events, i.e. nuclear or radiological emergencies combined with other emergencies, not only the impacts the potential concurrent events may have on the level of release, but also on the effectiveness of protective actions under such circumstances should be considered.

2.87. In addition to assessing the radiological consequences of identified hazards, the hazard assessment is required to assess how non-radiological hazards during an emergency could affect the ability to respond or the efficiency of a response. This should be done by considering significant non-radiation related hazards to individuals or workers, such as hazardous chemical releases, e.g. UF_6, both on-site and off-site associated with a facility in emergency preparedness categories I, II or III or in the event of transport emergencies (i.e. EPC IV).

2.88. The last stage in the hazard assessment should assess the effectiveness and consequences of possible protective actions. The projected doses to members of the public should be determined as a function of distance and spatial variation from the release to identify the appropriate extent of protective actions. The consequences resulting from the timing of the accident progression and of the implementation of protective actions should be assessed. The feasibility of applying protective actions and other practical factors relevant to the justification and optimization processes should be assessed. This information should aid in determining which actions would be most effective to achieve the goals of emergency response. Non-radiological impacts that could arise both in the absence of and as a consequence of implementing protective actions should be assessed.

2.89. Once the hazards have been identified and the assessment of each hazard has provided enough of an understanding of the possible range of consequences that could occur, each hazard should be assigned the appropriate emergency preparedness category. Assignment of each hazard to the appropriate emergency preparedness category does not necessarily need to be preceded by a complete radiological assessment of all hazard scenarios and possible consequences, such as the very low probability scenarios, but rather enough of an assessment to determine whether the hazard can result in consequences that clearly place the hazard in a given category. That is, assessment and assignment of hazards to emergency preparedness categories can usually be done without first completing a thorough radiological assessment. If this is the case, after the identified hazards are assigned emergency preparedness categories, further radiological assessments should be performed to complete the determination of the extent and severity of the radiological consequences associated with different

[10] An individual receiving a *dose* that is representative of the *doses* to the more highly exposed individuals in a population [11].

hazards. These final results of each hazard assessment are needed for detailed planning of the justified and optimised protection strategy and preparedness for the emergency response.

2.90. If in the review of hazard assessment, the new or modified hazard that may affect the feasibility of emergency plans and procedures is revealed within the State or beyond its borders, actions should be taken and emergency arrangements should be adjusted to ensure effective response [21, 22].

Threat assessment

2.91. GSR Part 7 [2] requires that hazard assessments consider results of threat assessment[11]. These results contain useful insights on criminal or intentional unauthorized acts involving or directed at facilities, activities, and sources and therefore should be used as an input at the stages of hazard assessment process related to the characterization of the postulated emergencies and assessment of their radiological and non-radiological consequences.

2.92. Considering the high confidentiality of the threat assessment document, arrangements should be made to communicate it without compromising neither safety nor security. What information can be shared, in what form and to whom should be discussed in close cooperation with nuclear security specialists who are responsible for the provision of the necessary nuclear security information and, where relevant, the competent authorities for nuclear security. In some cases, the part of the hazard assessment that contains sensitive information that need to be protected can be restricted and shared with only a selected group of relevant interested parties

2.93. More guidance on threat assessment is provided in the Nuclear Security Series NSS No. XX, National Nuclear Security Threat Assessment, Design Basis Threats and Representative Threat Statements [28] and No. 24-G, Risk Informed Approach for Nuclear Security Measures for Nuclear and Other Radioactive Material out of Regulatory Control [29].

Emergency preparedness categories (EPC)

2.94. The guidance in this publication is specified for the five emergency preparedness categories defined in the Requirements of GSR Part 7 [2], which for clarity are reproduced in TABLE 1, along with the suggested criteria for each category.

2.95. Emergency preparedness categories I, II and III represent decreasing levels of hazard and associated radiological consequences at major facilities and therefore correspond to decreasing stringency of requirements in emergency preparedness and response for the categories I through III. Facilities in emergency preparedness category I can result in severe deterministic effects off the site warranting precautionary urgent protective actions, or, for facilities in emergency preparation category I and II, in doses to people off the site that would warrant urgent protective actions or early protective actions and other response actions to achieve the goals of emergency response. Categories I and II thus warrant extensive on-site and off-site emergency preparedness arrangements that should be prepared to ensure an appropriate response to an emergency and that the goals of emergency response are met.

2.96. For facilities in emergency preparedness category III the radiation related hazard is limited to the site of the facility or to specific areas on the site (e.g. treatment rooms or laboratories), however some limited off-site arrangements like to inform the public in the event of an emergency are still

[11] Threat assessment is a process of evaluating the nuclear security threats, based on available intelligence, law enforcement and open source information that describes the motivations, intentions and capabilities of these threats, where threat refers to a person or group of persons with motivation, intention and capability to commit a malicious act.

warranted and should be prepared. Graded approach should be applied inside the emergency preparedness category III as it is very broad and covers facilities requiring relatively strong onsite emergency arrangements down up to the others with very basic ones.

2.97. Emergency preparedness category IV represents activities and acts that can lead to radiological emergencies that could occur anywhere, could occur unexpectedly, and applies always in all States and jurisdictions possibly together with other emergency preparedness categories. Emergency preparedness category IV includes emergencies resulting from activities and acts that can include severe effects at a site that can require protective actions at an unforeseen location. Arrangements should be prepared with responding organizations to minimize the difficulties associated with responding to these types of emergencies that can occur spontaneously and in unforeseen places. Emergency preparedness category IV covers variety of emergencies (see TABLE 1) with more (Category 1, 2 and 3) or less dangerous radioactive sources (Category 4 and 5) in Ref. [50]. Examples of types of events associated with emergency preparedness category IV are a lost or stolen dangerous source; an accident with mobile industrial radiography; a transport emergency; an emergency in radiology or nuclear medicine; terrorist attacks Such variety requires use of graded approach when planning emergency preparedness and response arrangements.

2.98. Emergency preparedness category V applies to areas within a State or jurisdiction that are part of emergency planning zones and distances for facilities in emergency preparedness categories I and II that are located across a border in a neighbouring State. Category V thus warrants off-site arrangements in accordance with the level of hazard determined in the hazard assessment with regards to the neighbouring State's category I or II facility. For consistency in emergency preparedness, the hazard assessment should be completed through cooperation and information sharing between the neighbouring States.

2.99. These emergency preparedness categories apply to all facilities and activities, including dangerous sources, in a State and its jurisdictions, for which various levels of preparedness are warranted. **Appendix III** provides examples of typical emergency preparedness categories for different activities and should be used as an aid to States in assigning categories. **Appendix II** provides a method for determining whether a quantity of radioactive material should be considered a dangerous source.

TABLE 1. SUGGESTED CRITERIA FOR DETERMINING EMERGENCY PREPEREDNESS CATEGORIES FOR FACILITIES AND ACTIVITIES

Emergency Preparedness Category	Description	Criteria[12]
I	Facilities, such as nuclear power plants, for which on-site events[a, b] (including those not considered in the design[c]) are postulated that could give rise to severe deterministic effects[d] off the site that would warrant precautionary urgent protective actions, urgent protective actions or early	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 reactors, nuclear ship and research reactors);[13]

[12] Site specific analysis can be performed to determine the appropriate emergency preparedness category.

[13] This is on the assumption that the reactor has been operating at this power level sufficiently long to build up the ^{131}I 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.

Emergency Preparedness Category	Description	Criteria[12]
	protective actions, and other response actions to achieve the goals of emergency response in accordance with international standards[e], or for which such events have occurred in similar facilities.	• Facilities and/or locations containing recently discharged irradiated reactor fuel with a total of more than about 0.1 EBq of ^{137}Cs (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.[14]
II	Facilities, such as some types of research reactor and nuclear reactors used to provide power for the propulsion of vessels (e.g. ships and submarines),for which on-site events[a, b] are postulated that could give rise to doses to people off the 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[e], 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 deterministic effects off the site, or for which such events have occurred in similar facilities.	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[15]); • Facilities and/or locations containing recently discharged irradiated reactor fuel requiring active cooling; • Potential for an uncontrolled criticality to occur at a distance less than 500 m from the site boundary; • Facilities with inventories of dispersible radioactive material sufficient to result in doses warranting urgent protective action being taken off the site.[16]
III	Facilities, such as industrial irradiation facilities or some hospitals, for which on-site events[b] are postulated that could warrant protective actions and other response actions on the site to achieve the goals of emergency response in accordance with international standards[e], 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 the site, or for which such events have occurred in similar facilities.	Facilities for which emergencies have been postulated that could result in doses warranting protective action and other response actions being taken on the site, including: • Potential for an uncontrolled criticality to occur at a distance more than 500 m from the site boundary; • Reactors with power levels of less than or equal to 2 MW(th); • Facilities with inventories of radioactive material less than identified for category II and sufficient to result in doses warranting protective action and other response actions being taken on the site but not off-site.
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[e] in an	Activities involving mobile sources, including: • A mobile source with:

[14] Inventories 10 000 times the A/D_2 value calculated in **Appendix II** may place a facility in EPC I if it is assumed that 10% of the inventory [30, 31] could be released to the atmosphere in a single event.

[15] Small modular reactors (SMRs) and transportable nuclear power plants (TNPPs) when they are docked in a fixed position, will most likely fall into EPC II, depending on the size, or electricity effect. Some of the larger ones could qualify as EPC I.

[16] Inventories 100 times the A/D_2 value calculated in **Appendix II** may place a facility in EPC II if it is assumed that 10% of the inventory [30, 31] could be released to the atmosphere in a single event.

Emergency Preparedness Category	Description	Criteria[12]
	unforeseen location. These activities and acts include: (a) transport of nuclear or radioactive material and other authorized 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 or radiological exposure device[f]. 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 State. Category IV represents a level of hazard that applies for all States and jurisdictions.	(i) potential, if shielding is lost, for causing direct external (shine) dose rates of more than 100 μSv/h at 1 m, or (ii) dangerous sources according to **Appendix II**; • Satellites containing dangerous sources according to **Appendix II**; • Transport of any radioactive material that is not a subject for exemption [12] . Facilities/locations at which there is a significant probability of encountering an uncontrolled dangerous source, such as: • Scrap metal processing facilities; • Foundries; • National border crossing points, seaports and airports.
V	Areas within emergency planning zones and emergency planning distances[g] in a State for a facility in category I or II located in another State.	Areas within the emergency planning zones and distances of facilities with criteria fulfilling emergency preparedness category I but with the facility located in a neighbouring 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 the 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 'deterministic effect' as they defined in Refs [2, 11].

[e] See the goals of emergency response in para. 3.2 and the generic criteria in Appendix II in GSR Part 7 [2].

[f] A radiological dispersal device is a device to spread radioactive material using conventional explosives or other means. A radiation exposure device is a device with radioactive material designed to intentionally expose members of the public to radiation. They could be fabricated, modified or improvised devices.

[g] See para. 5.38 in in GSR Part 7 [2]

2.100. TABLE 1 provides criteria as guidance for determining emergency preparedness categories for facilities and activities that should be used, when appropriate, for initial designation of emergency preparedness categories before the detailed radiological assessment of each hazard is completed. Typical emergency preparedness categories associated with a large number of different types of facilities and activities are presented in **Appendix III**, which provides more detailed guidance and should also be used for initially assigning emergency preparedness categories.

2.101. A level of hazard associated with emergency preparedness category IV exists for all States and jurisdictions. States should therefore assess their vulnerability to emergencies that can occur at any unspecified location and at any time. This hazard assessment should include (but not limited to):

— Types of shipments of radioactive material that have passed through the State and their main routes and focal points (e.g. distribution centres);

— Locations, operators and 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, hospitals including abandoned hospitals,

seaports and airports.

— Nuclear security risks in cooperation with those responsible for nuclear security.

2.102. The emergency preparedness category of off-site jurisdictions should be consistent with their responsibilities in the response to an emergency, as shown in TABLE 2 and as illustrated in *FIG. 4*. Different emergency preparedness categories may be applicable for a governmental jurisdiction (local or national), while typically only one emergency preparedness category can apply to a facility and on-site area. All jurisdictions, as a minimum, fall within emergency preparedness category IV.

2.103. For States containing an emergency preparedness category V hazard[17], the hazard assessment should either be performed in cooperation with the neighbouring State that has the facility in emergency preparedness category I or II, or, if each State performs its own independent hazard assessment, the results should be shared. Both the State with the emergency preparedness category V hazard and the State with the facility in emergency preparedness category I or II would benefit if an emergency response in the two States is coordinated. Thus, response plans between the two States should be coordinated.

2.104. The hazard assessments should be coordinated with assessments of other non-radiological hazards or nuclear security risks in an all-hazards approach, and integrated into the national all-hazards emergency management system to ensure coordination and consistency with relevant national and international emergency preparations and ensuing arrangements for response.

TABLE 2. EMERGENCY PREPAREDNESS CATEGORIES FOR GOVERNMENT JURISDICTIONS

Emergency preparedness 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 an emergency preparedness category I facility	With territory within the emergency planning zones and emergency planning distances of an emergency preparedness category I facility
II	With responsibility for urgent protective actions within the UPZ of an emergency preparedness category II facility	With territory within the emergency planning zones and distances of an emergency preparedness category II facility
III	With responsibility for providing emergency services to an emergency preparedness category III facility, including fire-fighting, law enforcement agencies and medical services	Containing an emergency preparedness category III facility
IV	Applies to all jurisdictions	Applies to all States
V	With areas within emergency planning zones and emergency planning distances[18] in a jurisdiction for a facility in category I or II located in another State	With areas within emergency planning zones and emergency planning distances[18] in a State for a facility in category I or II located in another State

2.105. Once a State has identified all hazards, assigned emergency preparedness categories, assessed and understood the extent and nature of the radiological consequences resulting from possible

[17] Any State that contains areas that are within the emergency planning zones and emergency planning distances for a facility in emergency preparedness category I or II located in a neighbouring State.

[18] See para. 5.38 in GSR Part 7 [2].

emergencies, and coordinated with other relevant hazards and nuclear security risks, the results of these processes should guide the planning and preparation for a emergency management system commensurate with the hazards identified, which is justified and appropriate for the level of hazards existing in the State and its jurisdictions. The hazard assessments should guide the planning for what type of emergency arrangements need to be prepared to ensure an adequate response.

2.106. Periodic review and, as necessary, revision of the hazard assessments is required in order to keep the hazard assessments and associated emergency preparedness and response arrangements current if new conditions appear. In this sense performing the hazard assessments is a continuous process in emergency preparedness and response. An on-going program should be established for guiding periodic reviews and revisions of the hazard assessments, with attention given to the points made in paragraphs 4.25 – 4.26 of the GSR Part 7 [2].

2.107. Documentation should be an integral part of hazard assessments. Throughout the processes described above adequate documentation should be kept to enable a clear understanding of what has been accomplished. The documentation should include but not limited to:

(a) a list of the hazards and their emergency preparedness categories;

(b) which assessment methods have been used for each hazard;

(c) the results of the assessments;

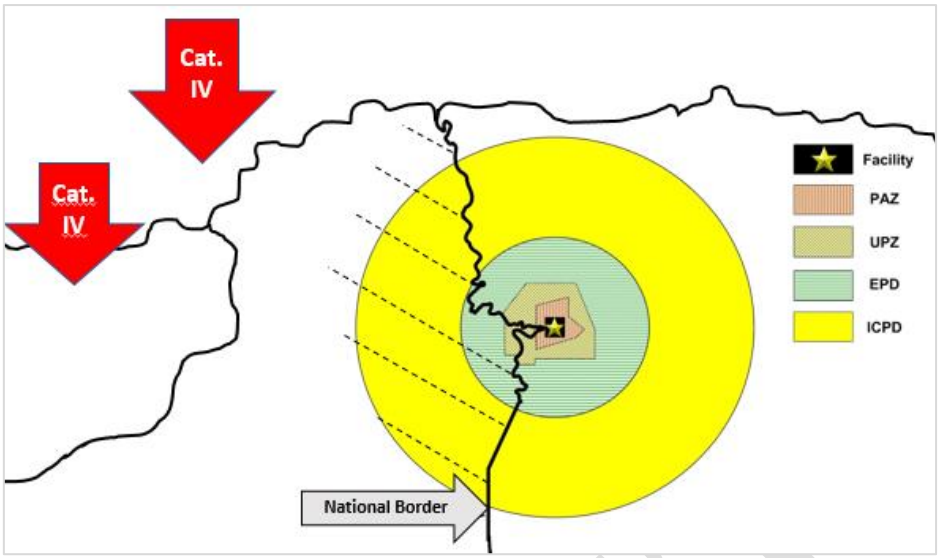
(d) locations on a map of the hazards;

(e) results of the coordination efforts with nuclear security risks and other non-radiological hazards;

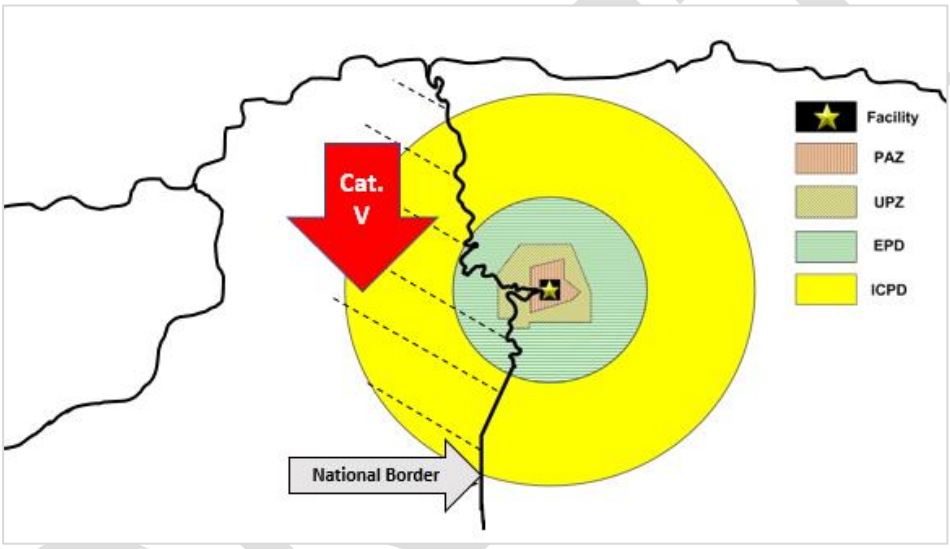
(f) an explanation of the reasons (motivation) for each hazard assessment, to be used in reviewing or revising the hazard assessment (e.g., during periodic reviews or modification in the design);

(g) results of the periodic reviews.

2.108. Throughout the documentation process protection of information of sensitive nature related to nuclear security should be considered [32]. The results of the hazard assessments that should be documented as part of the national emergency management system should be, at the minimum, a list and a map that show the emergency preparedness categories of the facilities and activities, including operators with dangerous sources, and their local jurisdictions.



(A)



(B)

FIG. 4. Emergency planning zones and emergency planning distances, and application of (A) emergency preparedness category IV and (B) emergency preparedness category V

3. FUNCTIONAL REQUIREMENTS

GENERAL

3.1. This section provides guidance for functional requirements that operators, and national, regional and local response organizations should consider in relation to managing operations for responding to a nuclear or radiological emergency in accordance with the performed hazards assessment, and taking into consideration national, regional, local and specific circumstances.

3.2. Functional requirements encompass arrangements that are essential for effective response to a nuclear or radiological emergency in order to achieve the goals of emergency response. These arrangements should build upon the distribution of roles and responsibilities between operating organisation, regulatory body and different response organisations and should ensure a mechanisms for coordination and information exchange between all involved. They should be integrated in the emergency management system and need to apply a graded approach throughout the different phases of an emergency, in compliance with the established protection strategy, required by GSR Part 7 and GSR Part 3[2, 12].

3.3. The full list of required arrangements is provided in section 5 of GSR Part 7 [2]. In the next sub-sections only the arrangements related to the management of operations in an emergency response, the identification and notification of a nuclear or radiological emergency and the activation of the emergency response, taking urgent and early protective actions and other response actions, requesting, providing and receiving international assistance, and analysing the emergency and the emergency response is addressed.

MANAGING OPERATIONS IN AN EMERGENCY RESPONSE

Requirement 6 of GSR Part 7 [2]:

"The government shall ensure that arrangements are in place for operations in response to a nuclear or radiological emergency to be appropriately managed."

3.4. The operations to be performed in response to a nuclear or radiological emergency are numerous and diverse and request the participation of many different organisations. To ensure that the emergency and its consequences are properly managed, clear arrangements should be developed in the preparedness under the leadership of the authority in charge based on the results of the hazard assessment. These arrangements should be consulted and agreed with all relevant interested parties.

3.5. All response organisations involved in a nuclear or radiological emergency need to develop, in the preparedness, their own arrangements documenting how to fulfil their specific role, and functions. These documents (i.e. organisation's plan, procedures and instructions) (see **Appendix VIII**) should specify their own engagement rules, duties and working technique to effectively respond to an emergency. Engagement rules should consider but not be limited to the following:

a. how justified is the response action (for example, sending field monitoring teams in an evacuated area may not be justified because of very high contamination levels while remote monitoring, if available, could be more appropriate solution for such conditions);

b. the operational criteria for initiating emergency response actions;

c. who could be involved or excluded from an implementation of specific response actions and under what conditions (e.g. volunteers, pregnant women);

d. what personal protection equipment is needed for implementation of specific tasks.

3.6. Management of emergency very often assumes involvement of several different response organisations that have to work together and cooperate to minimise the consequences and achieve the goals of the emergency response. For instance, in the event of an emergency with dangerous source in fire firefighters together with search and rescue services evacuate people from the site and pass the injured ones to the medical services for first aid and transportation to the designated hospital while the law enforcement services secures the cordoned off area and organises the evacuation routes. Because of the multifunctional nature, all individual arrangements should be coordinated and integrated with arrangements of other response organisations at all levels. The result of such coordination will be a multiagency emergency response plan.

3.7. Considering the complexity of the response, variety of functions to be carried out and the number of organisations and individuals involved in on-site and off-site response, the use of a Unified Command and Control System (UCCS) is essential to ensure an effective coordination of the response and information exchanges at all levels, including with neighbouring States and international organizations (para. 5.7 of GSR Part 7 [2]). A UCCS enables effective command and control on the site where the emergency has occurred, and off-site. Additional guidance on the UCCS is provided in para. 3.40, and in section 2.5 of Ref. [13].

3.8. The government is accountable for such arrangements. It should ensure that they are exercised in order to:

- check whether these arrangements are fully understood and applied by each participating response organisations,
- identify gaps and possible improvements, and
- improve these arrangements based on lessons learned.

Managing emergency response operations on-site

3.9. An onsite emergency plan and arrangements should be in place to promptly manage the response to an emergency in order to (i) identify an emergency, (ii) activate an emergency management structure with the necessary competence, (iii) request external support, (iv) evaluate the risks and consequences, (v) take the necessary mitigatory and (vi) urgent protective actions at the site and (vii) promptly notify the competent off-site authorities.

3.10. Arrangements should be in place that enable an operator or first responders, when applicable, to promptly identify, classify and notify of the actual or potential nuclear or radiological emergency and to manage the response.[19] These arrangements should include:

a. activation of designated on-site emergency response personnel and organization;

b. notification of on-site personnel of the emergency declaration, (i.e. use of emergency alert systems to enable notification of all on-site personnel); and

c. management of appropriate emergency operations based on implementation of plans and procedures, and actual facility operational conditions, (i.e. designated trained, qualified and competent supervisor/manager responsible for initial on-site response; trained operators and support personnel).

3.11. At the level of the operating organisation (or facility), such arrangements should unambiguously

[19] The detailed guidance on identifying and notifying a nuclear or radiological emergency and activating an emergency response is provided in paras 3.44-3.60.

allow the change from routine operations to emergency operations without compromising the safety and security performance of the affected facility and any other facilities located on the same site or in the close vicinity. When taking mitigatory actions consideration should be given to the safety and security measures needed for routine operations of the facility not impacted by the emergency as well as to the management of emergency response and/or continued operations at collocated facilities to enable management of individual facility and/or multiple facility emergency response activities, if each of them is under emergency conditions simultaneously.

Facilities in emergency preparedness categories I, II and III

3.12. For facilities in categories I, II and III, the operating organisation is required to make arrangements for organizing the on-site emergency response as soon as an abnormal conditions detected that could impair the safety or the security of the facility and give rise to a to an emergency warranting protective actions and other response actions. These arrangements request that:

a. the emergency situation and emergency class is promptly recognized based on emergency action levels (EALs) and other observables that should be defined in the preparedness based on the hazard assessment and the postulated emergency scenarios. A shift supervisor or any other shift member should be assigned the responsibility for classifying, declaring and notifying the emergency.

b. as soon as one of the predefined operational criteria described in bullet (a) is detected and confirmed, the procedures should be in place and used by the operator on declaration of emergency, clearly indicating the transition from normal operation to emergency conditions, and activation of the facility emergency response plans. Procedures should be in place to gather, without delay, an internal emergency management team, convening, by mobilizing the duty officers on calls, the necessary executive and technical experts to fulfil the different emergency management functions. Staffing of the emergency management team should be commensurate to the severity of the declared emergency class.

c. external support (such as fire brigades, law enforcement, medical care, technical teams from other national or neighbouring facilities) is requested whenever needed under the framework of pre-established agreements or contracts which should be elaborated and agreed during preparedness.

d. the internal emergency management team of the operating organisation quickly issues an evaluation of the actual technical situation and the corresponding evaluation of the consequences (diagnostic). The internal emergency management team should at the same time extrapolate on the expected evolution in absence of significant degradation or improvement (prognostic) as well as on potential degradation or improvement of the situation (aggravated or improved prognostic).

e. the operator promptly implements appropriate urgent mitigatory actions in order to quickly regain control of the situation and limit the consequences on-site and off-site. These actions should be implemented by specifically designated and trained on-site emergency personnel, (i.e., those workers designated in advance as emergency workers who are on-site and have to implement mitigatory and other actions).

f. the operator takes all necessary urgent protective actions (e.g. gathering, evacuating non-essential personnel or visitors, sheltering, iodine thyroid blocking) for any person (facility workers, external workers, visitors) present on the site. All non-essential personnel as soon as evacuated from the site should be treated as members of the public and any protective actions

and other response actions decided for the public should be applied to them, as well. In case of incoming support from off-site responders (e.g. fire brigades, law enforcement agencies), the operating organisation should organize the assistance and supervision of the external teams by facility experts.

g. the operator notifies the authorities in charge of the off-site emergency management according to notification schemes as described in its internal emergency plan and procedures and agreed by the emergency management off-site authority. The operating organization should confirm the off-site authorities that its emergency response structure is operational (i.e., once all designated emergency positions are staffed to enable, the responsible emergency response commander should declare and formally announce that full emergency response mode has commenced) and announce who is in charge, (i.e., designation of the emergency manager responsible for all on-site response actions under the unified command and control system). The internal emergency management team should remain in touch with the off-site management authorities, at least until the time the situation is brought under control, to keep them informed of the evolution of the situation on-site and to coordinate the on-site emergency response with the actions implemented off-site. In case of conflicting approach between the on-site and off-site management, the decision of the off-site managing authority should prevail on the decisions to the on-site management.

3.13. The emergency plan of the operating organisation should clearly define the role, responsibilities and tasks of the on-site personnel in an emergency (i.e., any and all teams as well as team leaders responsible for implementing various response actions, e.g. protective actions, radiation measurements, medical, public affairs, etc., should be identified and made known to others for effective implementation of command and control).

3.14. It should be ensured that the transition to operations under emergency conditions (e.g. taking mitigatory or protective actions) does not weaken the routine existing safety and security mesures (e.g. number of qualified operating personnel in the control room, or number and position of site security personnel) or, if they do, that remedial arrangements are foreseen to compensate these impairments. It should be taken into account that, in many cases, routine activities might be affected by the emergency and number and type of these activities might vary. However, despite of that, it is crucial that essential activities for ensuring safety and security should not be discontinued.

3.15. Where several facilities in emergency preparedness categories I or II are located on the same site, the operating organisation(s) should develop adequate response plans and procedures to deal with multiunit events, like the accident at the Fukushima Daiichi nuclear power plant [16], and create an overruling organization to coordinate the mitigatory and protective actions required by the situation at each unit, to allocate the available means depending on the priorities, to care for the protection of responders on-site and to communicate with off-site authorities.

3.16. Additionally, the management of an emergency at a given site should also consider the presence of other facilities of economic or social importance at the same site or in the neighbourhood of the affected site (for instance, chemical industries, food industries, harbours) and develop adequate arrangements to accommodate safety and security measures as well as the management of emergency response and/or continued operations at collocated facilities.

Authorized activities in emergency preparedness category IV

3.17. Authorized activities in emergency preparedness category IV, such as transports of nuclear or radioactive material, activities involving industrial radiography sources or radioisotope thermoelectric generators, under regulatory control, can take place in many locations in a State and

give rise to a nuclear or radiological emergency that necessitates actions to protect the population, the emergency workers and the environment and other response actions. These authorized activities, carried out under the regulatory framework, are subjected to specific requirements by the regulator who should impose to the operating organisation the development of response plans and procedures for nuclear and radiological emergencies [*e.g. SSG-26 (under revision)*].

3.18. For authorized activities in emergency preparedness categories IV, the response plans and procedures developed by the operating organisation should describe the arrangements to organise the first response on the accident site emergency response. These arrangements should allow the driver of the transport, the operator of the source or, if those are in such situation (e.g. unconscious driver of a radioactive transport) that they are not able to act, the first responders arriving first on the site to:

a. promptly recognized the nature and severity of the problem based on predefined indicators (e.g. radioactivity logos, UN marking) or observables (e.g. increased dose rates, damage to the vehicle).

b. implement protective actions such as evacuating and cordoning the area at risk based on a default radius value or measured dose rate and control the access (in and out) to the isolation perimeters.

c. the first responders should promptly take urgent mitigatory actions (e.g. extinguish fire, stabilize and evacuate the victims, isolate the source, organize the traffic) in order to quickly regain control of the situation and limit the consequences. The presence of a radiation or contamination risk should never delay lifesaving actions.

d. organize, without delay, a management team (emergency response command post (ERCP) under the authority of the emergency response commanders with representatives of the rescue teams and of the operating organisation representative present on-site to coordinate the mitigatory and protective action on the site.

e. notify the appropriate authority (e.g. the mayor, the province governor, the national level) in charge of the management according notification schemes as described in the emergency plan and procedures of the operating organization and agreed by the regulatory body. The ERCP should remain in touch with the off-site management authorities, at least until the time the situation is brought under control, to keep them informed of the evolution of the situation on-site and to coordinate the on-site emergency response with the actions implemented off-site.

f. request supplementary external support (e.g. fire brigades, law enforcement agencies, medical care, civil protection, radiological experts).

Illegal acts in emergency preparedness category IV

3.19. Illegal acts in emergency preparedness categories IV, such as the theft or loss of dangerous source, the use of a radiological dispersal device (RDD) or radiological exposure device (RED), can take place in any location and cause a nuclear or radiological emergency that requires the implementation of actions to protect the population the emergency workers and the environment and other response actions. For illegal acts, in absence of claim by the author, the identification of the emergency situation can delay quite a bit before the detection of elevated radiation levels of unknown origin or of commodities with contamination, the identification of clinical symptoms due to exposure to radiation.

3.20. The response plans and procedures for such situations should be developed by national authorities and integrated in the response plans and procedures of local authorities and in the operational procedures of rescue services. These arrangements should allow the first responders arriving first on the site or the medical doctors receiving patients with acute radiation symptoms to:

a. promptly recognized the nature and severity of the situation based on the predefined observables

(e.g. radioactivity signs, radiation burns) or observables (increased dose rates…) and adopt prudent behaviour (e.g. personal protection equipment, active dose rate meters with alarms, limiting the number of emergency teams entering the site area).

b. implement protective actions such as evacuating and cordoning the area at risk based on a default radius value or measured dose rate and control the access (in and out) to the isolation perimeters.

c. the first responders should promptly take urgent mitigatory actions (e.g. extinguish fire, stabilize and evacuate the victims, isolate the source, organize the traffic) in order to quickly regain control of the situation and limit the consequences. A special attention should be given to the protection of evidences. The presence of a radiation or contamination risk or the protection of evidences should never delay lifesaving actions.

d. organize, without delay, a management team (emergency response command post (ERCP)) under the authority of the emergency response commander with representatives of the rescue teams and of the forensics experts present on-site to coordinate the mitigatory and protective action on the site.

e. notify the appropriate authority (e.g. the mayor, the province governor, the national level) in charge of the management according notification schemes as described in the emergency plan and procedures of the operating organisation and agreed by the regulatory body. The emergency response commander should remain in touch with the off-site management authorities, at least until the time the situation is brought under control, to keep them informed of the evolution of the situation on-site and to coordinate the on-site emergency response with the actions implemented off-site.

f. request external support (for example, fire brigades, law enforcement, medical care, civil protection, radiological assessor).

Facilities in emergency preparedness category V

3.21. For facilities in categories I or II located in neighbouring States at planning distances from the border, a State will not be in a position to impose rules to foreign operators. However, bilateral agreements between homologue authorities can lead to operational arrangements to allow prompt notification of an emergency and the exchange of information regarding the actual situation its expected evolution and the consequences. These agreements do not replace the obligation of international notification under the Early Notification Convention [1].

Managing emergency response operations at the level of the off-site authority

3.22. The purpose of off-site response is to protect the public, the emergency workers and the environment. The national authority should develop adequate emergency plans and operational arrangements to cope with possible emergencies concerning installations or activities in the different emergency preparedness categories, based on their hazard assessment. These plans should allow for a graded approach and be flexible enough to adapt to the actual emergency situation and its evolution in time, from the urgent phase, through the transition phase and even after the emergency has been ended.

3.23. The national authority should ensure that their plans and procedures are complemented by plans and procedures by local authorities in a coherent and coordinated manner.

3.24. All plans and procedures at national, regional and local level, should put in place reliable, when possible redundant, communication channels to be notified of and to notify an emergency and exchange information on evaluations, decisions, implementation of follow-up activities all along the emergency situation. These plans should unequivocally state who, or which organization, will have the responsibility to perform a specific function [***GSR 7 Req.2, 20 and 21***]. They should describe their

management structures, the functions[20] to be fulfilled, the working process and the interactions between functions and the mechanism for mobilizing , without delay, these structures in order to start (i) gathering and analysing all (technical, radiological, meteorological, economic, measurement data and etc.) information available, (ii) evaluating the potential (radiological and non-radiological) consequences, (iii) deciding on protective actions to protect the population, the workers and emergency worker off-site, (iv) notifying the other authorities (in homeland, neighbouring States and at international level), (v) allocating available resources and (vi) requesting international support.

3.25. They should describe the coordination and interaction between the management structures at national, regional and local levels, as well as the coordination and interaction with structures put in place by the operating organisation(s) to coordinate actions on-site and by rescue teams to coordinate the implementation of mitigating and protective actions.

3.26. For each type of emergency, a single authority, national or local, should be identified as having leading role, acting under the Unified Command and Control System (UCCS). In general, emergencies involving emergency preparedness categories I, II or V will be typically managed at national level while the management of emergencies involving emergency preparedness categories III will usually remain at local level. Emergencies involving emergency preparedness categories IV could be managed either at national level or local level depending of the nature of the emergency (authorized activity or illegal act), the extent of potential consequences, including media impact, or as the result of a concertation between the concerned authorities. The role and contribution of non-leading authorities should be described: for example, in case of the activation of the national emergency plan, the local authorities will be responsible for the local implementation of the decisions on protective actions taken at national level. When a local authority has the lead, the national authority could be asked to provide some support the local management in terms of expertise, coordination of the means provided by other local administrations in the State, helping for communication.

3.27. The managing authority should have the responsibility to take strategic decisions but should also care for an effective coordination between the different response organisations involved in the on-site and off-site response.

Facilities in emergency preparedness categories I, II and areas in emergency preparedness category V

3.28. Emergencies involving facilities in emergency preparedness categories I, II and areas falling under the category V, are typically managed at national level. The plans and procedures developed at national level should define the organisation put in place and clearly state which institution or authority (Ministry of Interior, Ministry of Emergency Situations, Civil Defence, provincial authorities, local authorities, etc..) will take the lead and those that will assume other functions. They should ensure robust communication channels with local authorities, the affected installation, the responders' off-site and the international institutions and those in neighbouring States to regularly to keep them informed about the evolution of the situation and decisions that are taken, and effectively managed the off-site response in a coordinated manner with the on-site emergency response.

3.29. Specifically, for facilities in category I or II located within planning distances from a border, arrangements should be made in preparedness for coordinating with the neighbouring country(ies) the off-site response and protective actions taken on both side of the border and for providing mutual support [*GSR7 §5.10*]. These arrangements should be based on shared principles that are accepted by

[20] Such functions include "lead", "evaluation", "decision" and "coordination and follow-up of the implementation". For emergencies generated by illegal acts, the management structure needs to include a "security" aspect in these functions.

the parties, including reciprocal trust (e.g. agreement regarding the responsible use and non-disclosure of unofficial information exchanged) and shared knowledge and objectives in order to, harmonize plan and strategies in the preparedness and coordinate the decisions taken in response aiming at the alignment of protective actions along borders. It could e.g. be decided that the country will, in the beginning of the emergency, accept the evaluation of the neighbouring country where the nuclear installation is located and take the same protective actions. Later on, more time will be available and decision on protective actions could be discussed between the two countries.

3.30. In absence of possible collaboration with the neighbouring country, the State should be prepared to rapidly take protective actions and other response actions on its territory based on the (limited) information available.

3.31. The local authorities in charge of the implementation of the decision by the national level should organize the response off-site and implement the protective actions as part of the response strategy and plans or as decided by the national management structure. They should however be allowed to make decide on specific protective actions on their territory, provided they have previously informed the national level and obtained its consent.

Facilities in emergency preparedness category III

3.32. Emergencies involving facilities in emergency preparedness category III will not lead to extensive consequences or affect a wide area as compared to potential emergencies affecting facilities in emergency preparedness categories I and II. They will, typically, be managed at local level (e.g. province, county or municipality). These local authorities are responsible to make emergency response plans based on the hazard assessment for their territory. These plans will obey to the same rules and address similar aspects as the national plans (see above).

Activities in emergency preparedness category IV

3.33. Emergencies involving authorized activities, illegal acts or unauthorized activities in emergency preparedness category IV are not expected to lead to extensive radiological consequences or affect wide areas as compared to potential emergencies affecting facilities under emergency preparedness categories I and II. However, depending on the nature of the initiating event, depending on the area affected (local roads or motorways), depending on the infrastructure of concern (infrastructure of only local interest or national critical infrastructure) the management will be organized at a local level (e.g. province, county or municipality) according to local emergency response plans or will be taken at national level based on the national emergency response plan. The emergency response plans should cover response to emergencies triggered by nuclear security events (e.g. criminal acts or unauthorized acts with nuclear security implications) and therefore should clearly define distribution of roles and responsibilities between different emergency response organisations including law enforcement and intelligence services. The lifesaving actions and essential safety aspects should never be delayed by the protection of evidences, although the decisions taken and their implementation should aim, as much as realistically possible at the preservation of evidences.

Managing emergency response operations off-site by first responders and emergency workers

3.34. First responders and other emergency workers will be in charge of the implementation of the actions decided by the managing authority during the urgent and early response phases of an emergency. Later on, during the transition phase and after the emergency is ended, other workers will be requested to perform less urgent remedial actions. Each emergency and other service will be requested to intervene within the framework of its specific duties and routine missions, however in an environment where a radiation or radiological contamination risk is present.

3.35. GSG-2 [3], GSG-11 [4] and GSG-7 [6] provide further recommendations and guidance on, the protection of emergency workers and helpers in support of the requirements established in GSR Part 7 [2] and GSR Part 3 [12].

Facilities in emergency preparedness categories I, II, III and V

3.36. As required by the GSR Part 7 [2], for facilities in categories I, II and III, and, where appropriate, for areas falling under the category V, arrangements should be made for an **off-site** emergency response to be promptly executed and effectively managed. Facilities in category III are supposed to have very limited or no offsite consequences and therefore require less demanding and extensive arrangements. During the urgent and early response phases of an emergency first responders and other emergency workers will be in charge of the implementation of the actions decided by the managing authority.

3.37. The multifunctional nature of the off-site response and the need for many response organisations to work together and to provide mutual support calls for a good coordination between response organizations (including those of other States) within the emergency planning zones and emergency planning distances.

3.38. The off-site response should also be coordinated with an on-site emergency response to avoid incompatible response actions or conflicts regarding the use of available resources.

Activities in emergency preparedness category IV

3.39. For majority[21] of activities and acts falling under category IV, emergency rescue services will be the first on the scene. They will have to recognize and evaluate promptly the situation and take the urgent protective actions (e.g. evacuation, sheltering, cordoning off the area). They will have to classify the emergency and identify the administrative uppermost coordination and decision level (local, regional or national authority). If no administrative coordination is needed (e.g. in case of limited and localised risk), the coordination of the response could be organised close to the site area in a temporary structure (i.e. emergency response command post (ERCP)) grouping liaisons of the intervening organisations under the leadership of a emergency response commander.

Coordinating on-site and off-site operations and information exchanges

3.40. A Unified Command and Control System is essential to ensure an effective coordination of the information exchanges and response at all levels, including with neighbouring States and international organizations. It provides effective communications within the command, control and coordination structure; between levels; and includes all relevant organizations. A unified command and control system typically consist of three levels:

(a) Operational Level (on-site). The operational level is the on-site level and should be comprised of teams of individuals responsible for performing specific on-site response operations [*Add the reference*]. Depending on the classification of the emergency and the potential consequences, the operational level should:

i. establish a command post with a single individual (emergency response commander) in charge and staffed by the multidisciplinary experts (technical, fire, medical, safety, security, public information, environmental assessment, logistics, etc.) necessary to ensure an effective operational response;

[21] Not for the activities related to the detection of materials out of regulatory control (MORC), which are planned activities and therefore the workers in charge of those activities will be the first to respond.

ii. make decisions for on-site mitigatory actions, protective actions and other response actions;

iii. allocate necessary resources and provide on-site direction to response personnel;

iv. provide protective action recommendations to off-site authorities;

v. ensure coordination and information and data exchange with other levels (Strategic and Policy levels) of the unified command and control structure; and

vi. ensure coordination of public information.

(b) Strategic Level (off-site, local and/or regional). The strategic level is the off-site local and/or regional level and should be comprised of teams of individuals responsible for performing specific off-site response operations. Depending on the classification of the emergency and the potential impact to off-site health and safety, the strategic level should:

i. establish a strategic command post with a single individual (emergency response commander) in charge and staffed by the experts with different expertise (technical, medical, safety, security, public information, logistics, etc.) from the local authorities necessary to ensure an effective off-site response;

ii. ensure an appropriate command, control and coordination structure and effective communications between local and regional off-site centres;

iii. make decisions for off-site mitigatory actions, protective actions and other response actions;

iv. allocate necessary resources and provide off-site direction to response personnel;

v. provide response recommendations to local, regional and national authorities;

vi. ensure coordination and information and data exchange with other levels (Operational and Policy levels) of the unified command and control structure; and

vii. ensure coordination of public information.

(c) Policy Level (off-site, national). The policy level is the off-site National level and should be comprised of individuals at the highest level of National organizations with overall responsibility for National level policy decisions. Depending on the classification of the emergency and the potential impact to human life, health, property and the environment, the policy level should:

i. establish a national command post with a single individual in charge and staffed by the senior leaders of the relevant Ministries that have a role in the emergency response;

ii. ensure an appropriate command, control and coordination structure and effective communications between the various Ministry response centres;

iii. provide National level policy regarding off-site mitigatory actions, protective actions and other response actions;

iv. allocate necessary resources for effective response to off-site and, as necessary, to on-site authorities;

v. ensure coordination and information and data exchange with other levels (Operational and Strategic levels) of the unified command and control structure;

vi. ensure coordination of public information; and

vii. provide international coordination of the emergency, to include request for assistance.

3.41. The roles and responsibilities of the relevant organizations involved in the unified command and control structure should be clearly defined. This should be accomplished through formal arrangements such as written agreements or memoranda of understanding between the various organizations. The extent and complexity of these arrangements should be flexible to allow for the escalation or de-escalation of the command and control structure.

3.42. Effective and well-defined communications arrangements within and between each level of the unified command should ensure coordination, communications, information exchange and knowledge between the different organization resources and teams during a response. Effective communication within each level of the unified command and control structure, between levels and relevant organizations as well as all authorities and the public is critical to managing operations in an emergency response.

3.43. This pre-planning should enable trained and qualified responders to more effectively address possible situations encountered during a response to a nuclear or radiological emergency.

IDENTIFYING AND NOTIFYING A NUCLEAR OR RADIOLOGICAL EMERGENCY AND ACTIVATING AN EMERGENCY RESPONSE

Requirement 7 of GSR Part 7 [2]:

"The government shall ensure that arrangements are in place for the prompt identification and notification of a nuclear or radiological emergency and for the activation of an emergency response."

3.44. Arrangements for prompt identification and notification of a nuclear or radiological emergency and for the activation of an emergency response at different levels of response should be in place for all identified hazards. These arrangements may differ because of the different nature of facilities and activities and involvement of different response organizations.

3.45. For facilities in EPC I, II and III the identification of emergency and declaration of emergency class should be the responsibility of the operating organization, while for activities in EPC IV, due to the specificity of the category and broad range of possible radiological emergencies, the recognition of emergency conditions can be done either by the operator (e.g. car driver), any facility or location that encountered a dangerous source, medical professionals, first responders or by the public. In the event of an actual or perceived transnational emergency, the identification of suspected emergency conditions may come from the neighboring country with EPC V or from any other country (EPC IV) that detected elevated levels of radiation.

3.46. GSR Part 7 states that:

- "The operating organization of a facility or activity in category I, II, III or IV shall 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" (para. 5.14 of GSR Part 7 [2]).
- "The emergency classification system for facilities and activities in categories I, II, III and IV

shall take into account all postulated emergencies, including those arising from events of very low probability. The operational criteria for classification shall include EALs and other observable conditions (i.e. 'observables') and indicators of the conditions at the facility and/or on the site or off the site" (para. 5.16 of GSR Part 7 [2]).

3.47. The classification of the emergency (general emergency, site area emergency, facility emergency, alert, and other nuclear or radiological emergency) should be based on predefined EALs and observables and should not be delayed by awaiting full understanding of the initiating event. Lack of information should conservatively lead to considering the plausible "worst" scenario.

3.48. For facilities in EPC I, II, III and activities in EPC IV, when the operator is known, the EALs should be developed by the operating organisation. For facilities and locations where there is a significant likelihood of encountering a dangerous source that is not under control[22] and for emergencies at unforeseen location the regulatory body should be responsible for development of operational criteria for initiating a relevant response. The EALs should be based on the consideration of the full range of postulated emergencies, including those of very low estimated probability of occurrence (see paras 4.20 and 5.16. of GSR Part 7 [2]).

3.49. The EALs 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 emergency class. The EALs for reactor emergencies should be in accordance with GSG-2 [3]. More guidance on EALs for research reactors is provided in Ref. [33].

3.50. Considering the broad types of emergencies covered by the class 'other nuclear or radiological emergency' (see TABLE 1 and paras 4.21 and 4.22 in GSR Part 7 [2]), the simple declaration of this emergency class is not sufficient and should be accompanied by identifying the type of emergency.

3.51. The regulatory body or any other assigned authority should establish the notification scheme specifying: those emergency response facilities or emergency response organizations who should be immediately notified in the event of a nuclear or radiological emergency; and the time frame required for prompt notification to ensure effective response (see **Appendix V** for recommended time frames for notification). Those facilities, organizations and locations from where the notification may come from should be identified based on the results of the hazard assessment. The notification scheme may vary for different EPCs and emergency classes. TABLE 3 summarizes who is responsible for identification of emergency conditions for different EPCs and provides guidance on notification.

TABLE 3. IDENTIFYING AND NOTIFYING A NUCLEAR OR RADIOLOGICAL EMERGENCY

EPC	Identification	Notification
I & II	Operating organization based on the observables and pre-defined EALs.	Notify: • local/regional authorities within the UPZ[a]; • national authorities if it is foreseen by internal arrangements. Otherwise, local authority should notify national authority. • local authorities in the neighboring States with territories within UPZ[a] (if stipulated in bilateral or multilateral agreements). Otherwise, national authority, should do this.

[22] 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.

EPC	Identification	Notification
III	• Operating organization based on the observables and pre-defined EALs.	Notify local authorities.
	• Public;[b]	Notify first responders (e.g. police, firefighters, ambulance).
IV	• Operator or operating organization if available; • First responders arrived at the site based on observables; • Facility or location encountering a dangerous source based on observables; • Physicians based on the clinical symptoms and information collected form the patient; • Any State based on monitoring results;	Notify local authorities.
	• Public;[b]	Notify first responders (e.g. police, firefighters, ambulance).
V	State with territories within the areas in emergency planning zones and distances of facility in EPC I or II located in the neighboring state based on the monitoring results.[c]	Notify the IAEA and initiate communication with relevant neighboring States, if stipulated in bilateral or multilateral agreements.

[a] PAZ and UPZ for EPC I.

[b] Not responsible for detection of emergency conditions but could be one of those who first appears at the emergency scene.

[c] It may be that no notification was received from the 'Accident State' or the IAEA and the first indication of an emergency is the detection of airborne contamination. A State with an EPC V should have appropriate detection capabilities for continuously monitoring airborne contamination.

3.52. Paragraph 5.11 of GSR Part 7 [2] requires for an establishment of off-site notification point(s), to receive notification of an actual or potential nuclear or radiological emergency. The means for communication with the off-site notification point(s) as well as the means for communication between those involved in emergency response should be redundant to accommodate any breakdowns in the system, and regularly tested (see TABLE VII.3 in **Appendix VII**).

3.53. If an emergency triggered by nuclear security event is suspected appropriate security and law enforcement agencies should be immediately notified.

3.54. For notification of the IAEA about nuclear or radiological emergency and further communication, the States should follow the procedures established by the IAEA in relevant operational publications [34, EPR-IEComm-2019].

3.55. Many emergencies resulting from uncontrolled radioactive dangerous sources are first discovered through reports by physicians who have observed medical symptoms that they suspect to be radiation induced injuries [44, 35]. To facilitate the early recognition of clinical symptoms of radiation exposure, medical facilities should have relevant arrangements in place that will raise awareness of medical personal about effects of radiation exposure (e.g. periodical seminars) and allow collection of necessary information (e.g. predeveloped questionnaire). Medical personal should be aware of the chain of reporting within the medical facility and be trained on actions to be followed to notify about identified or suspected nuclear or radiological emergency.

3.56. The immediate actions that should be taken by operating organisation and off-site response organizations immediately upon declaration of the emergency class or level of emergency response should be in accordance with the guidance in **Appendix IV.**

3.57. Standardized national guidance on the response at the local and national level that encompasses

the types of radiological emergencies 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. [20] (Appendix 7) could provide a basis for the response actions for most of the types of emergency; Ref. [36] should be used for emergencies involving transport.

International Nuclear Event Scale (INES)

3.58. The emergency classification system should not be confused with the International Nuclear Event Scale (INES). The INES is used for communicating to the public the estimated severity of an event after it has happened and well understood and was not developed to be used as the basis for emergency response actions. The emergency classification system looks into the potential consequences of the emergency to determine what needs to be done, and once emergency class is declared, activates the emergency response.

3.59. Paragraph 5.16 of the GSR Part 7 [2] states that "It shall be ensured that any process for rating an event on the International Nuclear Event Scale (INES) does not delay the emergency classification or emergency response actions". Therefore, no rating should be assigned during the emergency response. Any INES rating made during the urgent or early phase of emergency may be subject to change as more information becomes available. More details on use of INES are provided in Refs [5, 37].

3.60. If an INES rating is requested but there is insufficient information available to define precisely a rating, 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 OTHER RESPONSE ACTIONS

Requirement 9 of GSR Part 7 [2]:

"The government shall ensure that arrangements are in place to assess emergency conditions and to take urgent protective actions and other response actions effectively in a nuclear or radiological emergency."

General

3.61. Meeting the goals of emergency response [para. 3.2 in the GSR 7 [2]] needs prompt decisions on and quick implementation of justified and optimised protective actions to avoid doses exceeding the threshold for severe deterministic effects and to reduce the risk of stochastic effects[23]. To be most effective urgent protective actions must be taken as promptly as possible, normally within hours or, even preferably, before any exposure to a radiation source or a significant release of radioactive material. This goal is primarily the responsibility of operators and the off-site response organizations.

3.62. Criteria need be defined at the preparedness stages for protective actions and other response actions. To enable prompt decisions on and quick implementation of urgent protective actions, it is necessary to developed operational criteria as indicators that generic criteria might be exceeded. They

[23] **Annex II** provides more information on radiation induced health effects.

should comprise of observables, EALs associated with conditions observed at a facility or on the site, and operational intervention levels and should be develop at the preparedness stage.

3.63. Depending on the hazard assessment, precautionary urgent protective actions, urgent protective actions could include the following, which are further described in **Annex III** and elaborated in the Appendix III of the Ref. [27, EPR-Protection Strategy]:

- isolation of the contaminated area or radioactive source;
- evacuation;
- control and restriction of access;
- sheltering (short term);
- iodine thyroid blocking (ITB);
- prevention of inadvertent ingestion;
- protection of the food and water supplies;
- restrictions on consumption of food, milk and drinking water and use of commodities;
- radiological monitoring of the public and decontamination of individuals.

3.64. Specific protective actions should also be considered to protect the emergency workers and helpers in the urgent response phase. Such actions include the following:

- respiratory protection (possibly combined with ITB) and protective clothing;
- doses monitoring and recording; and
- control of contamination and decontamination when needed.

3.65. An overview of key urgent protective actions and early protective actions is provided in **Annex III** and elaborated in the Appendix III of the Ref. [27, EPR-Protection Strategy]. This overview gives the objectives and describes each of the protective action; it defines their applicability domain, strengths, weaknesses and limitations; it suggests criteria and time-frame for decision-making, duration and gives considerations for development in preparedness, implementation in response as well as lifting or adapting (including criteria).

Actions in preparedness

3.66. As required by the GSR Part 7 [2] generic criteria shall be defined in the preparedness for decision making on protective actions and other response actions for the protection of the public and for determining whether, when and where the predefined protective actions may be warranted.

3.67. Generic criteria cannot be used directly during an emergency since they are not directly measurable quantities. As part of the preparedness process the States should, therefore, develop pre-established operational criteria such as observables, EALs and operational intervention levels (OILs), considering all relevant emergency preparedness categories and on the basis of the hazard analysis.

3.68. OILs should be developed for radioactive releases and/or direct exposures resulting from nuclear or 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. The default OILs should be consistent with values suggested in [GSG-11, table 3], [GSG-2].

3.69. Planning zones and distances should also be defined of each protective action. They should be established by matching the generic criteria and the results of the hazard assessment and cover the most severe postulated accident. They should be defined also with account taken of the uncertainties in and limitations of the information available when protective actions have to be decided and implemented to be effective. They should include (i) a precautionary action zone (PAZ) (for EPC I only) where emergency arrangements have been made to take urgent protective actions before or shortly after a release of radioactive material or an exposure, on the basis of prevailing conditions at the facility, (ii) an urgent protective action planning zone (UPZ) where urgent protective actions should be prepared and (iii) ingestion and commodities planning distance (ICPD) to protect the public against the consumption of food, milk and drinking water and the use of commodities other than food and also to mitigate non-radiological consequences. Sizes of areas, zones and distances are provided in **Appendix VI**.

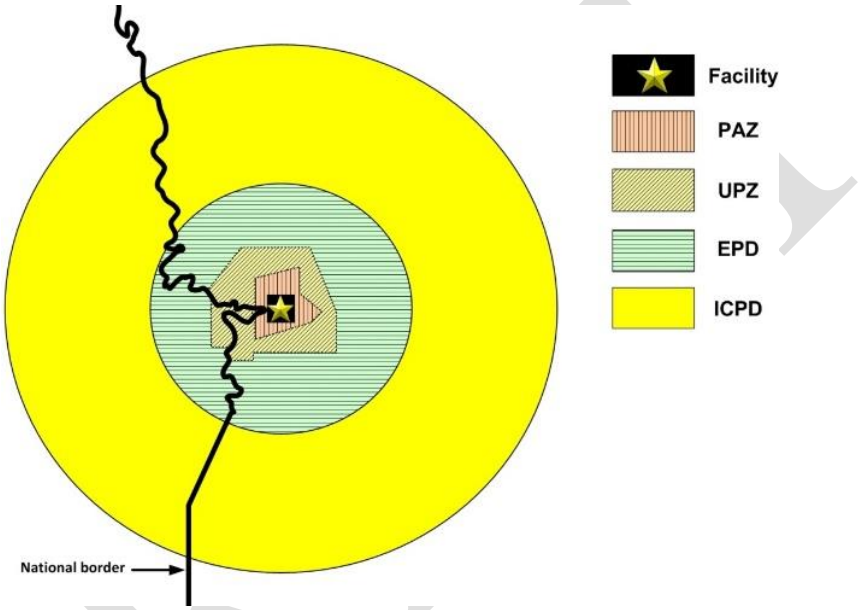


FIG. 5. Off-site emergency planning zones and emergency planning distances

3.70. These planning zones and distances should be used in preparedness to make all operational arrangements which are necessary to effectively implement the protective actions in nuclear or radiological emergency situation.

3.71. However, the actual accidental situation and consequences might often be more limited than predicted for the most severe postulated accident. Implementing the protective actions over the whole planning areas might not be justified. The actual area will be determined on the basis of the prevailing conditions and a mechanism should be developed as part of the response strategy to determine the area at risk and adapt the intervention area accordingly.

3.72. On another hand, the planning zones and distances, which cover most severe postulated accident, might not be sufficient for dealing with unforeseen extreme situation. A strategy should be developed to enable the implementation of protective actions beyond the planning zones and distances.

3.73. Implementation of protective actions requests time and means. The effectiveness of protective actions also depends on the degree of preparation. Therefore, it appears of paramount importance that the State prepares for response at the preparedness stage. This means that the State should among the rest:

- identify for the emergency preparedness categories on its territory and for neighbouring installations the emergency planning zones and distances i.e. the areas where precautionary protective actions (PAZ for category I and V) and urgent protective actions (UPZ for categories EPC I, II and V) might be warranted;
- identify the population, including most vulnerable groups;
- identify schools, enterprises and businesses, hospitals, prisons and other establishments located in these areas which would require specific attention;
- inventory the locally available human and logistic means and the means from other places that could be rapidly mobilized;
- pre-distribute ITB agents (e.g. stable iodine tablets) distributed within the PAZ and UPZ with instructions for use;
- develop a strategy to extend the distribution of ITB agents in areas beyond the planning zone (EPD), if needed;
- identify reliable channels for quickly notifying an emergency on-site and off-site and ordering precautionary and urgent protective actions;
- prepare the isolation of the area, control of access and traffic restrictions;
- prepare evacuation routes and commodities to accept, decontaminate if needed and register evacuees;
- prepare the organization for continuing activities that cannot be (rapidly) stopped and could be jeopardized by sheltering or evacuation (e.g. patients in intensive care, activities in Seveso type industries);
- identify communication means to keep the population informed (media, social media) and to answer their questions (call centres);
- inform periodically the population and responsible of concerned establishments on the arrangements prepared by the authorities and regarding the actions that they should/could take themselves to facilitate the actions of the authorities and better protect themselves (self-help actions);
- inform the emergency workers concerning their role in the implementation of the protective actions, the health risk associated to their actions, the personal protection equipment and the rules of engagement, insisting on the priority for lifesaving actions.

3.74. In order to be effective such arrangements should be discussed in the preparedness and accepted by the public, the emergency workers and other interested parties, including neighbouring countries.

3.75. The State should inform the population concerning these arrangements, providing clear instruction and plain language explanation on the actions expected from the concerned people and on how these protective actions would ensure their safety. This information should be periodically repeated to maintain the awareness, especially when changes are introduced.

3.76. First responders who should initiate the initial urgent protective actions and emergency workers should be duly informed in the preparedness about the health risks associated with their response actions and the use of protective equipment's in order to avoid misconceptions about the radiological risks, which may compromise the initial response. More precisely, they should be

informed that, in the event of an immediate hazard to the victim's life (such as a fire, transport emergency), 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. However, first responders and emergency workers refrain from putting their own life (or lives) at risk for a hypothetical benefit without a quick evaluation and clear justification of their intervention. In other words, putting several lives in imminent danger to extract one single critically injured victim might not be justified.

3.77. 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.

3.78. Guidance for this process is amply documented, step by step, in the Ref. [27].

Actions in emergency

3.79. Precautionary urgent protective actions, urgent protective actions and other response actions need to be taken promptly, generally on the basis of limited and partial information (e.g., observations, model assessments, measurements from fixed monitoring network).

3.80. By lack of time during the urgent response phase, the criteria related to urgent protective actions should be used as such, without adjustment to the actual conditions, unless absolutely required because of extreme conditions.

3.81. Reliable communication mechanisms should be in place to:

- rapidly alert the authorities and other responding organisations and continuously exchange all information relevant for effective management and the radiological protection of the public, the emergency responders and the environment;
- rapidly alert the population at risk about an emergency and to inform them regarding the decided protective actions to be taken.

3.82. Taking protective actions and other response actions would be more difficult and complex in a combined emergency scenario (natural disaster, security event, or disease outbreak/pandemic). This factor should be considered by the emergency planners (at operating organisation, regulatory body, local, regional, national authority) when developing the protection strategy and any emergency plans and procedures.

3.83. 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 could provide the sole basis for the decision on initial urgent protective actions. This is particularly true for emergencies for which protective actions must be effectively initiated before or shortly after a release or for which a release occurs in 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 VI**, or should be determined on the basis of site specific analysis.

Protective actions on-site

3.84. To warrant a prompt and effective response, arrangements must be in place that enable operators of facilities in emergency preparedness categories I, II and III and first responders or rescue

services for activities in the emergency preparedness category IV to promptly identify abnormal radiological conditions and anticipate their evolution and consequences so that protective actions and other response actions are taken without delay to achieve the goals of the emergency response. Development of operational criteria EALs and observables and other arrangements, should allow to effectively and without delay implement urgent protective action for all people present on site immediately after an emergency is declared. Such arrangements should allow for example, gathering, registering and sheltering of all people on the site (e.g., visitors, construction workers, truckers), organizing evacuation from the emergency site and return home of non-essential personnel while ensuring that all routine activities important to ensure safety and security of the facility or radioactive source are still safely performed.

Isolation of the contaminated area or the radioactive source

3.85. Procedure should be in place to rapidly identify and isolate a contaminated area or a radioactive source. The area presenting level of contamination or irradiation above the criteria for evacuation or relocation should be cordoned and the population should be moved to safer places as soon as possible.

Control and restriction of access

3.86. Access to areas from where population have been moved should be controlled to avoid exposure of 'visitors', to limit the exposure of people authorised to enter the area for short periods to realize specific tasks (e.g. rehabilitation workers, farmers for cattle feeding and milking, evacuees to collect belongings, documents, medicines, or to attend to the needs of pets) or to prevent plundering. Check points will need to be organized at entry points to register duly authorized person and to inform them about the conditions imposed by the authorities (e.g. personal protective equipment, dosimetry).

3.87. On exit, a control of the contamination of the persons who penetrated the isolated area and the registration of the dose they received should be organised. This will also contribute to limit the dispersion of radioactivity outside of the restricted area. This could delay safe evacuation of the public from the affected area.

Evacuation of the population

3.88. When large population needs to be evacuated (typically around emergency preparedness categories I), the authorities will need to organize, as soon as a general emergency is declared, traffic corridors and activate evacuation hubs, contamination control and decontamination centres and accommodation centres to be ready to receive the evacuees. It will also necessary to be prepared to cope with (self-)evacuation.

3.89. Transportation means should be organized to allow the evacuation of everyone. Personal means could be used but public and private collective transport means (i.e. busses) as well as military vehicles should be requisitioned to evacuate those who are not able to evacuate by themselves. Special attention should be devoted to evacuate patients from hospitals (especially those in intensive care), seniors from retirement homes, prisoners.

3.90. Before evacuation, the authorities need to invite the evacuees to collect their identity papers, valuables, some cash or other means of payment, prescriptions and necessary medicines necessary for a period of a few days, including stable iodine tablets (where these have been pre-distributed among the population). The authorities need also to instruct or arrange for the population of concern where to go (evacuation hubs) and the directions to take (evacuation routes).

3.91. When planning evacuation, it should be considered that not necessarily all evacuation routes will be available when emergency occurs (for example, due to the weather conditions, fire, traffic jam, construction or maintenance works). Therefore, evacuation plan should have a backup and either

consider additional evacuation routes or envisage other response actions that will not affect the effectiveness of response. Evacuation routs should have sufficient capacity for the number of vehicles that would be needed if evacuation is necessary. Should emergency happen in the facility, emergency routs should be sufficiently wide to accommodate the number of evacuating people.

3.92. The law enforcement services or other emergency workers responsible for verifying that people have been evacuated and controlling the traffic should be informed about the radiological risk and receive adapted individual protective equipment.

3.93. Although justified, evacuation can be staggered in time and space in combination with sheltering, i.e. when and/or where evacuation is not practicable due to bad weather conditions or by lack of means, authorities may wish to delay evacuation and advise sheltering until conditions for a safe evacuation are achieved. For example, depending on the available means, evacuation of large population may need to be executed gradually, starting with the groups or areas most at risk and later extended to groups and areas less threatened, and for which sheltering may be recommended instead.

3.94. In cases when evacuation is ordered up to a given distance while sheltering is recommended beyond, especially if evacuation routes pass through areas subject to sheltering, the sheltered population should be informed of the rationale for the process, in order to facilitate acceptance of such strategy and to avoid self-evacuation. Depending on the available time and/or transport means, priority may be assigned to the movement of infants and children in kindergartens or at school, as the most vulnerable groups.

3.95. At the evacuation hubs, where evacuees will transit, registration, information and advice should be provided for and, if relevant, distribution of stable iodine, medical and psychological support. Evacuees should then be redirected towards contamination control and decontamination centres, when necessary, and accommodation facilities.

3.96. At accommodation centres, the authorities together with helpers should provide the necessary equipment for housing people for a few days.

3.97. To ensure that people do not return until it is safe to do so, and to secure the evacuated area against robbery and plundering, the access to the evacuated areas should be controlled by the police and/or the military [see ‘Control and restriction of access’].

Sheltering of the population

3.98. To effectively implement sheltering, authorities should alarm the concerned populations using a robust system (sirens, public address systems, phone calls, SMS). They should pay particular attention to hearing and/or visually impaired people. During sheltering, the use radio, television and other media should provide complementary, and regularly updated, information and advice.

3.99. Those who do not have access to adequate shelters (e.g. tourists in mobile homes, caravans or tents, dockworkers or sailors in harbours, scout camps) should be invited to shelter in public buildings or evacuated instead. A system for the registration of individuals, information, medical and psychological support will need to be organised for those in public shelters.

3.100. If evacuation routes pass through areas subject to sheltering, clear explanations should be provided to the sheltered population to avoid panic reactions and self-evacuation.

3.101. The access to the sheltered area should be controlled by the police to avoid the entry of people from outside the area (e.g. journalists), while authorized responders provide urgent medical support and take protective actions and other response actions.

3.102. As soon as a general emergency is declared, the authorities need to activate contamination control and decontamination centres outside the sheltered area to receive returning emergency workers and self-evacuees and to be ready to provide information, contamination control and, if needed, decontamination, for the reassurance of the sheltered population once sheltering is lifted.

3.103. While sheltering is ordered, some outside activities must still be conducted (for instance, milking, safely stopping industrial processes) by workers who need to be duly informed of the risks and to be provided with adequate protective equipment. In some activity sectors, where shift work is the rule (e.g. hospitals, prisons), workers may be allowed to get to their workplace although sheltering is in place.

3.104. The population should be advised that good ventilation of the shelter is necessary to clear the inside contaminated atmosphere and replace it by fresh air, once the plume has passed.

Iodine thyroid blocking

3.105. ITB is effective against internal exposure from radioiodine only and will generally need to be administered in conjunction with other protective action (such as sheltering) to protect people from other exposure pathways and other radionuclides. This action can also be implemented in conjunction with evacuation to protect people in case if they are evacuated under the plume.

3.106. To effectively implement ITB, authorities also need a functioning alarm system (sirens, public address systems, phone calls, SMS) to contact the populations concerned. Particular attention should be paid to reaching the populations particularly at risk, including infants and children at school, in kindergarten or in nurseries and those responsible for these groups (teachers, nursery nurses).

3.107. If necessary, a distribution at the time of emergency of thyroid blocking agents to those in the planning zone and extension zones who are missing it should be implemented by emergency workers who are informed about the radiological risk and provided with the adequate protective equipment.

3.108. Arrangements will need to be made for the registration, information, medical and psychological follow-up, control of contamination and decontamination of the concerned population and the emergency workers involved in the just-on-time distribution.

Prevention of inadvertent ingestion

3.109. Recommendations to the public, emergency workers and helpers should be provided to prevent inadvertent ingestions of radioactive material deposited on the skin by regularly washing hands with soap and water especially when returning back home after visiting contaminated area place, manipulation of contaminated objects and, before each meal or smoking. Wearing a face protection such as full-face masks, half-face mask, surgical mask or even a piece of tissue could help when working or just being outside in contaminated areas. The mask has to be changed regularly.

Protection of the food and water supplies

3.110. Recommendations should be provided to protect food stocks and water supplies from contamination. Covering harvested food and cattle feeding stuffs will allow the further use as clean material. Rainwater tanks should be isolated and rainwater collecting pipes disconnected until collecting surfaces are prove to be decontaminated.

Control and decontamination of individuals from the population

3.111. As soon as an emergency is declared, the authorities should activate the contamination control and personal decontamination infrastructure and mobilize all necessary personnel (civil protection, fire brigades, law enforcement agencies, medical and psychological support teams). All necessary information and materials (e.g. information leaflets, registration forms, spare clothes), monitoring equipment and decontamination material should be conveyed to these centres and deployed. The personnel in charge should receive individual protective equipment (including personal dosimetry) appropriate for their specific task.

3.112. The organization of the contamination control and decontamination actions needs to address the case of babies and children, disabled persons, prisoners, religious or philosophical considerations, pets.

3.113. Internal contamination measurements might be needed to complement the external contamination control, especially for those demonstrating excess of predetermined operational criteria for skin (i.e. OIL4) after simple decontamination measures (i.e. change of clothes and shower). For these people, internal exposure resulting from inhalation or inadvertent ingestion may be more significant than external exposure.

3.114. The authorities should ensure that transparent information, advice and medical and psychological support is provided and that the results of the contamination measurements, the decontamination process used and its efficiency are registered for later follow-up, if necessary.

3.115. Plastic bags should be provided for individual clothes and personal belongings together with adequate identification stickers. Measurements of activity levels on the clothes might also be necessary for dose reconstruction, for individuals who have undergone self-decontamination (domestic shower), or to decide whether the clothing may be returned after washing or if it needs to be disposed of as radioactive waste.

3.116. Arrangements for waste management and treatment of decontamination water and contaminated clothes and belongings should be considered.

Restrictions on consumption of food, milk and drinking water and use of commodities

3.117. To avoid the production of foodstuffs contaminated above admissible concentration levels, agricultural remedial actions might be considered such as (deep)ploughing, top soil removal, increased application of fertilizers or amendments [see the relevant section below]. If, despite of agricultural countermeasures, food restriction is expected to remain in force for a long time, an interdiction of production of food products could be decided upon, possibly involving a drastic conversion of the land use and agricultural production in the affected area.

3.118. Substitution of animals' diet with uncontaminated feed, adoption of a selective grazing regime or movement of animals to less contaminated pasture before slaughter is particularly effective at reducing radionuclide transfer to animal products. However, the supply of clean feed to animals will have an economic impact. If an alternative supply of clean feed is not available, drying the dairy cows, moving the cattle to non-affected areas or even slaughtering are possible options.

3.119. Interdiction or restrictions on collecting wild products (mushrooms and berries) may also need to be considered.

3.120. In general, providing advice, monitoring information, and support to the public for self-help actions may be helpful and are relatively inexpensive.

Control and decontamination of individuals from the population

3.121. Authorities will need to consider access restrictions where evacuation, relocation or sheltering is in force. If implemented, checkpoints will need to be installed to monitor and control those authorized to access a restricted area. Lists stating who (e.g. emergency services, medical doctors, rehabilitation workers), when and for what purpose people may be allowed access (e.g. collect personal belongings, documents, medicines, to check on the security of property or to attend to the needs of pets and livestock) need to be defined in the preparedness stage. Duly authorized person will need to be registered at entry, informed about the conditions imposed by the authorities (personal protective equipment, dosimetry), monitored for contamination (and decontaminated if necessary) and registered (access times and exposure dose) on exit.

3.122. The controllers at checkpoints need to be informed about the risk, precautions and protective equipment necessary for their role.

3.123. These arrangements should be regularly re-evaluated to cope with changes in the local situation (population, education, industries) and thoroughly tested through exercises.

TAKING EARLY PROTECTIVE ACTIONS AND OTHER RESPONSE ACTIONS

Requirement 14 of GSR Part 7 [2]:

"The government shall ensure that arrangements are in place to take early protective actions and other response actions effectively in a nuclear or radiological emergency."

3.124. As the emergency proceeds and progresses from the urgent response phase into the early response phase and transition phase, more information becomes available, improving the understanding of the accident and its consequences and allowing more accurate assessments. As the radiological situation becomes characterized sufficiently well and consequences are better assessed, taking early protective actions and other response actions can be considered and implemented when and where needed, in accordance with the protection strategy [2, 12,] and using pre-established operational criteria [see GSR 7 §4.28(4)].

3.125. Entering into the early response phase after precautionary and urgent protective actions have been implemented, lifting or adapting urgent protective actions already in place could be considered. In particular, attention should be given to assessing whether urgent protective actions need to be lifted because they cannot be prolonged (sheltering) or repeated (ITB) or because they are no longer justified (evacuation). Lifting or adaptation of urgent protective actions and implementation of early protective actions, might also be needed to account for any major deviation from the assumptions made at preparedness stage.

3.126. On another hand, new protective actions should also be envisaged in the early response phase and implemented where and when justified taking into account, primarily, the potential of actual radiation exposure of the public and the environment, but also considering how the potential or actual situation varies from the scenario assumed in the beginning of the emergency and how the situation may continue to evolve. These new actions are intended to avert doses delivered over longer periods (weeks to months). A limited delay in their implementation, while measurements are taken and the situation is assessed, would therefore appear to be acceptable.

3.127. The most commonly considered early protective actions and other actions after the urgent response phase include:

- permanent or temporary relocation after evacuation has been lifted;
- permanent or temporary relocation after sheltering has been lifted;
- prevention of inadvertent ingestion and consumption of significantly contaminated foodstuffs and water (e.g. restriction of non-essential local produce, wild berries, wild mushrooms, milk from grazing animals);
- long term restrictions on the consumption of food, milk and drinking water;
- prevent contaminated products to enter the food chain;
- restrictions on the use of commodities that have the potential to result in significant exposures;
- actions to prevent to control the spread of contamination (including access control to areas where evacuation or relocation is implemented);
- decontamination of areas or commodities (e.g. schools, children playground) to further reduce the individual doses;
- extended monitoring, sampling and analysis (also beyond planning zones and distances, if necessary);
- control and decontamination of individuals from the population;
- control of food products and goods aimed for international trade;
- management of the medical and psychological response.
- providing information and advices to Embassies, citizens and travellers in (and travellers from) (an)other affected State(s).

3.128. An overview of key early protective actions is provided in **Annex III** and elaborated in the Appendix III of the Ref. [27, EPR-Protection Strategy].

3.129. In order to be effective such arrangements should be discussed in the preparedness and accepted by the public, the emergency workers and other interested parties, including neighbouring countries.

3.130. To warrant a timely and effective response in the early response phase and transition phase, the State should ensure that arrangements are in place to rapidly obtain suitable relevant information on the actual emergency situation to improve the exposure assessment and to adapt the response consequently. As part of the protection strategy and emergency response plan, arrangements should allow to expand, withdraw or adapt urgent protective actions or to introduce new (early) protective actions and to communicate any decision to the public and other interested parties, providing clear explanation on the rationale behind the decision.

3.131. The situation will need to be assessed in an iterative process in order to make adjustments about the extent to which the protection strategy continues to be appropriate for the hazards posed by the prevailing circumstances. Any further adaptation of the strategy will be based on an iterative process of justification and optimization that takes account of a range of radiological (generic criteria and OILs [3]) and other relevant non radiological factors (see Section 5 in Ref. [27]). The objective is to ensure that the adapted protection strategy continues to do more good than harm and is achieved by the application of justification and optimization processes. In the past (Chornobyl in 1986 and Goiania in 1987), the development of criteria for taking longer term protective actions was driven by public

mistrust and political pressure, resulting in criteria that were not in accordance with generally accepted radiation protection principles.

3.132. The effectiveness of protective actions also depends on the degree of preparation and available time and means. The establishment of the protection strategy and associated plans at the preparedness stage has to clearly identify the infrastructure and the human, technical, and financial resources available to support the expansion, withdrawal or adaptation of urgent protective actions and the implementation of new protective actions.

3.133. The State should inform the population concerning these arrangements, providing clear instruction and plain language explanation on the actions expected from the concerned people and on how these protective actions would ensure their safety. This information should be periodically repeated to maintain the awareness, especially when changes are introduced.

3.134. Emergency workers should be duly informed in the preparedness about the risks associated with their emergency response actions and the use of protective equipment's in order to avoid misconceptions about the radiological risks, which may compromise the initial response. Such information should be refreshed and complemented by specific information relative to the specific response and intervention context should be repeated or provided prior to any emergency response actions ('just on time' training).

3.135. 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, bilateral and international 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.

3.136. Therefore, it appears of paramount importance that the State prepares for emergency response. This means that the State should:

- identify the population, including most vulnerable groups;
- identify communities such as schools, enterprises and businesses, hospitals, prisons and other establishments located in these areas which would require specific attention;
- identify the potential non-radiological consequences of decisions;
- inventory the locally available human and logistic means and the means from other places that could be rapidly mobilized;
- identify the relevant interested parties;
- identify reliable communication channels (media, social media) to keep the population and interested parties informed regarding the removal, adaptation or introduction of protective actions and to answer their questions (call centres);
- prepare the isolation of the area, control of access and traffic restrictions;
- prepare evacuation routes and commodities to welcome, decontaminate if needed, and register late evacuees;
- identify possible source of alternate resources (e.g. non-contaminated food, milk, drinking water, animal feeding stuffs, goods);
- inform periodically the population and relevant interested parties on the arrangements prepared by the authorities and regarding the actions that they should/could take

themselves to facilitate the actions of the authorities and better protect themselves (self-help actions);

- inform the emergency workers concerning their role in the implementation of the protective actions, the risk linked to their interventions, the personal protection equipment and the rules of engagement; should be regularly re-evaluated to cope with changes

3.137. These arrangements should be regularly re-evaluated to cope with changes in the local situation (e.g. population, education, industries) and tested through exercises.

REQUESTING, PROVIDING AND RECEIVING INTERNATIONAL ASSISTANCE FOR EMERGENCY PREPAREDNESS AND RESPONSE

Requirement 17 of GSR Part 7 [2]:

"The government shall ensure that adequate arrangements are in place to benefit from, and to contribute to the provision of, international assistance for preparedness and response for a nuclear or radiological emergency."

3.138. A nuclear or radiological emergency can affect any State, even those with little or no nuclear operations and activities. Although not all States may have capabilities to provide assistance, all States are required to have appropriate arrangements in place (see para. 5.94 of GSR Part 7 [2]) for requesting, obtaining or for providing assistance based on the international instruments, bilateral agreements or other mechanisms. This section provides guidance on the spectrum of aspects to be considered at the preparedness stage and during the response in relation to requesting, providing and receiving international assistance in the event of a nuclear or radiological emergency.

3.139. A request for international assistance should not at any time be used to replace a States responsibility for preparedness and response for a nuclear or radiological emergency. International assistance can be requested when radiological consequences of an emergency, irrespective of its cause, exceed, or are expected to exceed, the State's response capabilities.

3.140. The responsibility to receive and make requests for, and accept offers of, assistance should be clearly assigned. States and relevant international organisations should designate and make known to the IAEA and to other States, directly or through the IAEA, its competent authorities[24] authorized to make requests for, and accept offers of, assistance and their single 24-hour point of contact (i.e. national warning point).

3.141. Depending on the specific national emergency systems in place in States, the functions of the national warning point and competent authorities under the terms of both the Early Notification Convention and the Assistance Convention [1] may be combined and performed by one or more institutions in a State. Unless otherwise informed, the IAEA assumes that the competent authorities nominated under the Early Notification Convention and the Assistance Convention have the authority for issuing notifications/reports and for providing information concerning transnational or transboundary emergencies, as specified in GSR Part 7 [2].

3.142. Arrangements for requesting and receiving international assistance should be included in the

[24] Referred to as competent authorities and points of contact in the Early Notification Convention and the Assistance Convention [1].

national emergency plan and elaborated in corresponding procedures.

3.143. It should be ensured that the arrangements for requesting and providing assistance considers also the combined emergencies.

3.144. During the preparedness stage the competent authority(ies) should develop a strategy for any foreseen requested or provided international assistance. This strategy should, at least, consider the following (as outlined in Refs [34, 38]):

a. the administrative, technical and logistic aspects (e.g. predeveloped request forms, entry points, communication languages, transportation, designation of translators, liaison officers, lodging, nutrition);

b. expected timeline for activation of the national assistance capabilities;

c. the safety and security of field operations personnel;

d. provision of access to the individuals, locations, facilities and information necessary for the successful implementation of the assistance;

e. criteria for the termination of assistance that should go beyond the time criteria but should also take into account relevant technical criteria;

f. financial arrangements.

3.145. Arrangements should be in place to afford privileges and immunities to the assistance mission team for the duration of assistance mission [25].

3.146. All relevant organisation and institutions that may be involved in the provision of, or accepting, offers of assistance (e.g. hospitals, armed forces, laboratories) should be engaged and consulted in the preparedness stage, in order to ensure smooth and timely emergency response. They all should develop and maintain appropriate arrangements and test them periodically.

Providing international assistance

3.147. Assistance could be needed at different levels, from a single individual (e.g. suffering from radiation overexposure) to the national response. The States should identify and determine in advance what type of assistance there are capable to provide (e.g. technical advice and recommendation, equipment, experts, funds, any other resources) and have a mechanism in place (e.g. information exchange) to ensure before the deployment of assistance assets that any such assistance is compatible with the arrangements existing in the requesting State (e.g. equipment, methodologies, criteria for decision making, units). The areas where assistance can be requested and therefore provided includes but not limited to the following: nuclear installation and advice; radiation source search and recovery; radiation monitoring, sampling and analysis; radiological assessment and advise; decontamination; medical support; and dose assessment.

3.148. The identified national assistance capabilities available for international assistance should be made known to other States, directly or through the IAEA, to provide awareness about existing capabilities that can be requested in the event of a nuclear or radiological emergency [1].

[25] In accordance with the Agreement on the Privileges and Immunities of the International Atomic Energy Agency, which was approved by the Board of Governors on 1 July 1959 (see INFCIRC/9/Rev.2)

Requesting and receiving international assistance

3.149. Based on the hazard assessment the State should identify any specialized assistance that could be needed in nuclear or radiological emergency and that could be provided by other States and ensure that formal arrangements are in place to request and receive that assistance. For example, if there is no hospital in the State that can provide highly specialised medical treatment to exposed and/or contaminated individuals as well as for those with combined injuries as a result of a nuclear or radiological emergency, national arrangements should be put in place to request necessary treatment at such a facility through the IAEA under the Assistance Convention [1].

3.150. When requesting for assistance the requesting State should provide at least the following information:

a. Nature of the emergency;

b. Location, date and time when emergency occurred;

c. Emergency description;

d. Name and full address of organization in charge of response actions;

e. Name and contact details of person assigned to liaise with the assisting parties; and

f. Scope and type of assistance required.

3.151. If it is not practicable for the requesting State to specify the scope and type of assistance required, the State, as appropriate, may consult the potentially assisting States or the IAEA upon the scope and type of assistance required.

3.152. The national emergency plan and associated procedures should explain how to coordinate with the assisting parties when providing of, or accepting of, offers of assistance.

3.153. The requesting State should ensure that in a situation when assistance may be provided simultaneously under different agreements or mechanisms, e.g. through IAEA under the Assistance Convention [1] or based on bilateral or multilateral agreements, a coordination mechanism is in place to ensure that provided capabilities are not duplicated.

ANALYSING THE NUCLEAR OR RADIOLOGICAL EMERGENCY AND THE EMERGENCY RESPONSE

Requirement 19 of GSR Part 7 [2]:

"The government shall ensure that the nuclear or radiological emergency and the emergency response are analysed in order to identify actions to be taken to avoid other emergencies and to improve emergency arrangements."

3.154. Once a nuclear or radiological emergency has occurred, the situation provides an opportunity to gain information and knowledge on what was done wrong during both the preparedness stage and the emergency response. Requirement 19 of GSR Part 7 [2] requires the government to ensure that response to a nuclear or radiological emergency is analysed and data and information are gathered that can be used to improve emergency arrangements and to avoid similar emergencies.

3.155. One of the functions assigned to the national coordinating mechanism is the responsibility for coordinating the analysis of any emergency and emergency response that may have occurred (see para.

4.10 (g) of GSR Part 7 [2]). This is particularly relevant if there are different analyses to be performed independently by different organizations or agencies. In fulfilling this responsibility arrangements are required for documenting and preserving data and information needed for the analysis, in line with the requirement 19, para. 5.102 of GSR Part 7 [2].

3.156. An analysis of any nuclear or radiological emergency that has occurred should ensure involvement and contribution from all organizations taking part in the emergency and emergency response. A successful analysis should include, among the other elements, description of preparedness arrangements and how coordination was achieved throughout the emergency response.

3.157. An analysis of a nuclear or radiological emergency should identify, analyse and document the root causes of the emergency. Data and information critical to the cause should be collected and stored. This information and the application of the lessons learned should contribute to preventing or diminishing the consequences of similar or other emergencies.

3.158. Procedures for record keeping of data and information relevant to the emergency response should be established and documented during the preparedness stage. Data and information stored should include, but not limited to, log books including personal logs of actions taken by personnel and organisations involved in the response; telephone or email records or other records of communication between personnel in the same response organization and between different response organizations in a State; decisions taken at all levels of the response organization, including important analyses, information and other relevant factors that supported the decisions taken; records of relevant meetings held at all levels in the response organization including time of meetings, list of participants and minutes; all press releases and information shared with the public and with other relevant interested parties; and all international correspondence and communications.

3.159. Which data and information that should be preserved by the operator, as well as by the emergency response organization at local, regional, and national levels should be decided upon and documented during the preparedness stage. It should be considered that some data have dynamic character and vary with time and/or geographical location (e.g. monitoring data, dose of exposure). An authority or organisation with the responsibility for preserving and storing the data and information from the emergency and the emergency response should be decided upon and assigned in preparedness stage, including how the data and information will be submitted, stored and preserved.

3.160. Some data and information relevant to the emergency and emergency response may have proprietary rights and/or be governed by laws and regulations requiring security clearance for access. Access rights and how to deal with such data and information should be decided upon and documented during preparedness stage. Which laws or regulations exist that govern security clearance for the data or information should be identified. A decision should be taken as to who will have the responsibility for sharing or distributing the results of the analyses.

3.161. A system for data storage should be acquired. It should be preferably an electronic system that is continuously available and that can be used by the various monitoring teams involved in the emergency response. Stored data should include both on-site and off-site monitoring data that are collected by different response organizations. System needs to have storage capacity to also store results of the analysis of the data.

3.162. During preparedness stage, arrangements should be established on how an independent analysis of an emergency or emergency response can be performed. Arrangements should establish requirements for choosing the experts or organizations to perform independent analysis, with consideration given to the need for independence and impartiality, and identify experts or organisations that will have responsibility for the analysis/analyses, How the analysis will be conducted should be

the responsibility of the experts organisations chosen to be responsible for the analysis. Consideration should be given that more than one analysis can be conducted and that the details of each analysis will depend on the type of emergency.

3.163. In preparedness stage, for a nuclear power facility in emergency preparedness category I, a procedure should be established for regular transfer of crucial nuclear reactor data to the appropriate authority for recording and permanent storage.

3.164. If an emergency results in a discharge and/or dispersion of radioactive materials in the environment, outcomes of an analysis should, inter alia, determine total activity and radionuclide composition of the release including chemical composition , geographical distribution of deposits, impact of weather conditions observed during the emergency, and should provide doses received by the public and emergency workers.

3.165. If the emergency involves a radioactive plume which develops and changes with time, processes should be established for reconstructing the source term, the plume movement and deposition, and dose reconstruction. Reconstruction of the source strength of the discharge should be coordinated with available monitoring data. The capacity to carry out processes should be acquired and prepared in the State where such an emergency could occur, or secured through cooperation with another State or with international organizations such as the IAEA or WMO.

3.166. Besides a variety of different technical issues that could have caused the emergency and should be investigated by the analysis, there could also be safety culture issues that contributed to the emergency, and that also should be part of the analysis.

3.167. The analysis should include a review of the arrangements for emergency response plans and procedures. The following questions should be among those considered.

a. Was the emergency management system well established?

b. Were roles and responsibilities well defined at all levels and clear to all those involved in emergency response?

c. Had the occurred emergency been adequately covered in the hazard assessments?

d. Was the prepared protection strategy adequate? Was there appropriate balance between protecting against the radiological versus non-radiological consequences of the emergency?

e. Were the emergency plans at all levels well established and well defined?

f. Were there enough human resources, at all levels?

g. Was there a lack of measurement methods that were needed for monitoring? If so, was it a lack because they don't exist (implying a need for research and development), or a lack because the monitoring personnel were not aware of them (implying a need for better education and training)?

h. Was there a lack of personnel, technical or measurement equipment that was necessary for obtaining the necessary monitoring results?

i. Was the communication plan effective? In answering this question, consideration should be given to both the public communication and to communication between those involved in emergency response, i.e., inter-agency, inter-governmental, governmental-operator-response organisations and international communications.

3.168. An analysis should be performed of the regulatory controls, regulations and regulatory oversight procedures relevant to the emergency response to determine any weaknesses in the regulatory system.

The analysis should determine whether deficiencies in the regulatory system played a role in the cause of the emergency, and if any improvements to or changes in regulatory control are necessary.

3.169. The analysis is required to consider any implications for improving nuclear safety or nuclear security arrangements. These considerations should result in concrete suggestions for improvements in the system for nuclear safety and nuclear security, for example increased coordination on specifically targeted tasks identified in the analysis, which can be implemented in a timely manner.

3.170. Lessons learned are valuable for other States and the international community. There have been extensive lessons learned from both the Chornobyl and the Fukushima-Daiichi nuclear power plant accidents both by the countries in which emergencies have occurred, and international community, as addressed in international analyses and reports, for example from the IAEA and UNSCEAR [16, 39, 40, 41]. Thus, the State should give consideration to make contributions to other relevant analyses, for example analyses from other relevant response organizations or States, either directly or through the IAEA. The results of the analysis and the lessons learned should be shared with other States and relevant international organisations in a transparent manner, when not involving sensitive information (e.g., through publications of the results including relevant data, or organising technical meetings and conferences), with the aim of strengthening the global emergency preparedness and response.

3.171. In summarizing the outcome of the analyses, due consideration should be given to identifying gaps in knowledge and the way these gaps can be addressed in future research and development.

4. REQUIREMENTS FOR INFRASTRUCTURE

AUTHORITIES FOR EMERGENCY PREPAREDNESS AND RESPONSE

Requirement 20 of GSR Part 7 [2]:

"The government shall ensure that authorities for preparedness and response for a nuclear or radiological emergency are clearly established."

4.1. This section elaborates on establishing the authorities for developing, maintaining and regulating arrangements, both on the site and off the site, for preparedness and response for a nuclear or radiological emergency. It provides general guidance on a spectrum of aspects that these authorities should consider when setting the infrastructural elements, essential for fulfilling the requirements for emergency preparedness and response.

4.2. Authorities for emergency preparedness and off-site response should be established under a legal framework. The legal framework should clearly assign who has responsibility, in general terms, at the various jurisdictional levels within the country.

4.3. The establishment of authorities for nuclear and radiological emergency preparedness and response should take into consideration what is already in place taking into account an all-hazards approach and should be consistent with the establishment of a coordinating mechanism as defined in GSR Part 7 para 4.10.

4.4. The establishment of authorities for emergency preparedness and response should take into consideration the legislative practice of the country and may vary from a single legal document to several acts, codes or statutes. Nevertheless, the legal framework should be clear on the assignment of the roles and responsibilities, differentiating between the on the site and off the site response.

4.5. The establishment of the authorities for emergency preparedness and response should take into consideration a graded approach based on a hazard assessment. This will allow alignment with the needs arising from the hazards expected to affect the country and optimize the use of resources, leading to a more efficient response to an emergency.

4.6. The roles and responsibilities needed to establish an effective response may be different from the ones needed to establish an efficient preparedness. The assignment of the responsibilities for emergency preparedness and response should take this fact into consideration.

4.7. The assignment of roles and responsibilities for emergency preparedness and response should take into consideration the need to avoid overlaps, conflicts and gaps, making it clear which authority is in charge for each aspect and phase of preparedness and response for an emergency for both off-site and on-site response.

4.8. The NCM should identify legislation, regulations or plans that may hamper an adequate emergency preparedness and response (e.g. lack of legislation or legislation creating conflicting responsibilities, overlapping of roles and responsibilities) and work with the national organizations to resolve the conflicts or potential conflicts to an adequate response in all the phases of an emergency.

4.9. Roles and responsibilities for preparedness for and response to emergencies irrespective of the initiating cause (i.e. nuclear safety and security related emergencies) should be clearly defined so that the response organizations may draft clear and accurate response plans based on their own legal responsibilities.

4.10. A mechanism for reviewing the assignment of roles and responsibilities of authorities should be in place to take into account lessons from past experiences and exercises. This need for review may arise from several issues, e.g. the assessment of lessons from exercises, drills and real events, changes in legislation or political, social and economic changes.

4.11. A comprehensive legal framework should be developed based on a national policy and fit for the country's needs. This legal framework should address in detail all the roles and functions (as stated in Section 5 of the GSR Part 7), authorities, responsibilities, the delegation of authority, and the responsibilities of stakeholders, specifically differentiating between the different phases of an emergency.

4.12. The assignment of roles and responsibilities of the authorities should address the details necessary for all the levels of the decision making.

4.13. The roles and responsibilities for the exchange of information within a response organization and between response organizations, at all levels, should be clearly assigned, both for the on-site and off-site response. This means it should clearly state: who communicates what, to whom, wen and how, for all the phases of an emergency, aiming to ensure communication clarity and completeness.

4.14. The development of a workable concept of operations for emergency preparedness and response arrangements may require considerable time. In the meantime, agreements should be developed based on a practical concept of operations between the relevant organizations under the existing legal framework.

4.15. During the preparedness stage the NCM should ensure that the personnel with authority and responsibility to perform critical functions in an emergency response, on site or off site, should not have assigned any other responsibilities in an emergency.

4.16. The regulatory body should also ensure that during the evaluation of the emergency plan for a facility or an activity, critical response functions are clearly allocated and that the plan is exercised frequently.

4.17. Communication with the public during an emergency may need approval from several levels of the hierarchic chain, also the content of what is communicated to the public may need input from several organizations. The national coordinating mechanism should ensure that the authority and responsibility for communication to the public is clearly assigned, the flow of information feeding this authority is defined and understood by all the response organizations. The approval process should be focused on providing accurate and verified information in a timely manner.

4.18. The arrangements for delegation and/or transfer of authority for all the relevant phases of an emergency should be specified in the relevant emergency plans, together with arrangements for notifying all appropriate parties of any changes. These arrangements should be trained on a regular basis.

4.19. The authority and responsibility for initiating and implementing initial protective actions off-site should be assigned to the appropriate level of the State's administrative structures (national, regional or local level), This assignment of the authority should be unambiguous, comprehensively defined and with a clear procedure for the transfer of responsibilities between administration levels.

ORGANIZATION AND STAFFING FOR EMERGENCY PREPAREDNESS AND RESPONSE

Requirement 21 of GSR Part 7 [2]:

"The government shall ensure that overall organization 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."

4.20. GSR Part 7 [2] states that:

"…[the] overall organization 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."

It should include the following considerations:

- The need for the interfaces between all response organisations to be established as part of the overall organisation;
- The need to identify the positions responsible for undertaking each response function in each organisation in the emergency plans and procedures;
- The need for the positions responsible for the performance of activities at the preparedness stage to be assigned as part of the routine organizational structures and, where appropriate, in the emergency plans and procedures;
- The need for personal assigned to positions in operating and response organisations to be and remain both qualified and fit for the particular duty assigned
- The need for appropriate number of staff to be available 24/7 to ensure positions can be promptly staffed;
- The need for appropriate numbers of staff to be available to maintain a longer term response, and
- Where there are several facilities on the same site that may be under emergency conditions simultaneously, to ensure appropriate number of on-site staff are available to respond on each facility as well as off-site services are sufficiently staffed to manage response to emergency at multiple facilities.

4.21. The national emergency plan should identify each of the emergency preparedness [units] functions and responsibilities at the national, regional, local and facility levels.

4.22. This description of the organizational relationships and interfaces between all of the major response organisations should be documented in a clear and easily understandable format in an official document (e.g. in the national protection strategy or national emergency plan).

4.23. Each response organization should have explicit and demonstrable means of achieving the following outcomes:

a. Preparation and maintenance of adequate emergency preparedness and response plans to deliver the allocated responsibility;

b. Provision of suitable and sufficient competent and capable emergency response personnel, and

c. Demonstration of emergency response capability through drills and exercises.

4.24. Each response organization should develop an emergency plan that identifies what activities it will undertake during a nuclear and/or radiological emergency and identify who will undertake these roles.

4.25. The specific activities to be carried out; which roles are responsible for implementing specific activities; the organizational structure for the response team, and the interfaces with other response organisations should be documented in the organizational emergency plan.

4.26. The following functions should typically be identified within the plan, together with the details of the specific role or role(s) necessary to undertake the function:

a. Command and control;

b. Provision of information to the public;

c. Liaison with other response organizations;

d. Technical assessment;

e. Personnel protection; and

f. Administrative support.

4.27. Individual response organisations should, either in the organizational emergency plan or a separate formal document, produce a staff baseline that identifies: (a) the numbers of personnel required to undertake each activity, both immediately following declaration of an emergency and over an extended period of time where this may be necessary, and (b) the qualifications and experience necessary to properly undertake identified activities without supervision.

4.28. Personnel should be assigned to specific roles taking account of their individual capability[26] and capacity[27] to undertake the role. Factors that should be considered include qualifications, training on the necessary roles, experience and personal attributes. For example, individuals react differently to stress or fast-moving environments and may not wish or be able to undertake specific roles when considerations such as these are taken into account even if they are suitably qualified and experienced.

[26] The capability to undertake a specific role refers to whether an individual is suitably qualified and experienced to effectively and efficiently undertake a specific role.

[27] The capacity to undertake a role refers to whether an individual has the necessary mental attributes to undertake the role.

4.29. The allocation of specific individuals to emergency response roles should take account of their ability to fulfil the role on the necessary timescales.

4.30. The staff baseline should help identify staffing gaps (taking account of both the numbers available and the capability of those in post to undertake the work) such that corrective staffing measures can be taken.

4.31. The staff baseline should make appropriate allowance for the possible unavailability of staff, either when the emergency is declared or unexpected unavailability during the emergency itself; in particular key roles vital to the effective resolution of the emergency should have alternative staff able to undertake the role available as required so that unavailability of individuals does not affect key emergency management functions.

4.32. There should be a formal process for assessing and confirming the capability and capacity of each person allocated to undertake a specific role in emergency preparedness and response. The assessment and confirmation, together with the record of the outcome, should be subject to a formal quality management system.

4.33. The capability and capacity to act of each person undertaking a specific role should be formally reviewed and re-assessed at appropriate specified intervals, taking account of how regularly they carry out the roles and other practical evidence such as their performance during drills and exercises.

4.34. It may be some of the emergency preparedness and response roles within a specific response organisations plan are populated by personnel from other response organisations and institutions. Where this is the case, justification that the emergency response will be effective at all times should be confirmed, and the arrangements by which said personnel are assessed as competent and capable and available on the timescales required. In addition, procedures will need to be in place to ensure access to relevant sites or locations in a manner and on a timescale which does not hinder the emergency response.

COORDINATION OF EMERGENCY PREPAREDNESS AND RESPONSE

Requirement 22 of GSR Part 7 [2]:

"The government shall ensure that arrangements are in place for the coordination of preparedness and response for a nuclear or radiological emergency between the operating organization and authorities at the local, regional and national levels, and, where, appropriate at the international level."

GENERAL

4.35. GSR Part 7 [2] requires arrangements to be developed and documented for the coordination of emergency preparedness and response between operating organizations and authorities at the local, regional and national levels and, for transnational emergencies, with other States. The organizations and authorities for which coordination arrangements are required include those responsible for the response to conventional emergencies and to nuclear security event.

Coordination within a response organization

4.36. Response to an emergency may require action by different teams and functions within a response organization. Arrangements should be developed by each response organization during preparedness that allow for the coordinated implementation of the assigned response functions by different parts of the organization. The arrangements should include provision for management of the

organization's response, sharing of information between teams within the organization, mobilization and re-allocation of resources, and a mechanism for the prompt resolution of any conflicts.

Coordination between response organizations

4.37. Arrangements between response organizations are essential for effective coordination during an emergency response and should be developed, agreed, documented and tested during preparedness. Such arrangements should include the coordination of on-site and off-site responses and between authorities at different levels (local, regional and national). The arrangements should include the respective roles and responsibilities of different organizations, sharing of information between organizations as well as the interfaces and interoperability of the arrangements. The NCM should ensure that this is attained at the preparedness stage and tested in exercises.

4.38. Coordination arrangements between organizations should be agreed and documented through bilateral/multi-lateral agreements, joint or overarching plans or protocols, memoranda of understanding or other appropriate means. The documented arrangements should be reviewed regularly to ensure they remain valid and effective.

4.39. The documentation arrangements developed should clearly define the concept of operations and operational interfaces between the operating organizations, regulatory body and local, regional and national response organizations. They should define which organizations interact together, where, when and how they interact (e.g. liaison staff at the emergency response centre, telephone, web-based information platforms), and the point-of-contact within each organization. These protocols should be summarized in the emergency plans, for example under the agreements section.

4.40. The coordination arrangements should be supported by a redundant, resilient means for communication and exchange of information between organizations. For example, maintaining a number of diverse systems such as VOIP, conventional landline, cellular/GSM, microwave links, satellite telephone, internet, VPN or Fax. The systems chosen should be tested regularly during preparedness, including during emergency exercises.

4.41. Coordination arrangements between operating organizations and authorities at different levels should be tested regularly through joint drills and exercises. This should include assessing interfaces between organizations, including coordination with organizations responsible for responding to conventional emergencies and to nuclear security events. The interoperability of the plans, arrangements and tools used by different organizations should be assessed and tested during preparedness. For example, interoperability issues may include, but are not limited to, differences in communication networks (e.g., between on-site and off-site organizations or between security and safety organizations) and comparability of results obtained from different decision support tools or radiological monitoring instruments.

4.42. The coordination arrangements should include integration of the radiological/nuclear planning and response arrangements with those established for conventional emergency and nuclear security. This may be achieved as part of an all-hazards plan (ref to Section) or through the Unified Command and Control System (ref to section). Arrangements should be made to provide appropriate training or support to first responders to enable them to recognize and understand, radiation hazards and how to react proportionally to the hazard presented and to carry out their response functions safely. Arrangements should be made to provide access to radiological expertise and equipment for first responders where necessary. This may, for example, be achieved by providing specialised training to a cohort of first responders, or through providing access to expertise in the operating organisation, regulatory body or nuclear/radiological authority.

4.43. The government should designate a single national coordinator who is part of the national

coordinating mechanism and ensure they are provided with sufficient resources to co-ordinate response planning at the national level. Their coordination activities should include review of responding organizations' plans and arrangements in order to identify areas of overlap or interface, facilitate development of coordination arrangements between organizations and resolution of differences and incompatible arrangements. Commitment from all response organizations should be sought to support and facilitate this co-ordination in preparedness.

4.44. Multiple organizations may have roles in the assessment of the emergency and its consequences. In preparedness, the tools, procedures and criteria to be used in assessments of contamination, doses and health effects should be agreed and documented. These should be assessed and tested in emergency exercises to ensure that they can provide comparable results, in order to avoid inconsistency and confusion during an emergency. This should include establishing and testing mechanisms for sharing the information and data on which the assessments are based and the results of the assessments.

4.45. Communicating information to the public quickly is particularly difficult during emergencies and potentially many organizations may have messages to convey. A mechanism for coordinating public information should be established and tested during preparedness to ensure that a consistent message can be delivered to the public. This mechanism could include use of a common electronic information system for sharing press statements and FAQs, a coordinating committee for press officers from different response organizations, organization of joint press conferences, or through other means. A lead Public Information Officer should be a part of the unified command and control system, to coordinate public information with the relevant response personnel and organizations' public information officers. The topic of public information is covered in more detail in GSG 14 [5].

Coordination with other States

4.46. GSR Part 7 requires development of coordination arrangements with neighbouring States that may be directly impacted by a transboundary emergency to ensure consistent and coordinated responses.

4.47. Bilateral or multilateral agreements should be established between neighbouring countries during preparedness. Such agreements should cover arrangements for prompt notification of emergencies, and for the exchange of information in preparedness and during an emergency (see Section on notification, identification and activating response para.__). The IAEA's EPRIMS tool may be used to facilitate sharing of information on arrangements between countries. Where direct negotiation between the States is difficult, the IAEA may be able to assist in fostering the development of agreements between States.

4.48. The information shared between neighbouring States during preparedness should be sufficient to enable compatible arrangements to be developed, particularly where the off-site emergency zones or emergency planning distances extend over the border. Such information should include the basis on which the planning zones and distances were decided, an overview of the protection strategy in place, and arrangements for notification of emergencies and communication with the public.

4.49. During an emergency, the information shared between neighbouring States should include early notification of site and general emergencies, key results of consequence assessments, decisions on public protective actions to be implemented, including the rationale underpinning them, and public warnings and information issued. Confirmation of the point(s) of contact for follow-up queries should be provided in the initial notification message. The information to be shared and how this will be done should be agreed during preparedness.

4.50. If neighbouring States do not have common criteria for protective actions, sufficient information should be shared between States during preparedness to allow them to understand the basis for the

differences and to be ready to explain these differences to the public and media during an emergency.

4.51. The coordination arrangements between States should be tested on a regular basis as part of national or bilateral exercises and updated as required to ensure they remain current and fit-for-purpose.

PLANS AND PROCEDURES FOR EMERGENCY RESPONSE

Requirement 23 of GSR Part 7 [2]:

"The government shall ensure that plans and procedures necessary for effective response to a nuclear or radiological emergency are established."

GENERAL

4.52. GSR Part 7 [2] requires the government to ensure that plans and procedures necessary for effective response to an emergency are established by each response organization, with a plan established at the national level that integrates all relevant plans in a coordinated manner.

4.53. A set of feasible, consistent and coordinated emergency plans should be developed for the facility, local, regional and national levels, regulatory body, other emergency response organisations, as appropriate. The emergency plans and procedures should cover all phases of the emergency and should be developed in a manner that will allow for the effective implementation of the protection strategy [2, 12]. The resulting integrated response should be consistent with the State's concept of operations.

4.54. In line with the all-hazards approach, the nuclear and radiological emergency plans should be consistent and coordinated with those used to respond to other emergencies like conventional emergencies or security events in order to ensure that simultaneous implementation of the plans would not reduce their effectiveness or cause conflicts.

4.55. As described in [*Section on Hazard Assessment; give a para*] the hazard assessment should be used to provide a basis for preparation of the plans and procedures required. The results of this hazard assessment should guide the implementation of a graded approach to emergency preparedness arrangements commensurate with the potential magnitude and nature of the hazards and protective actions and other response actions that may be required. The key aspects of the hazard assessment which have driven the emergency arrangements put in place should be summarized and documented in the relevant emergency plan.

4.56. In addition to the results of the hazard assessment, pertinent information on local factors (such as population demographics, land use, local climate, transport infrastructure, location of vulnerable facilities or populations, local customs and habits, etc.) should be gathered and used to inform the planning basis to be used in developing specific plans and procedures.

4.57. The concept of operations (Section 5) should be included in the relevant emergency plan.

4.58. The roles and responsibilities of each organization (including operating organizations, off-site response organizations, emergency services, regulatory bodies and local, regional and national authorities), team or individual involved in emergency preparedness and response should be identified and assigned on the basis of the concept of operations. The roles and responsibilities to be assigned should include critical tasks required to deliver the following functions:

- Developing and maintaining emergency arrangements, including organizing training, drills and exercises
- Managing operations in an emergency response
- Identifying and notifying an emergency and activating an emergency response
- Taking mitigatory action
- Assessing and anticipating emergency conditions, actual and potential exposures, radioactive releases and releases of other hazardous materials.
- Taking urgent protective actions and other response actions
- Providing information and issuing instructions, warnings and relevant information to the public
- Protecting emergency workers and helpers
- Managing the medical response
- Communicating with the public
- Taking early protective actions and other response actions
- Taking agricultural countermeasures, countermeasures against ingestion and other longer-term protective actions
- Managing radioactive waste
- Mitigating the non-radiological consequences
- Requesting, providing and receiving international assistance
- Conducting recovery operations
- Terminating an emergency
- Analysing the emergency and the response

4.59. Allocation of responsibilities should be carried out in consultation with each relevant individual, team or organization. Once roles and responsibilities are agreed, the assigned individual/team/organization should commit to developing and maintaining the necessary response capability.

4.60. Each organization and level (local, regional and national) should develop the necessary plans and procedures to allow it to execute its assigned roles and responsibilities in response to the relevant hazards identified by the hazard assessment and in line with the protection strategy [2, 12, 27].

4.61. A planning coordinator (this may be an individual, team or committee) should be designated by each organization that may have a role in emergency response. The planning coordinator's roles should include leading on development of the plans and procedures for their organization, coordinating with other organizations where there is an interface in terms of response and working with the overall coordinator or National Coordinating Mechanism to ensure plans are consistent with and integrated into the overall or national emergency plan.

4.62. Plans at the national, regional, local or facility level should be based on the use of harmonized:

- Terminology;
- Concepts of operations;
- Management of emergency operations;
- Organization and functional descriptions;
- Coordination, activation and integration;
- Emergency management facilities and communications;
- Procedures, methods and equipment used for performing common or integrated tasks;
- Training and exercises; and
- Maintenance and quality management.

4.63. The plans and procedures of all the response organizations at different levels should be structured into a coherent and interlocking system, to the extent possible, under the national "all hazards" emergency plan where this exists. Consideration should be given to the following arrangements that may already be a part of the national "all hazards" emergency plan:

- Emergency management;
- Communications technology;
- Logistics;
- Information management;
- Warning the public;
- Evacuation;
- Health and medical care;
- Mass care (i.e. caring for a large number of people who are in need due to an emergency. This may include provision of shelter, food any other supplies); and
- Resources management

4.64. The national emergency plan should clearly describe the roles and responsibilities of all relevant organizations during response to an emergency, the alerting and notification arrangements, responsibility for declaring and terminating an emergency, coordination arrangements, the decision-making processes and criteria, the necessary human resources, information management provisions and the arrangements for carrying out planned protective actions and other response actions.

4.65. The national emergency plan should provide sufficient detail to ensure the roles and tasks that are performed by different organizations can function effectively. The way in which the various organizations will operate together during an emergency should be documented in the Emergency Management System or within the national emergency plan.

4.66. In addition to describing the assigned roles and responsibilities, the national emergency plan should include the objectives of response, the planning basis (including a summary of the hazard assessment), the concept of operations, emergency management and coordination structures and arrangements, logistical arrangements, functional arrangements, and provisions for training, exercising and review of the plan (and associated procedures). A guidance on the content of the national emergency plan is provided in **Appendix VIII**.

4.67. In order to optimize the use of resources and the response effectiveness, response plans should be developed in consultation with all relevant teams (internal) and organizations (external). All authorities and organizations addressed in the plan should be given an opportunity to review the plan prior to its adoption. In addition, consultation with neighbouring States may be helpful in supporting harmonisation of cross-border arrangements, particularly for EPC Category V facilities.

4.68. Emergency procedures are a set of instructions describing in detail the actions to be taken by emergency workers in an emergency. The plans developed should provide the basis for the development of the necessary emergency procedures. The plans and procedures should be highly integrated for maximum effectiveness.

4.69. The emergency procedures developed should have the following characteristics:

- Common structure, appearance and terminology
- Be 'stand-alone' so that it is not necessary to refer to other procedures
- Clearly indicate under what conditions the procedure is to be used
- Identify analytical tools, protective equipment or other resources required to effectively use the procedures

- Identify the response position or team responsible for their performance and what skills are required to execute the procedure
- Be tested under 'simulated' conditions prior to adoption

4.70. The plans and procedures should be subject to regular review to ensure they remain up-to-date and effective. A schedule for their review should be included in the plan or procedure, as well as assignment of who is responsible for initiating the review. The lessons identified from any emergency exercises should be taken into account when reviewing the plans and procedures. In addition to regular reviews, a review of the plans and procedures should be carried out after the response to an emergency. Reviews should be carried out in consultation with all relevant teams and organizations. The reviews should identify any changes or updates that need to be made and an individual, team or organization should be assigned to make each change or update within a given deadline.

LOGISTICAL SUPPORT AND FACILITIES FOR EMERGENCY RESPONSE

Requirement 24 of GSR Part 7 [2]:

"The government shall ensure that adequate logistical support and facilities are provided to enable emergency response functions to be performed effectively in a nuclear or radiological emergency."

4.71. It should be ensured that adequate logistical support and emergency response facilities needed to perform the critical response functions are available, and these should be included in the emergency plan. Logistical support includes tools, instruments, supplies, equipment (e.g. radiological monitoring and protective equipment), vehicles, communication systems and documentation (such as documentation of procedures, checklists, manuals, telephone numbers and email addresses) for performing the emergency response functions. It also includes survival resources and habitability for long term delivery of response activities. The specific emergency response facilities or locations that should be provided are described in **Appendix VII**.

4.72. If some equipment to be used in emergency response is the same as to be used in existing or planned exposure situations it should be ensured that their availability for use in the emergency is not compromised by the other uses.

4.73. All elements of logistical support and facilities should be kept operational and be a subject for the quality management (see para 4.121).

4.74. Equipment and facilities should be in place for each emergency response organization. The responsible organisation should determine appropriate locations of equipment and facilities. Each response organisation should determine whether a dedicated facility is required or if it can be collocated with an existing facility.

4.75. An analysis of needs should be performed to determine the facility function, size and location, and the minimum equipment required. Issues such as inclusion of laboratories for sample analysis, hosting of survey and sampling teams, information and data management, and communications all need to be considered in the design of the facility. The design should take into consideration that the facilities must be usable under emergency conditions and fully integrated into the unified command and control system.

4.76. Arrangements should be made to replace supplies that are likely to be expended, contaminated or need replacement (perishables) such as cables/connectors, batteries, air tanks, filters, clothing,

sample containers, and office supplies should be available.

4.77. It should be ensured that the equipment, procedures and techniques used by different response organizations remain compatible. This includes communication systems (e.g. radio frequencies), power supplies, monitoring and sampling instruments and methods.

Communication system is crucial in emergency response. It should be ensured that upgrades or ongoing revisions to the communications systems (e.g. buying new equipment) do not result in an incompatibility in crucial parts of the response communication system. Regular (e.g. quarterly) communication tests should be conducted between the various response organizations. The communication systems should be resistant to loss under emergency conditions due to network overloading or loss of power. Public telephone systems, including mobile phone systems, should not be relied upon for critical response purposes because of their vulnerability to overloading during emergency.

4.78. It should be demonstrated that the emergency response equipment is adequate for response purposes. This should include tests during which emergency responders use the equipment under possible response conditions (e.g. light, temperature, moisture, weather, field conditions, use while wearing protective equipment). These tests help to identify vulnerability or limitations that should be placed on the use of the equipment.

4.79. The established emergency procedures should include any limitations concerning use of the equipment (e.g. should not be exposed to temperatures below 10°C).

4.80. For EPC I and II facilities on-site emergency response facilities or facilities located within the UPZ should be suitably protected in order to control risks from radiation exposure and other hazards (e.g. high temperatures, chlorine) to emergency workers and to prevent disruption of emergency response functions (e.g. dispatch of monitoring teams) in emergency conditions. Off-site facilities that are not protected against a radiological release (e.g. shielding and filters) should have backups beyond the UPZ. There should be provisions to continuously monitor radiological conditions and control of contamination within the facilities and for evacuation if warranted.

4.81. An on-site technical support centre (TSC) and operational support centre (OSC), separate from the facility control room to serve as meeting place for the emergency staff not directly associated with control room operations should be provided. Information about important facility parameters and radiological conditions in the facility and its immediate surroundings should be made available within the TSC. The facilities should provide means for communication with the control room, the back-up control room, and other important points in the facility, on-site teams, off-site officials in the Emergency Operations Facility (EOF) and other emergency response organizations. Appropriate measures should be taken to protect the occupants for a protracted time against hazards resulting from a severe accident.

4.82. Means should be established within the emergency response facilities (e.g. TSC, EOF, RMAC) to analyse, record, transmit and display information to support effective decision-making. This may include the status of facility systems, weather data, radiological assessments (e.g. dose projections), environmental data, protective action implementation, and the status of response actions. Key data should be synthesized and presented in such a way that it is understandable to the relevant decision makers and any uncertainties associated with the data are clear. The effectiveness of data presentation should be evaluated during exercises.

4.83. Measurement capabilities (fixed or mobile) should be established or identified outside the UPZ for the analyses needed to perform the emergency response functions. This should include analysis of high radioactivity samples (e.g. reactor coolant) and environmental samples. The

measurement capability should be able to provide analysis of facility samples within three hours.

4.84. Laboratory capability should be established or identified to perform analyses of environmental and biological samples (outside the UPZ for category I and II facilities). These laboratories should have arrangements to support and co-ordinate with forensic laboratories and to preserve the "chain of evidence" if requested by law enforcement.

4.85. A single off-site public information centre (PIC) for the release of official information should be established. The PIC should be established as soon as possible (within hours) in the vicinity of an emergency site. All information to be provided to the media should be coordinated by the PIC based on the input from all organizations (facility, local and national authorities) involved in response. Provision of uncoordinated information may result in confusion and unwarranted actions taken by the public. A location, to be used as the PIC, should be pre-established outside the UPZ for EPC I, II and V. For EPC IV the PIC should be established outside of cordoned off area.

4.86. It should be ensured that provisions will be in place to promptly re-supply and obtain additional resources. This should include provisions to bypass normal (time consuming) procurement procedures, to request international radiological assistance through the IAEA or through the bilateral agreements and to expedite the entrance of personnel and equipment into the State.

4.87. Once established, the facility and associated support functions should be tested, and exercised, as discussed in Section on drills and exercises and Appendix 14 of Ref. [20].

TRAINING, DRILLS AND EXERCISES FOR EMERGENCY PREPAREDNESS AND RESPONSE

Requirement 25 of GSR Part 7 [2]:

"The government shall ensure that personnel relevant for emergency response shall 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."

4.88. The requirement for training in emergency preparedness and response should be identified in national regulations.

4.89. The training process consists of three distinct elements:

a. Provision of knowledge and practical ability through classroom based education;

b. Practicing application of those abilities in the actual work environment, (drills); and

c. Demonstration of competence (exercises).

4.90. Every organization involved in the response to an emergency should establish a flexible, fit-for-purpose and proportionate training programme that trains individuals to accomplish all procedures and tasks identified for specific response positions. If procedural requirements change, training should be rapidly updated to account for the change. The aim is to achieve consistently trained and similarly qualified members in each response organization.

4.91. The basic knowledge needed to carry out each role in the emergency response plan should include, but not necessarily limited to, the following:

a. Broad understanding of how the overall response to an emergency will take place;

b. Familiarity with their own organisational emergency plan and interfaces with other

organisations involved in response;

c. Understanding of their own role in the plan and in-depth knowledge of procedures associated with that role;

d. Familiarity with the roles and functions of the other responders within same organisation;

e. Basics of radiation protection.

4.92. The specific knowledge, skills and abilities necessary to undertake each role within each emergency response organization and operational organisation should be determined and documented in each organization's individual training programme.

4.93. The operating organisation and each emergency response organization should ensure that the personnel assigned to positions with responsibilities for certain emergency response functions within the organization have the requisite knowledge, skills and abilities for the position they are in.

4.94. Where response organizations depend on support from external personnel, that response organization should ensure that appropriate periodic training is given to those external personnel and confirm, so far as reasonably practicable, that they are competent to undertake the expected tasks.

4.95. The training and exercise programme should include coverage of the arrangements governing how response organisations coordinate effectively and how those providing essential support (e.g. firefighting, police or medical services) integrate effectively in the facility they are supporting.

4.96. For the purpose of assessing training needs, the organisation should identify all of the positions in the response organization for which appropriately tailored training material is needed. The following positions, as a minimum, should receive formal training:

a. Decision-makers and emergency response commanders;

b. Emergency planners (at the facility, local, regional and national levels);

c. Emergency response co-ordinators;

d. Staff of regulatory authorities (i.e. regulatory body);

e. Qualified experts/radiation protection officers (radiological assessors, technical advisers to decision-makers);

f. Medical personnel: medical doctors, medical specialists, nurses and technicians (supporting personnel);

g. First responders: police, fire fighters, emergency medical personnel (paramedics), civil protection;

h. Public information and communications personnel;

i. Political authorities and civil servants.

4.97. Response organizations should ensure that those persons responsible for training in emergency preparedness and response have the knowledge, experience and training in emergency preparedness and response to deliver effective training.

4.98. The training of all those involved in the emergency response, and particularly those off-site emergency services providers, contractors, and others who have responsibilities for supporting the emergency response but may not regularly work with ionising radiation should be co-ordinated and undertaken in a way that ensures consistency of the emergency response across different response organisations.

4.99. The training programme should be based on a training needs assessment for operating organisation, response organisations and specific response roles. The training needs assessment should determine which personnel need training, the number of people needing training, the core competencies the training is intended to provide and the expected outcomes in terms of what specific personnel need to achieve, when the training should be performed and how often, and the required resources (e.g. human, equipment, tools, funds) for development and running of the training .

4.100. Response organisations should have a prepared training program designed to give, in a timely manner, "just in time training" to those not designated in advance emergency workers and helpers for whom training in advance of an emergency is either not possible or would not be effective or efficient (perhaps because such training would not be used or rehearsed sufficiently often for the knowledge to be embedded).

4.101. Examples of those falling into this category (i.e. emergency workers not designated in advance) should include but are not limited to conventional responders, law enforcement and military personnel who may need to respond to, or prepare for, respond to a nuclear or radiological emergency. Capacity of involvement will be based on the results of hazard assessment.

4.102. The "just in time training" will require brief update on the situation and need for the actions, immediate information about the risks present including radiation risk, information on the exact means of undertaking a task (which may need careful oversight), training on their use and the use of relevant personal protective equipment. should include provision of information and training on, as appropriate, risks associated with the tasks to be implemented including radiation risks, radiation protection, use of detection equipment, and integration with the overall response.

4.103. A system (e.g. tests, evaluations) to ensure that appropriate proficiency levels needed to carry out assigned emergency functions have been achieved and maintained should be developed.

4.104. An effective training programme should ensure:

a. that personnel relevant for emergency response are:

- familiar with the plan, procedures and interfaces, especially insofar as they affect their own role;
- proficient in the performance of assigned emergency functions,
- the right ones for the tasks; and

b. discovering weaknesses in the plans and procedures, which can then be corrected before a real emergency occurs.

4.105. The training programme should consider the level of the training (e.g. its duration, frequency, type and format, and arrangements for performance review) warranted for different personnel carrying out different activities in different phases of an emergency.

4.106. The training programme content should directly correspond to the job task analysis conducted and should have clear documentation as to how the developed training material maps to the core competencies required for the target training audience.

4.107. The precise training course content should be dependent upon the target audience for the training. Training for operational personnel (such as on-site teams for mitigating the consequences of an emergency) will have a different emphasis than training for those managing the response (such as an emergency response commander). For example, considering first responders to a radiological emergency, some of the core competencies that should be considered in the training include:

a. Basics of radiation, radiation protection and exposure pathways;

b. Hazards and personal protective actions;

c. Radiation sources and devices;

d. Past radiological emergencies;

e. Goals of emergency preparedness and response;

f. Concept of operations;

g. Unified command and control system (e.g. Incident Command System);

h. Emergency response facilities or locations;

i. Basic radiation detection instrument operation and interpretation;

j. Contamination control and decontamination;

k. Communication with the public.

4.108. The design of the training programme should clearly identify the entry level requirements for attendees, an overall description of the proposed training, the specific training objectives and how competence and/or performance will be assessed.

4.109. Appropriate subject matter experts should be utilised to develop the training materials, and these should be shown to have been reviewed, piloted and approved for implementation. In the development phase, qualified instructors should be identified, and any course materials (for example, course outline, schedule, lecture slides, notes, working sessions) should be formally documented and be the subject for revision control.

4.110. Appropriate arrangements should be made for the training, including training venue, resources and logistics to attain the predefined training objectives. All personnel involved in giving the training (instructors, administrative support, trainees, etc.) should be competent for the role they undertake. The document control procedure should show how training will be recorded, examination will be held and results will be stored, feedback from the trainees will be collected and used for training improvement, and how instructor performance results will be obtained and utilized within the organization.

4.111. The process for post-training evaluation and identification of key performance indicators should be documented. Evaluation should include both qualitative and quantitative data related to training performance (pre- and post- testing, course content training, etc) and analysis of feedback results. A system for taking corrective actions on the content and delivery of the training material and testing based upon results of the evaluations should be in place.

4.112. The totality of the training programme, from design through to implementation and review, should be subject to appropriate and regular review to ensure it remains fit for purpose.

4.113. The exercise program of an response organization should complement the training program, with the objectives of both co-ordinated to ensure the response will be successful, and that response personnel are both trained and demonstrably competent to undertake the role assigned to them.

4.114. Exercise scenarios should be realistic. The goal should be to generate realistic experience, including realistic timing and advance notice, media interest, workloads, confusion, weather conditions, and emergency progression. Operating organization should periodically participate in exercises together with response organisations.

4.115. Response organisations should ensure that individuals at all levels of seniority that are assigned

to emergency response roles participate in drills and exercises on a pre-defined and regular basis. Substitutes who would not fill those positions during a real emergency should be avoided.

4.116. Participation in exercises should be arranged so that all personnel who may be required to undertake a response role are given the opportunity to demonstrate their competence and understanding. Repeated scheduling of the same individuals should be avoided.

4.117. Exercise performance should be evaluated against pre-established criteria and pre-established response time objectives.

4.118. Detailed guidance on preparation, conduct and evaluation of exercises can be found in Ref. [42].

4.119. Qualification requirements should be established for each emergency response team position and the required training courses/activities listed as part of each responder's qualification credential. Ideally, these responder qualifications credentials should be managed within an electronic training management system, to allow for dynamic tracking of qualification requirements and re-qualification requirements. The latter are as crucial to retaining a highly qualified and high-functioning response organization.

4.120. Training and qualification programs may include:

a. Demonstration of proficiency. For most positions, demonstration of proficiency (as opposed to knowledge) can be satisfied by successful participation in a drill or exercise with minimal assistance from qualified emergency responders. Interim qualification may be granted until participation in a drill or exercise can be completed.

b. Credit for previous training and experience. For purposes of initial qualification, individuals who have previously attended the requisite training and/or demonstrated proficiency in their assigned positions should be given appropriate credit within the training tracking system. In some cases there will be an aspect of the formal training requirements that have not yet been completed. That training or activity should be completed on a suitable timescale to provide assurance that all responders serving in a particular response position have been similarly trained and qualified.

c. Position-specific training. Even similar positions have different roles, responsibilities, and deliverables. Some positions require additional hands-on training sessions and workshops to attain the needed skill set. Training instructors should make every effort to ensure that individuals are ready to assume the duties of a new response position. As people gain more experience in conducting emergency response, it is anticipated that they will progress through different response positions. This would provide that they are qualified for multiple positions during a response. It remains prudent that they undergo some re-familiarization training prior to sitting a position that they had qualified in the past, however, if required this person could then provide needed positions as described in each team's minimum manning requirements. Effort should be made to maintain a person within a single position, even if they are trained for multiple positions, to help with accurate scheduling during a protracted event.

d. Qualification status/documentation. Qualification status is attained when those responsible for managing the response program have confidence that the individual will be able to perform the tasks identified in his or her response position procedures with only a minimal level of assistance from other responders.

QUALITY MANAGEMENT PROGRAMME FOR EMERGENCY PREPAREDNESS AND RESPONSE

Requirement 26 of GSR Part 7 [2]:

"The government shall ensure that a programme is 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."

4.121. Operating organizations and response organizations are required to ensure, through their quality management programme, that logistical support and facilities needed for an emergency response are continuously available and functional. Procedures (e.g. conducting supply inventories, equipment tests and calibrations, and restocking perishable items such as batteries, fuel, and food) and the schedules for performing them should be developed and documented at each organization that has relevant assigned responsibilities for providing logistical support in the emergency response to nuclear and radiological emergency. Performance of these procedures should be documented on a periodic basis.

4.122. Functioning communication systems are crucial during an emergency response, and response operations are particularly vulnerable if critical communication systems fail. A quality control programme shall include arrangements for testing the performance and reliability of all communication systems to be used in emergency response, including all primary and backup communication systems, such as systems designed to warn the public, communication warning message systems for keeping the international community informed and fulfilling obligations under the conventions[28] [1], systems for communicating sensitive information, radio and telephone communication systems, data transfer communication systems[29] and internet or backup internet systems (could be provided by the rescue services or military).

4.123. As required by the GSR Part 7 [2], a quality control programme should contain arrangements for measurement methods and equipment resources for radiological analysis (e.g. monitoring teams and laboratories) to produce consistent, comparable and adequate results. As a part of these arrangements, monitoring teams and laboratories that are responsible for implementing the measurement and monitoring for emergency response, (these can come from, but not limited to, private institutes, universities and/or research laboratories), should take part in inter-comparison exercises or programmes at national or international level, at minimum once a year.

4.124. In order to enable efficient and timely use of data from environmental monitoring and from laboratory measurements of environmental samples during an emergency response, a system for compatible data reporting from different response organisations involved in monitoring should be established. A programme for educating and training all relevant participants on data reporting should be developed and established. The programme should include a procedure for periodic testing of the system through drills or exercises. States should strive to establish a single robust overarching programme, used in emergency response, for data-collection, including backup and redundancy. This

[28] As an example of a verification test for quality control of a communication system, a test, exercise or drill of international communications arrangements could be used, e.g., IAEA's ConvEx-1a exercises that are targeted to test that National Warning Points and are available continuously for receiving notifications.

[29] An example of a data transfer communication system is a system for data flow between field monitoring equipment or on-site facilities to other response organizations or to a central data storage facility operated by a designated responsible organization.

should ensure compatibility between data reported by different sources during an emergency response, and thus directly available for assessments.

4.125. Procedures for recording the amount and, if possible, activity or radionuclide determination of radioactive waste generated in an emergency should be developed and documented. For radioactive waste temporarily stored during an ongoing emergency, records should be made that include as much information as possible, including amount, type of radiation present in the waste, and location of the temporary storage. Arrangements for all records containing the inventory of waste production and temporary storage should be made to ensure the records are stored (archived), protected and include redundant back-ups. These records and inventory keeping should assist in the long-term management and storage of the radioactive waste (para 6.37 of GSR Part 7 [2]).

4.126. Methods should be developed and documented for calibration of monitoring equipment, e.g. field calibrations, and for prompt inter-comparisons of the results between the monitoring teams during an emergency response. Methods shall for include considerations for supplement equipment.

4.127. Methods, including calibration techniques and data standardization, should be established to record and store dose assessments received by the public and emergency workers during an emergency response. The methods should be formulated to ensure compatibility between data reported from different sources. These data should be documented and used in determining any medical follow-ups that may be needed.

4.128. Documented methods should be established and followed for periodically testing the compatibility and operational procedures of measurement equipment, monitoring equipment or other types of equipment designated for use during an emergency response in all relevant response organizations. These methods should be established for both regularly and not regularly used equipment and should ensure that measurement and monitoring results from different response organizations are compatible with each other and easily comparable during an emergency.

4.129. For each role in emergency response, the abilities that are required to carry out the duties should be described and documented in the quality management programme. This is applicable for all positions at all response organizations and authorities at the on-site, local, regional and national levels, i.e., each separate response organization or authority should be able to provide expertise for each type of response position documented in the quality management programme. The documentation should make clear what qualifications are necessary for each emergency response position to be able to carry out the expectations and responsibilities of their roles, such as: level of knowledge (education), ability to use the variety of tools available (equipment, computer programs, etc) and other qualifications ; as relevant to each response position. As a part of a quality control management program, periodic appraisals of the required abilities for each response position should be carried out and documented.

4.130. The schedule for shifts and shift changes in the emergency centre should be outlined in the emergency centre operating procedures and addressed within the quality management programme, including a schedule for overseeing reviewing the personnel list and an exercise scheme.

4.131. Participation in international or national drills and exercises should be evaluated either internally by the participating response organization or externally by an independent consultant. Lessons learned should be taken into account in planning for revisions of the affected plans and/or procedures.

4.132. A flexible training programme that trains individuals to accomplish all procedures and tasks identified for specific response positions should be established. If procedural requirements change, training should be rapidly updated to account for the change. This should provide consistently trained and similarly qualified members of a response organization across the organization to promote a common understanding of response concepts.

4.133. Procedures should be developed, and incorporated in the quality management programme, as required by the GSR Part 7 [2]. The periodic appraisals shall be part of a national or an international independent system[30]. The procedures should incorporate a process for evaluating and, when relevant, implementing the recommendations that result from an appraisal and should include a time schedule for doing so. A process for who is responsible for approving the procedures should be established. All responsible authorities or organisations that have been part of the appraisal (or have been appraised) should receive the appraisal report.

4.134. The regulatory body, or any overarching organization appointed by the government with the responsibility of assessing response capabilities of operating organizations or other response organizations (depending on the State's arrangements) is required to establish procedures for analysing emergencies, emergency responses and assessing exercises to identify any deficiencies in the response actions of the operating organizations or other response organizations[2]. To ensure that appropriate response actions would be taken in the future, any identified deficiencies should be corrected. The time-scale for correcting deficiencies should be documented in the quality management programme of the relevant organization, along with a follow-up procedure to be followed by the regulatory body, or any overarching organization appointed by the government with the responsibility of assessing response capabilities of operating organizations or other response organizations, to ensure corrections have been implemented. Lessons learned that could be useful to or could significantly enhance emergency programmes in other States should be reported to other States through the IAEA.

4.135. A procedure for periodic review of reports on actual emergencies to identify relevant lessons learned should be developed and implemented by the operating organization and response organizations. Responsibility for implementation of corrective actions should be clearly assigned by the relevant operating or response organization and the results of the implementation documented and audited by an independent participant.

4.136. A procedure for analysing an emergency and the resulting emergency response to determine which issues have occurred and what corrective actions are needed should be established. Determination of whether there were failures of, or any other deficiencies in the regulatory process should be included in the procedure.

4.137. An arrangement for regular review and maintenance of the emergency plans and procedures should allow for improving emergency plans and procedures based on lessons learned from actual emergencies, exercises or from any new information obtained from relevant research results. Any critical deficiencies in emergency plans or procedures that are identified should be updated within a shorter set time span, and improvements and modifications that are not critical should be updated within a longer set time span. The programme for maintenance of emergency plans and procedures should include arrangements for updating all perishable or temporary information (for example phone numbers, addresses). The frequency of information update should be based on a judgement by the responsible organization. The decision by the responsible organization may depend on the speed with which information perishes or changes in any given State, but reasonable guidance would be every two to four years, or, after periods of instability.

4.138. Relevant international organizations shall periodically review and update their any new standards, guidelines and arrangements applicable to emergency preparedness and response arrangements using a quality management programme. Reviews and updates shall be based on

[30] Examples of international appraisals include those organized by the IAEA, such as the Emergency Preparedness Review (EPREV) missions.

information from research and lessons from actual emergencies and exercises. Time schedule for reviews, criteria for updating information and record of updates shall be documented.

5. CONCEPT OF OPERATIONS

GENERAL

5.1. GSR Part 7 requires [2] each response organization to prepare an emergency plan for coordinating and performing their assigned response functions. An emergency plan benefits from containing a 'concept of operations' that is defined by the IAEA Safety Glossary [11] as follows:

> "**concept of operations**. A brief description of an ideal response to a postulated nuclear or radiological emergency, used to ensure that all those personnel and organizations involved in the development of a capability for emergency response share a common understanding."

5.2. A concept of operations for relevant scenarios in different emergency preparedness categories should be developed as early as possible during the preparedness stage, to facilitate an efficient preparedness. This section provides a summary of the hazards posed by nuclear or radiological emergencies associated with the different emergency preparedness categories, and an example of a concept of operations for selected specific emergency types for each emergency preparedness category. These examples are generic in nature and should be used as a guide for preparing more detailed country-specific or organisation-specific concepts of operations. The country-specific or organisation-specific concepts of operations should include the identified critical response functions, activities or tasks in emergency response , which organisation or team is responsible for the actions identified, and the pre-determined response time objectives for the actions (see **Appendix V** for response time objectives).

5.3. **Appendix IV** gives examples of different classes of emergencies at facilities and activities in emergency preparedness categories (EPC) I, II, III and IV that are useful in preparing the concept of operations. The arrangements for facilities and activities in emergency preparedness categories I – V should be established in a way to meet the recommendations and response time objectives given in **Appendix V**. The times given in the examples of the concepts of operations provided in this section are consistent with those given in **Appendix V**.

5.4. Overarching operational concepts that are important for achieving the goals of emergency response, and apply when responding to all emergencies, include the following.:

- Arrangements should be operational for the response to operate under an integrated emergency management system using a unified command and control system (UCCS) for emergency response (see para. 5.7 of GSR Part 7 [2]). The UCCS is directed by a single overarching emergency response commander at each of the national, regional and/or local (local/regional), and on-site levels, as appropriate for the type of emergency, who are responsible for directing the activities of all the organizations within each level and for coordinating with the response at each of the other levels (i.e. national, local/regional, and on-site levels) responding to the emergency[31]. This overarching responsibility should be assigned to an individual position in the response organization that has the primary role in each of the levels of the response.[32]

- Arrangements should be operational to promptly provide useful, timely, true, clear, appropriate and coordinated information to the public. This should include arrangements to ensure that the public statements of the operator, local/regional and national officials are coordinated and

[31] The structure of the UCCS is strongly dependent on national political and administrative organization, Also, I suggest referring to jurisdictions instead LEVELS. The distribution of roles among 3 jurisdictions (or levels) may vary from country to country and even in some countries may vary from one region or federal state to another.

[32] Figure 2 and the associated text in Ref. [13] provide a more detailed description of a UCCS for different levels of emergency response.

provide a consistent message to the public. To ensure consistency, a single location should be chosen, if possible, for a public information centre (PIC) (see **Appendix VII**). It should be recognized that this also applies to any event perceived as an emergency by the public or the media.

- Arrangements should be operational for the coordination and exchange of information and active communications between the various response organizations at the international, national, relevant local/regional, and on-site levels to ensure a coherent and smooth handling of the response.
- Arrangements should be operational for the initial response to be guided by pre-determined emergency response actions as part of the protection strategy, in order to ensure that the initial response avoids unnecessary detrimental developments as the emergency evolves.
- Arrangements should be operational for handling both the temporal and geographical sequence of the various phases of emergency and exposure situations, see Ref. [4].

5.5. If additional assistance is needed beyond what a State can provide, national officials should request it through the IAEA (under the Assistance Convention [1]). The IAEA would arrange for additional support and advice. If any foreign nationals are among the exposed, the affected nations and the IAEA should be informed and kept up to date.

5.6. Even if radiation exposure or contamination is suspected in an emergency response, first responders should promptly implement justified life-saving actions (e.g. rescuing persons from a fire) and provide first aid for serious injuries without delay and without waiting for the results of radiological monitoring. At the same time, radiological monitoring should always be initiated as soon as possible to assist in characterizing the radiological aspects of the situation and reduce the exposure of response personnel.

5.7. Strategies to deal with the long-term impact of an emergency should be carefully developed and include consideration of social, psychological and economic factors. Methods for compensation (if any) should be carefully considered and targeted at compensating for the tangible consequences of the emergency (see Ref. [4] for further details). Recovery operations should be subject to the full system of detailed requirements in respect of occupational exposure.

5.8. The concept of operations should be distinguished from the protection strategy. While a protection strategy is a strategic level document developed at the national level that describes the national approach to a nuclear and radiological emergency response to achieve the goals of emergency response, the concept of operations together with emergency plans and procedures constitutes part of the operational arrangements that enable effective implementation of a protection strategy.

EMERGENCY PREPAREDNESS CATEGORIES I AND II

Hazard description

5.9. Facilities in EPC I and II are characterized by their large on-site inventories (source-terms) of dispersible radioactive material that can cause considerable consequences if emergency occurs, for example from airborne or aquatic releases of radioactive material. For significant releases postulated at facilities in EPC I (i.e. general emergencies, see **Appendix IV**), there may be a risk of severe deterministic effects off the site. For facilities in EPC I and II (see TABLE 1), airborne releases could result in doses from exposure that warrant taking protective actions and other response actions to prevent severe deterministic effects or to reasonably reduce the risk of stochastic effects. The risk of deterministic effects is relevant for both on-site and off-site locations for category I facilities and for the on-site location for category II facilities.

5.10. Deposition from significant releases can warrant relocation and the imposition of restrictions on food, milk and drinking water consumption, which could occur at considerable distances. Deposition from major releases can also cause longer term effects on the environment, including the long-term radioecological cycles that can concentrate radionuclides, most commonly radioisotopes of caesium and strontium, in both the terrestrial and aquatic environments and resulting food chains. Discharges from facilities in EPC I and II can include alpha, beta and/or gamma emitting radionuclides, thus the monitoring capabilities should be developed to take this into account (see TABLE III.1 in **Appendix III** for a summary of typical hazards and emergency preparedness categories for selected facilities and activities).

5.11. There could also be emergencies at facilities in emergency preparedness category II involving unshielded criticalities that result in off-site doses (without a significant airborne radioactive release)[33] sufficient to warrant the implementation of urgent protective actions within several hundred metres. Off-site doses arising from criticalities at facilities in emergency preparedness categories II are not predictable with any accuracy and an emergency could result in a very complex pattern of doses off the site, or other hazardous material.

5.12. On-site dose rates during an emergency at facilities in emergency preparedness categories I and II may be very high (e.g. >10 Gy/h) [43], and there is a risk of contamination by radioactive materials and/or being exposed to other hazardous conditions (e.g. emission of steam) in areas where actions by emergency workers may be needed to mitigate the consequences of the emergency.

5.13. The actions taken to respond to the long term consequences of these emergencies may result in serious detrimental social, psychological and economic impacts on the public if they are not based on internationally accepted criteria and if their long term social, psychological and economic impacts are not considered [4].

Concept of operations - general emergency at facility in EPC I (or II)

5.14. The emergency begins with the occurrence of an event at a nuclear facility that results in conditions (e.g. severe fuel damage) warranting taking urgent protective actions off-site before or shortly after a release in order to be effective in protecting the public (see **Appendix IV**).

5.15. Within 15 minutes after detection of the emergency conditions, the operator classifies the emergency and declares a general emergency on the basis of EALs, observables and other indicators of conditions on the site. Declaration of a general emergency triggers a coordinated response by all response organizations. The operator activates the facility's emergency response plan (ERP) and initiates actions on the site that are necessary to mitigate the consequences of the emergency including immediate actions to protect people on-site. The on-site Emergency Centre (EC) and Operational Support Centre (OSC) are activated. Contingency measures are initiated if a nuclear security event is suspected and security response is required. All those responding on site or within the emergency planning zones are considered as emergency workers and protected according to international standards.

5.16. Within 15 minutes after declaration of general emergency, the operator notifies the off-site notification point(s) of the local/regional authorities (according to pre-determined notification scheme) within the facility's emergency planning zones (PAZ and UPZ), and the national authority. Notification is also made through the pre-determined channels to off-site contact points to obtain support (if needed) from off-site emergency services (e.g. the fire brigades in case of fire, the police in case of intrusion,

[33] Criticalities cannot produce sufficient amounts of fission products to result in an airborne radioactive release that would warrant the implementation of urgent protective actions off the site. Nonetheless, it is likely that the energy produced by a criticality would result in the release of other hazardous materials that may be present.

rescue workers) to the activated on-site damage control teams. The Technical Support Centre (TSC) is activated to provide technical assistance for control room operator, on-site damage control teams and off-site emergency services operating on-site. By this time the EC and OSC are fully operational and coordinates and manages all actions on site (see **Appendix VII**). An evaluation of the status on the site and a first evaluation of the potential radiological consequences is provided to the authorities with recommendations on off-site urgent protective actions (e.g. evacuation, sheltering, iodine thyroid blocking (ITB), food restrictions) for protection of the public. The facility staff performs the pre-determined and planned immediate actions as prescribed by the facility's emergency plan.

5.17. Within 15 minutes after being notified by the facility (operator), the emergency response plans (ERPs) and emergency operations facility (EOF) of the local/regional and national authorities are activated (see **Appendix VII**). Communication between the EOF off-site and the facility is immediately initiated. If an emergency triggered by a nuclear security event is suspected, appropriate security and law enforcement agencies are notified. If requested, the local/regional emergency services are ready within 30 minutes after being notified of the emergency to support the on-site responders with, for example, fire brigades, police and medical assistance.

5.18. Within 45 minutes after detection of the emergency conditions, if stipulated in bilateral or multilateral agreements, facility notifies local authorities of the States with territories within the emergency planning zones (PAZ and UPZ). States which territories falling into emergency planning distances (EPD and ICPD) are notified by national authority within 1 hour after notification. If not done by the facility, national authority notifies States within the UPZ, as well.

5.19. Decisions on precautionary urgent protective actions and urgent protective actions off-site are made at the local/regional level, as appropriate according to pre-determined emergency plans. Within 30 minutes after being notified of the emergency, the local/regional authority decides on urgent protective actions (including precautionary) in the PAZ and UPZ. Within 1 hour after being notified, the local/regional authority warns (e.g. by means of sirens) and informs the public within the PAZ and UPZ of the situation and urgent protective actions that are warranted. Following the issued instructions public promptly takes the protective actions. Local monitoring teams are activated and ready to be deployed.

5.20. Within 1 hour after detection of the emergency conditions, the facility has completed implementation of protective actions on-site. The technical support centre (TSC) is fully operational and provides any requested technical assistance. Environmental monitoring is conducted on-site and near the facility (PAZ) by the facility monitoring teams. The facility ensures that all people on the site (including those responding from off the site) have appropriate personal protective equipment and radiation dosimetry.

5.21. As soon as possible after being notified of the emergency, but within 1 hour period, a public information centre (PIC) is activated at the local/regional and national levels to coordinate and provide information to the media and public from all organizations involved in the response, including coordinated briefings between the facility and off-site officials. Joint press briefings are given periodically (at PIC) with participation of the operating organization of the facility and local and national officials to provide a single and understandable message to the public and other interested parties. See reference [5] for detailed guidance on communicating with the public during a nuclear or radiological emergency.

5.22. Within 2 hours after being notified of the emergency, and as soon as conditions permit, the environmental monitoring is initiated at the local/regional level. Local authorities identify and requests any needed assistance from the national authority. National officials activate national monitoring teams and notify the IAEA of the emergency.

5.23. Within 4 hours after being notified of the emergency, the national authority decides on protective actions to be taken in the EPD and ICPD and instructs the public.

5.24. A radiological monitoring and assessment centre (RMAC) coordinates all environmental monitoring, sampling and assessment (see **Appendix VII**). The RMAC is established as soon as possible after the declaration of general emergency in accordance with emergency plan, and fully operational not later than within 6 hours after being notified of the emergency at the local/regional level and within 12 hours at the national level.

5.25. The EOF at the local/regional and national levels are fully operational within 4 hours and 6 hours after notification, accordingly. The Emergency Management System is fully operational (with all emergency response organisations represented) within 12 hours and 24 hours at the local/regional and national levels, respectively. The full emergency response, including all local and national response organizations, is operating under a single emergency management system directed by a single emergency response commander within a unified command and control system. Within 24 hours after being notified of the emergency, any identified international assistance (if any is needed) is requested by the national authority.

5.26. Reception centres are established to register and assess evacuees. Individuals with possible contamination and individuals who have possibly been sufficiently overexposed to radiation are provided with medical screening and triage at the reception centres. Individuals who are assessed as needing highly specialized medical treatment are taken to predesignated medical facilities.

5.27. Within weeks, to months, as long as necessary, the RMAC continues to coordinate monitoring, sampling and assessment to assess based on predetermined OILs the areas where protective actions and other response action have been implemented as a precaution, to determine if these actions need to be adapted or can be lifted, and identify areas where further protective actions may be necessary. The responsible authority communicates with the public of any changes in the protective actions and addresses any public concerns regarding potential health effects by using a pre-established and accepted system for putting radiological health hazards in perspective. The authority also ensures access control and enforcement of restrictions for evacuated areas and areas from which the public has been relocated. The people who need support are provided with the medical care, psychological counselling and adequate social support by designated organizations.

5.28. The media (including websites and social media) is continuously monitored in order to identify and address inappropriate or misleading information that could confuse the public and address new concerns that may arise. Public communication strategy, to deal with the long-term radiological, social, psychological and economic impact of the emergency, is established.

5.29. Where the emergency results in residual contamination of the environment, the affected State develops a programme for dealing with the long term impact according to internationally accepted criteria, and considering the long term psychological, social and economic impacts, see Ref. [4].

5.30. As the emergency develops over weeks to months after the detection of the emergency conditions, both the temporal and geographical variations of the consequences associated with the emergency that can have detrimental effects are handled through a pre-determined protection strategy. When all prerequisites for terminating the emergency are met, all interested parties are consulted, and the emergency transitions to the transition phase and finally to the official termination of the emergency, see Ref. [4].

5.31. This concept of operations is written for facilities in EPC I. Facilities in EPC II would have a similar concept of operations for a general emergency, except for the absence of all actions associated with the occurrence of severe deterministic effects off the site due to on-site events at EPC II facilities, and thus the PAZ zone. By definition EPC II facilities do not result in severe deterministic effects off

the site, even for events not considered in the design.

EMERGENCY PREPAREDNESS CATEGORY III

Hazard description

5.32. Emergencies at facilities in emergency preparedness category III may occur with little warning and could result in significant exposure in areas at the site (e.g., a radiotherapy treatment room). where they involve sources in an exposed (unshielded) position, sources emitting alpha, beta or gamma radiation, or the dispersal of radioactive material resulting in contamination of people, places or objects at the facility (e.g. industrial, research or educational facility). Such dispersal could occur, for example, as a result of a source being melted, ruptured or spilled. In most cases only a limited area (e.g., a treatment room) of the facility is involved.

5.33. While EPC III has no credible emergencies postulated for which urgent off-site protective actions are warranted, such emergencies could cause considerable concern and lead to unnecessary actions being taken among the population and by off-site officials and result in significant adverse psychological and economic consequences if the public or off-site officials are not aware that the emergencies do not pose any risk off the site. However, there may be a risk that contaminated persons, products, packages or equipment leave the site.

Concept of operations

5.34. Within 15 minutes after detection of emergency conditions (e.g., abnormal dose rate measurement in a building or in a room, a leakage of radioactive solution), the operator classifies emergency and declares the emergency class (**Appendix IV**) on the basis of predetermined conditions and EALs. As soon as the emergency conditions are detected, protective and mitigatory actions on-site are initiated without delay and access to all potentially hazardous areas is restricted except for the purpose of saving lives. Life-saving actions and provision of first aid are administered if necessary. The facility emergency response plan (ERP) and the emergency management team (EMT) on-site are activated. Contingency measures are initiated by the operator if a nuclear security event is suspected and security response is required.

5.35. Within 30 minutes after detection of the emergency conditions at the facility, the operating organisation notifies the local/regional authorities and provides the off-site authorities with a first evaluation of any potential radiological consequences, and with any relevant recommendations on the possible need for off-site actions. Emergencies in this class do not present an off-site hazard from the radiation protection ground therefor can include actions necessary due to hazards other than radiological hazards such as exposure to smoke from a fire or to chemical or biological hazards. On-site damage control team(s) are activated and hazardous areas are evacuated and secured. The EMT is fully operational and the operating organisation notifies relevant off-site local/regional emergency services and requests any needed off-site support to the site (e.g. police, fire-fighting services, medical assistance, radiation protection officer or radiological assessor). The requested off-site services and support are provided within 30 minutes after notification. Any further decisions on protective actions on-site are made, which is an ongoing task as new information becomes available. The operating organisation ensures that all emergency workers on the site (including those responding from off the site) have appropriate personal protective equipment and radiation dosimetry.

5.36. Within 15 minutes after being notified of the emergency, the local/regional authority(ies) activate their off-site local/regional ERP. They establish local/regional emergency response command post (ERCP) that is ready to operate at its full capacity within 4 hours.

5.37. The local/regional authority(ies) notify the relevant national authority within 30 minutes after

being alerted of the emergency. Within 15 minutes after that, relevant components of the national ERP are activated and, if an emergency triggered by a nuclear security event is suspected, appropriate security and law enforcement agencies are informed.

5.38. Within 1 hour after detection of the emergency conditions, but as soon as possible, radiological monitoring is initiated on the site to determine areas that need to remain restricted and those that can be reopened based on predetermined OILs. The operating organization finalises implementation of protective actions on-site and requests additional support from local/regional authorities if any is needed.

5.39. The local/regional ERCP activates local monitoring teams within 1 hour after notification and initiates environmental monitoring near the facility within 2 hours after notification in order to confirm that no contamination has occurred and be able to inform the public around the facility that the surrounding environment is not contaminated, and no further actions or restrictions are necessary there. If the operating organisation determines that contaminated individuals or products could have left the site, the off-site authorities are immediately notified and advised on the known facts, in order to determine actions to be taken. Decisions are also made by the local/regional authority(ies) on other response actions. If any are necessary, public is instructed accordingly, within 1 hour after decision is taken. The national officials provide advice, as needed, to the local/regional authority(ies).

5.40. As soon as possible within 1 hour after notification, the local/regional public information centre (PIC) is activated and briefings for the news media are coordinated between the facility and off-site officials. If needed, or if not co-located with the local/regional PIC, the national PIC is activated as soon as possible not later than 2 hours after the national authority is notified of the emergency. Information about the emergency (e.g. what has happened, where, when and if known why; status of emergency response actions taken on-site and off-site) is communicated to the media and the public. The media (including websites and social media) is monitored in order to identify and address rumours and incorrect and misleading information, prevent unwarranted emergency response actions being taken by the public and address new concerns that may arise. Detailed guidance on communication with the public can be found in Ref. [5].

5.41. Within 2 hours after notification, the local/regional authority(ies) may request any necessary assistance from the responsible national authority, which provides that assistance within next 2 hours (or within 4 hours after notification).

5.42. If considered necessary, the local/regional RMAC is activated and operates at required capacity within 6 hours after notification, and the local/regional emergency management system is fully operational within 12 hours after notification.

5.43. If relevant, responsible national authority sends notification to the IAEA (within 12 hours after being informed about the emergency) and requests any needed international assistance (within 24 hours after notification).

5.44. The doses from all exposure pathways are estimated by the RMAC using the data gathered from monitoring and other relevant information collected by the response teams. All those who have incurred exposures exceeding the established criteria for long term medical actions (see Appendix I and II of GSR Part 7 [2]) are registered and referred for follow-up medical actions aimed at early detection and effective treatment of any radiation induced health effects.

5.45. Where serious overexposure or significant contamination of people has occurred, those individuals are identified and taken to designated hospitals for assessment and medical treatment in accordance with pre-established procedures. The operating organisation gathers information concerning the circumstances of the emergency and any other relevant information that will facilitate dose reconstruction and identifying and locating those that could have been overexposed.

5.46. The guidance on terminating an emergency including a facility emergency at a facility in EPC III can be found in Ref. [4].

EMERGENCY PREPAREDNESS CATEGORY IV

Hazard description

5.47. Planning for emergencies in emergency preparedness category IV represents the minimum level of preparedness appropriate for all States. Emergencies in EPC IV are associated with activities or acts leading to an emergency that occurs at an unforeseen location and warrants protective actions. Such emergencies can take some time to be detected and can give rise to severe radiological consequences. These aspects make emergencies in this category particularly challenging during the response. This category includes but is not limited to radiological emergencies involving dangerous sources, transport of radioactive material and emergencies triggered by malicious acts. Examples of specific hazards associated with this category are provided below.

5.48. **Appendix II** provides information on the risks from uncontrolled dangerous sources and **Appendix III** describes the off-site and on-site hazards arising for activities in EPC IV. Reference [20] provides 'action guides' that summarize the hazard and the necessary response to a range of radiological emergencies.

5.49. Dangerous source related emergencies resulting in overexposure or severe overexposure can be emergencies involving:

- Lost dangerous sources;
- Mobile dangerous sources (e.g. radiography);
- Public exposure and/or contamination due to a damaged or unshielded dangerous source;
- Contaminated products, food or water (unintentional);
- Re-entry of satellites containing nuclear or radioactive material;
- Transportation emergency;
- Nuclear security events which trigger an emergency (e.g. use of radiation exposure device (RED) or radiological dispersal device (RDD), or intentional contamination of products, food or water).

5.50. Among the most common types of mobile dangerous sources are radiography cameras. The operator generally handles these sources with limited or no assistance and serious exposure of the operator, other workers or members of the public could result from an inadequate response by the operator and/or a loss of control over the source by the operator.

5.51. Emergencies with contamination and/or radiation exposure of the public may involve the spread of radioactive material for a long period before it is detected. Such emergencies can result from the rupture or dispersal of uncontrolled (lost, stolen or abandoned) radioactive material in the public domain. These emergencies can result in significant doses to people handling the material, potentially resulting in severe deterministic effects, and contamination of members of the public and the wider environment. The Goiânia accident is the bright example of this type of emergency [44]. The undetected melting of radioactive sources into gauges or other metal products is another example. The most important feature of such emergencies is that the source and the scope of the emergency are unknown at the time of detection. These emergencies are often detected through the diagnosis of radiation-induced injuries by physicians or during routine checks, such as monitoring at borders or

entrances to facilities that detects radioactive contamination of people, vehicles, packages or products. In some cases, contamination has been detected in imports, leading to transnational emergencies. By the time contamination is detected the area contaminated and the number of people exposed can be very large [45].

5.52. The re-entry of nuclear-powered satellites into the atmosphere could result in radioactive debris being dispersed over very large areas. In most cases it would be virtually impossible to identify the area of impact in advance with sufficient accuracy to allow effective precautionary protective actions to be taken. For emergencies involving satellites, the risk to human populations is very low because the vast majority of the earth's surface is uninhabited and is primarily connected to someone finding and handling radioactive debris. Re-entry into the atmosphere of a satellite containing radioactive material (e.g. equipped with a thermoelectric generator) could in theory lead to radioactive contamination in the atmosphere with subsequent deposition (not just debris). None of the satellite re-entries to date have resulted in any known cases of significant exposure or the contamination of water or food. Nevertheless, these emergencies often receive intense attention from the international news media.

5.53. Emergencies involving severe overexposures can result from controlled sources such as radiotherapy devices, or from uncontrolled sources such as an abandoned dangerous source. In some cases, equipment, software or human factors (e.g. confusion over the procedures provided by the manufacturer) have been contributing causes. For such cases the risk is that other users (nationally and/or internationally) of similar devices could experience the same problem and further overexposures could occur.

5.54. A transport emergency could result in a release of radioactive material, a loss of shielding or a loss of criticality control. While the standard protective clothing and equipment for respiratory protection used by fire fighters normally provides good protection against radioactive contamination and inhalation of airborne radioactive material, it does not provide protection against penetrating radiation. Thus, if the response to the transport emergency involves significant time being spent close to an unshielded source, there is a risk of overexposure [46].

5.55. Some criminal acts or unauthorized acts with nuclear security implications that are perceived by the public or officials as terrorist acts will warrant a radiological response. These could involve, for example: (a) a radiological dispersal device (RDD) or radiation exposure device (RED); (b) contamination of places, food, drinking water or products; (c) intentional exposure of people; (d) sabotage; or, (e) attacks on facilities including nuclear facilities. The objective of the perpetrators may be to destabilize, spread panic and "terror" among the public with a resulting psychological, social and economic impact. Experience shows that the public's perception of the hazard posed by the threat may be more damaging than the actual hazard.

5.56. A radiation exposure device (RED) is one or more unshielded dangerous gamma sources, deliberately placed in a public location where the intent is for many people to be exposed to high dose rates [Glossary]. The RED's deployment may or may not be announced by the perpetrators and its existence may only be detected due to persons going to hospitals with the symptoms of radiation exposure or by fortuitous radiation measurements. The RED may have been in place for days or weeks before its existence is announced or suspected. People who may not be seriously exposed, contaminated or injured, but have concerns about their health ("worried-well") may go to the local hospitals on their own, thus interfering with the ability of the hospitals to treat those who are injured (especially if those that are injured arrive later). The principal hazard with a RED is external irradiation. The doses received may be sufficient to cause localized radiation injuries, severe deterministic effects and even death. Exposure may warrant long-term medical follow-up or it may be too low to warrant any longer-term medical actions because of the lack of health concerns. But in all cases, there will be considerable concern among the public that they may have been exposed, irrespective of their

exposure.

5.57. The dose and health impacts for people would depend on factors including the source characteristics (isotope and activity), construction of the device, level of exposure received (depending on proximity to source, time spent near the source and shielding effects from objects and other people) as well as the health status of those exposed (e.g., pregnancy, pre-existing health conditions). It is very unlikely that there would be any severe radiation induced health effects among those who were more than about 10 m from the RED. It would most likely require a large dangerous source with an activity 10 times the D_1-values in **Appendix II** to result in a serious injury. There may be more than one source as well as hoaxes once the occurrence of the RED is publicly known.

5.58. If a radiological dispersal device (RDD) fails to explode or the explosion is incomplete, it still may present both an external radiation hazard to those nearby and a contamination risk. If the source remains mainly intact, there is still a risk for the device to explode. If the device is effective in dispersing the radioactive material in an explosive blast and plume, the greatest radiological hazard comes from:

- radioactive particles or shards from the source blasted into victims;
- inhalation or inadvertent ingestion of the material dispersed by the explosion, fire, or from handling the radioactive debris.

However, attention should be given that explosive threat and physical hazard of RDD is far more significant comparing to the radiological hazard.

5.59. A RDD containing a large dangerous source with an $\left[\frac{A}{D}\right]$ ratio greater than 10 in accordance with **Appendix II** would be required to result in dispersal of material that is life threatening. The radiological risk is likely to be limited to a distance within about 100 metres of the explosion. However, the recommended inner cordoned off distance is set at 400 m (see **Appendix VI**) to protect against the effects of the explosion and possible pieces of radioactive debris. If the device contains an alpha emitter (e.g. plutonium, americium, polonium), resuspension of the radioactivity on the ground could be hazardous near the source due to inadvertent inhalation or ingestion. The location where the RDD was assembled, those involved in the assembly and the route or means by which it was transported are likely to be contaminated. During assembly and transport, people, including the public, may be exposed that could result in severe deterministic health effects. There may be more than one RDD, and there may be hoaxes once the nuclear security risk is publicly known.

Concept of operations

General steps in the concept of operations applicable for the different emergency types in EPC IV

5.60. The response organization for a nuclear or radiological emergency in EPC IV may be composed of elements drawn from authorities at the national or the local/regional levels and organizations responsible for the first response to an emergency involving hazardous material (e.g. radioactive material), conventional hazards (e.g. fire), or criminal acts (e.g. theft or terrorism). All of these elements should form a single coordinated response organization (i.e. unified command and control system) within an all-hazards emergency management system that is structured to take into account the concerns of the various elements in the response, such as the need for the collection of evidence, while also ensuring the safety of the responders, in particular with respect to nuclear or radiological materials. This is true for all emergencies in the five EPCs, but particularly relevant for EPC IV because of the wide variation of emergency types.

5.61. Nuclear or radiological emergencies in EPC IV may result from natural phenomena, accidents, criminal acts or unauthorized acts with nuclear security implications. Due to the many differences in

the emergency types in EPC IV, the concept of operations will also vary. Also, since the cause or the source of exposure associated with an emergency can be either known or unknown, the starting point or time of a response is difficult to generalize. In this section, and in the response time objectives given in **Appendix V** for EPC IV, the starting point for the on-site response is defined as either the detection of emergency conditions by an operating organization, or, if an operator is unconscious or doesn't exist, when first responders arrive at an emergency site area, or a facility or location (e.g., airport, border crossing point, seaport, customs entry points) where a dangerous source has been encountered. For the local/regional and national responses the starting point for the response time objectives are the same as for the other EPCs, i.e. from the time of being notified. It is important to consider in the response and recovery efforts that for some of the emergency types in EPC IV, exposures of the public or workers could have occurred before, or long before, detection of the emergency conditions.

5.62. This section presents response time objectives that are common to the different response characteristics for EPC IV emergencies, in agreement with **Appendix V**, followed by a brief description of a concept of operations for selected specific scenarios, or emergency types, in EPC IV.

5.63. Within 15 minutes after detection of emergency conditions or arrival of first responders at emergency scene (e.g. traffic accident involving a radioactive transport, discovery of an orphan radioactive source, explosion of a bomb), the operator[34] or, if operator is unknown or unconscious, first responders identify the type of emergency. Any needed life-saving actions, provision of essential first aid, necessary mitigatory actions and protective actions on the site are initiated without delay. First responders establish the Emergency Response Command Post (ERCP) that coordinates all response actions. Contingency measures are initiated at the site if a nuclear security event is suspected and security response is required.

5.64. Within 15 minutes after declaration of emergency the local/regional authorities are notified. If needed, the operating organisation request support from off-site emergency services (for example fire brigades in case of fire, the police in case of intrusion, or medical teams in case of injured victims). The hazardous area is cordoned off and secured (see **Appendix VI**). By this time Emergency Response Command Post (ERCP) established by first responders is fully operational.

5.65. Monitoring at and around the site is initiated within 1 hour as soon conditions allow. If this is not possible, request for support in radiological assessment is made to local authority. Within 2 hours the area that has been cordoned off is adjusted based on the received monitoring results (when relevant). Assistance from local/regional authorities if any is needed is requested within 2 hours.

5.66. Within 15 minutes after being notified or requested, the local/regional authority(ies) activates the off-site local/regional ERP and establishes the local/regional ERCP, if not already established by the first responders, that is ready to operate at its full capacity within 4 hours after notification. Within 30 minutes after being alerted, the local/regional authorities notify the national authority, provides any requested support from emergency services to the onsite responders (e.g. fire brigades, police, medical assistance), and makes decisions on protective actions to be taken in the vicinity of the emergency scene, if relevant.

5.67. Within 15 minutes after notification by the local/regional authority(ies), relevant components of the national ERP are activated and, if an emergency triggered by a nuclear security event is suspected, appropriate security and law enforcement agencies are informed. Local/regional authorities

[34] Depending on the emergency, the on-site level response will be first of all carried out either by operating organization, if available, or first responders, or facility or location at which a dangerous source was encountered (e.g. airport, border crossing point, seaport). For simplicity, this section specifically written for operating organization assuming that the same level of response is expected from facility or location at which there is a significant likelihood of encountering a dangerous source.

are advised by national officials on respective aspects of emergency response driven by the nature of emergency and its progression.

5.68. Within 1 hour after notification, local monitoring teams are activated to initiate environmental monitoring to further assess the radiological situation.

5.69. As soon as possible within 1 hour after being notified, the local/regional public information centre (PIC) is activated for keeping the public and media informed. If decision is taken on protective actions in the vicinity of the emergency site, the public is warned and instructed on any warranted actions.

5.70. Within 2 hours after notification, the local/regional authority(ies) request any needed assistance from the national officials. This can include provision of assistance with monitoring, decontamination, public information and media relations and medical treatment. Depending on the request the national authority provides the requested assistance within 2 to 4 hours.

5.71. If a transnational impact is suspected, the responsible national authority notifies the IAEA and, potentially affected States within 4 hours after notification. If relevant, it requests any needed international assistance (within 24 hours after notification).

5.72. If considered necessary, the local/regional RMAC is activated and operates at required capacity within 6 hours after notification, and the local/regional emergency management system is fully operational within 12 hours after notification.

Specifics of concept of operations for different types of emergency in EPC IV (without time objectives)

5.73. The following highlights in more general terms the different characteristics of concept of operations for specific scenarios/emergency types in EPC IV.

5.74. In the case of a **lost or stolen dangerous source** the operator reports the loss to the appropriate officials and provides them with a description of the device and of the potential hazard to the public. The operator also conducts a search for the source and provides technical support to officials. National or local/regional officials make a timely public announcement describing the source (providing an illustration if possible) and emphasize the possible health hazard. If a criminal act (e.g. theft) is suspected, the operator needs to secure the scene, protect any records that may be important to an investigation and coordinate any additional action with law enforcement officials. If a lost or stolen dangerous source may have been taken across a border, the potentially affected States and the IAEA are notified. When the source is located, a cordon off area is established and efforts are made to identify all those who may have been exposed while the source was not controlled. A recovery plan is developed to minimize the exposure of workers, emergency workers and the public. The recovery operation is carried out with the use of suitable monitoring equipment and other tools and without exceeding occupational dose limits. During the recovery operation, the location of the source and the doses to the workers are continuously monitored, controlled and recorded for future reference. The recovered source is stored in a properly shielded and secure container. If the source has come into contact with the public, the exposure is estimated and any clinical signs are addressed by appropriate and knowledgeable medical personnel. Officials conduct an investigation to determine the reason why the source was not properly controlled and whether other sources may have been lost or stolen.

5.75. In an emergency involving a **mobile dangerous source** under the control of an operator, the operator: carries out a radiation survey; cordons off the area (see **Appendix VI**); sets up barricades as required; verifies the location of the source; notifies the local/regional authorities; and requests advice and support from the local/regional authorities. A recovery plan is developed to minimize the exposure of workers. During the recovery operation, the location of the source and the doses to the emergency workers needs to be continuously monitored, controlled and recorded for future reference. The

recovered source is stored in a properly shielded and secure container.

5.76. In any emergency involving **public exposure and/or contamination**, the local/regional authority(ies) notify the national authority. First responders identify and isolate, on the basis of preliminary information, potentially contaminated people and areas. An emergency response command post (ERCP) is established in the vicinity. Monitoring and interviews are conducted to identify the source and to cordon off significant contamination in accordance with **Appendix VI**. The public is evacuated from cordoned off areas, established and adjusted based on predetermined OILs, and kept informed of the status of the situation, and any actions they should take. Possible health hazards and any other concerns (e.g. consequences for their families and property) are explained and placed in perspective. The news media is briefed as soon as possible on available information on what has happened, including information on protective actions that are initiated in public areas. Medical facilities where exposed or contaminated individuals can be treated are notified about incoming patients, and medical personal are briefed on the treatments being used, precautions for self-protection for safe implementation of necessary actions and the possible health hazard. An experienced radiological assessor is assigned to the medical facility (e.g. designated hospital) if needed. Radiological monitoring and assessment centre is established in the vicinity for management and decontamination of potentially contaminated individuals and for isolated temporary storage of contaminated items (see *FIG.VI.1* in **Appendix VI**). The affected population is monitored in accordance with predetermined criteria, decontaminated and admitted to a hospital if appropriate. Preparations are made to inform or monitor those who are concerned about possible contamination (the 'worried well'). If necessary, assistance (e.g. additional expertise or equipment) is promptly requested through the IAEA under the Assistance Convention [1]. Arrangements are in place (e.g. contamination control points) to ensure that items and people leaving the area are not contaminated above predetermined criteria. Before recovery efforts begin, a long-term plan (remediation plan) is developed with objectives and criteria that are in accordance with international standards [47, DS468]. Decontamination and other options of remediation are justified and optimized, and tested before their long-term application. Compensation for the damage caused either by the emergency or by the emergency response are carefully considered; see Ref [4] for more detailed guidance on compensation. The doses from all exposure pathways are estimated and those who have incurred exposures due to the emergency at a level exceeding established criteria for long term medical actions (see Appendix I and II of GSR Part 7 [2]) are registered. Press briefings are periodically given at a public information centre (PIC), with participation considered from the operator (if existing/relevant) and local/regional and/or national officials.

5.77. For emergencies involving **contaminated commodities, food, drinking water or milk**, monitoring, sampling and analysis, and interviews are conducted to identify and cordon off the source of contamination. If the contaminated products may have originated from another State or may have been taken across a border, the potentially affected States and the IAEA are notified. If, necessary, protective actions and other response actions are taken and recommended to the public based on predetermined OILs on the basis of international standards [2, 3, 4]. The media is briefed by a pre-determined lead official spokesperson. Arrangements for radiological monitoring are in place to ensure that food, drinking water and products leaving and entering the areas are not contaminated in excess of predetermined operational criteria that are based on the generic criteria of Appendix II in GSR Part 7 [2]. The results are used to inform the public and interested parties.

5.78. In response to the **re-entry of a satellite containing dangerous amounts of radioactive material**, the State responsible for the satellite notifies the IAEA of the estimated time and location of re-entry and provides an analysis of the possible hazards. The IAEA informs the potentially affected States. These States inform the public on the nature of the hazards to health, and the public is instructed to report on any relevant findings and to avoid possible debris from a crash. If, following re-entry, the area of concern can be bounded (e.g. through sightings) the local/regional public is instructed to avoid

contact with possible debris from the crash. Monitoring is conducted to locate radioactive debris if the search area is reasonably accessible. Airborne monitoring is initiated if the search area is large and on land. Ground based monitoring is used to investigate reported possible debris or areas first identified by airborne monitoring.

5.79. In response to a **transportation emergency** the carrier, if conscious, or the first responders promptly implement any necessary life-saving actions (e.g. rescuing persons from a fire) and provide first aid for serious injuries without delay and without waiting for the results of radiological monitoring. Local/regional emergency services are notified, and the source is isolated. First responders take the predetermined response actions appropriate for the United Nations number (UN number) or labels affixed to the item being shipped [20, 46], which involves cordoning off the area, taking the names of people who may have been in the area (for possible follow-up) and requesting radiological assistance from the local/regional authority(ies), who may also request assistance from the national authority. The national officials, upon request, promptly provide the required expertise and services (e.g. in radiation protection, media relations, managing the medical response). The responsible national authority promptly notifies, directly or through the IAEA, those States that might be affected by the emergency if a transnational emergency is suspected. The IAEA informs other States of relevant information that warrants their attention.

5.80. In a case of **severe overexposure**, the operator of the facility or device or the responsible physician notifies local/regional/national officials (according to predeveloped emergency plans and procedures) who provide advice and support if necessary. The operator conducts an investigation to determine the cause of the overexposure, and takes actions to prevent further overexposures and to preserve information that may be important in the investigation of the cause. Any relevant data and information helpful for assessing and reconstructing the doses is gathered at the site and preserved. If the cause of the overexposures could give rise to similar overexposures in other States, the responsible national authority reports the results to the IAEA. The IAEA informs other States of relevant information that warrants their attention. Severely overexposed persons are identified. They are examined and treated at designated hospital. Medical examinations and blood tests are promptly performed to assist in dose estimation. The IAEA or World Health Organization may be contacted to arrange for consultation with experts who have experience in dealing with overexposures. A course of treatment, based on the estimated doses received, is established in consultation with national or international experts with experience in dealing with overexposures. Decisions on treatment take into consideration both the physical and the psychological suffering of patients. Psychological counselling is provided when needed. According to pre-determined arrangements, the local/regional or national authorities promptly provide as necessary: warnings and instructions to the public, expertise and services in radiation protection, and management of the medical response. The media are briefed and kept informed.

5.81. Some **criminal acts or unauthorized acts with nuclear security implications** that are perceived by the public or officials as a terrorist act will warrant a radiological response. For a credible nuclear security risk or actual event, an integrated response is activated including law enforcement under an emergency response commander. Law enforcement responders are briefed on radiological and safety concerns while other emergency services involved in the response are briefed on law enforcement concerns (e.g. collection of evidence for nuclear and classical forensics). The social, economic and psychological consequences of the nuclear security risk or act are mitigated, for example, by promptly making a public announcement realistically describing the hazard and the actions taken to limit the spread of contamination and contaminated products. Actions are taken to neutralize or reduce the ability to carry out a possible nuclear security event or further acts by improving security, and establishing means for early detection. Preparation is made for secondary or simultaneous acts and for hoaxes, especially once the risk of the nuclear security event is made public. Any potentially affected States and the IAEA are notified if there are indications that other States or

their citizens may be affected.

5.82. If a *radiation exposure device (RED)* is detected, an area is cordoned off and secured (see TABLE VI.1 in **Appendix VI**) with involvement of law enforcement responders. The dose pattern near the RED (and dose to individuals) is best estimated based on dose rate measurements made while the source is in-place or by measurements made with an exact reconstruction of the exposure situation, including the shielding of other individuals. If a *radiological dispersal device (RDD)* is detected, an area is cordoned off at the recommended distance of 400 m and secured (see TABLE VI.1 in **Appendix VI**) with involvement of law enforcement responders. Monitoring is performed for alpha, beta and gamma emitting radioactive material in the cordoned off area, and areas beyond as judged necessary, in order to map the dispersion and determine the dose rate to obtain a dose pattern and dose to individuals. Based on the onset of symptoms and on dose estimates, those who should receive an immediate medical examination are identified and delivered to the designated medical facility. Specialised treatment is provided for those severely exposed and others are registered for later medical follow-up. Many of those who were not exposed may express a symptom of severe exposure (i.e. vomiting), so arrangements are made to deal with the "worried-well" and those who want an early examination. The local/regional and national officials can expect a large percentage of the local population to be concerned. The public information centre (PIC) is established to take actions to promptly make a public announcement, realistically putting the health hazard in perspective (see **Appendix II** and Ref. [5]) and mitigate through communication means any non-radiological consequences (economic, social and psychological).

5.83. For both the RED and RDD scenarios, the emergency response command post (ERCP) makes sure that emergency responders support and do not impair the law enforcement in their investigation, including forensics of the source. Briefings for law enforcement and other emergency responders are made by a lead official spokesperson with support of official technical briefers (e.g. designated health and/or radiation protection officials) regarding the risks, hazards and actions to take to protect themselves. The recovery is conducted to protect evidence for investigative and forensic use.

EMERGENCY PREPAREDNESS CATEGORY V

Hazard description

5.84. A State with areas within emergency planning zones and emergency planning distances for an EPC I or II facility that is located in another State can be impacted by a severe emergency at that facility. A nuclear emergency at such a facility could warrant protective or other response actions in the neighbouring countries, depending on the distance from the facility. The atmospheric or aquatic releases of radioactive material resulting from the emergency could give rise to complex patterns and levels of contamination, varying both temporally and spatially. The hazard description given for emergency preparedness categories I and II is relevant for this category also.

Concept of operations

5.85. The State in the emergency planning zone or distance receives direct notification of the general emergency at the facility from the accident State, or the accident facility itself, via pre-determined channels, in addition to through the IAEA, of a possible significant transboundary release. If no notification of an emergency from a neighbouring State has been received but a State detects levels of radiation that significantly exceed the background levels, the responsible national authority promptly contacts the neighbouring state with the facility in category I or II to confirm any emergency occurrence and alerts the IAEA of the possible occurrence of a transnational emergency.

5.86. Within 15 minutes after being notified (or detection of significantly elevated levels of radiation occurring but without a notification), the local/regional and the national authorities activate their emergency response plans (ERP) and their local/regional and national emergency operations

facility(ies) (EOF). Within 30 minutes after being notified the responsible local/regional authority decides on urgent protective actions in the UPZ (including precautionary actions). Within 30 minutes after decision is taken, the public is warned, instructed and protective actions are initiated Local/regional authorities are continuously advised by national officials on respective aspects of emergency response.

5.87. Within 1 hour after being notified the local/regional and national response organizations activate their public information centre(s) (PIC). The arrangements for maintaining information exchange between the two States and the IAEA are activated; this includes the affected State sending a representative to the emergency operations facility of the accident State to facilitate coordination and information exchange. This information is used to keep the relevant decision makers in the affected State continually informed of the status of the accident facility and the protective actions and other response actions being taken in the accident State. Press releases are coordinated with the accident State and accident facility.

5.88. Within 2 hours after being notified, the affected State informs the IAEA about the initial protective actions being taken.

5.89. The local/regional and national monitoring teams are activated within 1 and 2 hours after notification, respectively. Environmental monitoring that initially focuses, unless otherwise motivated, on populated areas is initiated by the local/regional authority(ies) within 2 hours after being notified and later supported by national authority. The local/regional RMAC operates at its full capacity within 6 hours after notification. National RMAC, if not co-located with the local/regional RMAC, is fully functional within 12 hours after notification.

5.90. Within 4 hours after being notified, the national response organization has decided on the protective actions to be taken in the EPD and ICPD and instructs the public accordingly.

5.91. The relevant decision makers in the affected State implement protective actions and other response actions according to the national emergency plan and protection strategy. The public in the affected state is provided with relevant information that places the possible health hazards in perspective according to the communication plan. The information released to the public and media is coordinated between the affected State, the accident State and other neighbouring States. The affected State shares its data from its monitoring programme with the IAEA.

5.92. The EOFs of the local/regional and national authorities have all organizations represented and are fully operational within 4 and 6 hours, respectively.

5.93. The emergency management system is fully functional at the local/regional and national levels within 12 and 24 hours after notification. The full emergency response, including all local and national response organizations, is operating under a single emergency management system directed by a single emergency response commander within a unified command and control system. Within 24 hours after being notified of the emergency, any identified international assistance (if any is needed) is requested by the national authority.

5.94. Paragraphs 5.26. – 5.30. in the concept of operations for a general emergency in EPC I and II are also relevant for EPC V.

5.95. Where the emergency results in residual contamination in the environment, the affected State develops a programme for dealing with the long term impact according to internationally accepted criteria, and considering the long term psychological, social and economic impacts [4].

Appendix I

FUNCTIONS TO BE REQUIRED VIA REGULATIONS AND GUIDES FOR OPERATING ORGANIZATIONS

I.1 The regulations and guides established by the regulatory body[35] for operating organizations should require, at least, that the operating organization:

a. Performs a hazard assessment as a basis for a graded approach in establishing the on-site emergency preparedness and response;

b. Executes promptly and manages safely and effectively the on-site emergency response including the transition from normal operations to operations under emergency conditions;

c. Classifies promptly the emergency, declares the emergency class, initiates the on-site emergency response and notifies and provides sufficient information to the off-site notification point;

d. Decides on and takes mitigatory actions on-site;

e. Assesses and determines, at preparedness stage, when and under what conditions assistance from off-site emergency services may be needed to be provided on the site;

f. Assesses the hazards and possible development of hazardous conditions initially and throughout the emergency and takes necessary urgent protective actions to protect all persons present at the site in an emergency;

g. Ensures suitable, reliable and diverse means of communication for use in taking protective and mitigatory actions on the site and for communication with relevant off-site officials;

h. Designates in advance workers who will act as the on-site emergency workers

i. Has arrangements for protecting emergency workers responding on the site;

j. Communicates effectively in a nuclear or radiological emergency in coordination with relevant off-site response organizations (Ref. Comm Safety Guide);

k. Manages radioactive waste generated on-site in an emergency safely and effectively;

l. Sets conditions, criteria and objectives to be met to terminate the emergency on the site and to provide relevant information in this regard to relevant off-site officials;

m. Documents, protects and preserves, to the extent practicable, data and information important for an analysis of the emergency and emergency response;

n. Analyses the emergency and the emergency response with the aim to identify actions to be taken to avoid other emergencies and to improve emergency arrangements;

o. Develops capability to be able to effectively respond in an emergency which includes:

    i. Clear assignment of authorities and responsibilities in emergency preparedness and response for various positions within its organizational structure;

[35] (or any other body assigned by the government that has the authority to issue regulations and guides)

ii. Ensuring adequate number of suitably qualified personnel is available to promptly staff necessary positions in an emergency response as well as in the long term if needed;

iii. Ensuring means for coordination with other organizations in the use of necessary tools, procedures or criteria with the aim to ensure consistency in any relevant assessments made in a nuclear or radiological emergency;

iv. Developing emergency plan, procedures and analytical tools for emergency response which are coordinated with those of other organizations and with other relevant plans;

v. Validation of various procedures and analytical tools through testing them under simulated emergency conditions prior to initial use;

vi. Ensuring adequate tools, instruments, supplies, equipment, emergency response facilities and documentation are available to support the on-site emergency response including, where appropriate, alternative supplies for taking on-site mitigatory actions (such as alternative electrical power supply);

vii. Developing and implementing training and exercise programmes;

viii. Establishing a quality management programme, as part of its management system, to ensure the availability and reliability of all supplies, equipment, communication systems and facilities, plans, procedures and other arrangements necessary for an emergency response which includes review and revisions of emergency plans, procedures and other arrangements on a regular basis and maintaining records.

Appendix II

DANGEROUS SOURCES

II.1 "Dangerous source", as defined in [11] is a sources that could, if not under control, give rise to exposure sufficient to cause severe deterministic effects. This definition is used for determining the need for emergency arrangements and is not to be confused with categorizations of sources for other purposes. The term "dangerous source" relates to dangerous quantities of radioactive material (or D-values) as described in Ref. [49].

II.2 The GSR Part 7 [2] uses the term 'dangerous source' to identify activities and acts that fall under emergency preparedness category IV as described in TABLE 1 and establishes requirements for operating organisations using such dangerous sources, facilities and locations where there is a significant likelihood of encountering a dangerous source that is not under control and for first responders in an emergency at an unforeseen location (see Paras 4.21, 5.13, 5.28–5.30, 5.44 and 5.47).

II.3 This appendix provides guidance on:

- Determining the quantity of radioactive material that should be considered as dangerous;
- Providing plain language statements of the risks to the public and emergency responders and typical public warnings and instructions for radiological emergencies.

Determining dangerous quantities (D-values)

II.4 A source or uncontrolled radioactive material should be categorized as a dangerous source in accordance with the process described below, with the following exceptions:

- This guidance does not apply for irradiated fuel (e.g. reactor spent fuel). In these cases, TABLE 1 should be used to determine the emergency preparedness category.
- Radioactive material being transported in accordance with international requirements (Ref. TS-R-1 [48]) should not be considered a dangerous source provided that it is properly controlled and only removed from the packaging under supervised conditions. However, if the radioactive material being transported is lost, stolen or inadvertently removed from its packaging, this guidance should be applied to determine whether it should be considered a dangerous source.

II.5 For not dispersed materials (e.g. encapsulated), the following ratio should be calculated:

$$\left[\frac{A}{D}\right]_1 = \sum_i \frac{A_i}{D_{1,i}} \qquad (1)$$

where

A_i is the activity (TBq) of the radionuclide *i* over which control could be lost in an emergency;

$D_{1,i}$ is the D_1-value for radionuclide *i* taken from TABLE II.1 that represents activity of a radionuclide *i* in a source that if uncontrolled, but not dispersed, might result in an emergency that could reasonably be expected to cause severe deterministic health effects.

II.6 For dispersible material[36] the following ratio should be calculated:

$$\left[\frac{A}{D}\right]_2 = \sum_i \frac{A_i}{D_{2,i}} \qquad (2)$$

where

A_i is the activity (TBq) of the radionuclide *i* over which control could be lost in an emergency;

$D_{2,i}$ is the D_2-value for radionuclide *i* taken from TABLE II.1 that represents activity of a radionuclide *i* in a source that if uncontrolled and dispersed, might result in an emergency that could reasonably be expected to cause severe deterministic health effects.

II.7 A source or uncontrolled material should be categorized as a dangerous source if either $\left[\frac{A}{D}\right]_1$ or $\left[\frac{A}{D}\right]_2$ values calculated as given by Eqs (1) or (2), accordingly, is greater than 1.[37] Ref. [49] gives a thorough explanation of the basis for the calculation of D-values and provides recommended D-values for more than 350 radionuclides. TABLE II.1 provides D_1 and D_2 values for a selection of the most common radionuclides.

Plain language statements of the risks and typical public warnings for radiological emergencies

II.8 This section provides plain language statements of the risks to the public and to the emergency workers in the event of a radiological emergency, and typical warnings that should be given to the public.

II.9 The risks are assessed on the assumption that the source or material concerned is not being managed safely or kept securely, and that someone could — either intentionally or unintentionally — remove the radioactive material from the container or packaging in which it was to be used or safely shipped. Handling of the material, contamination of public water supplies and fires and/ or explosions were considered.

Risks to public

II.10 An amount of radioactive material is considered 'dangerous' if it could cause permanent injury or be immediately life threatening if not managed safely and contained securely. Permanent injuries include burns requiring surgery and debilitating injuries to the hands. Temporary injuries include skin reddening and irritation and temporary changes in the composition of the blood. Exposures are considered to be immediately life threatening[38] if they could result in injuries to tissues or organs that are fatal within at most a few years. Exposures that are immediately life threatening:

- Typically arise from very high radiation doses received over a period of hours to months owing to the presence nearby of dangerous amounts of unshielded material, for example from a

[36] Powders, gases and liquids, and especially volatile, combustible, water soluble and pyrophoric material, should be considered to be at risk of dispersal.

[37] It is possible, but unlikely, that a smaller amount than this could cause injury. However, sources this large are considered sufficiently dangerous to warrant taking extraordinary measures (searches, public announcements) to secure them if control over them is lost (e.g. by their being stolen or lost) and if they could be in the public domain.

[38] This does not refer to the possibility of causing cancer, for which the probability of occurrence depends on the dose and which are characterized by latency period (i.e. it appears years after an exposure to ionizing radiation).

dangerous source placed in a drawer next to the bed.

- Arise in rare cases from inadvertently eating or drinking (or for someone very close by, inhaling) small amounts of dispersible material, for example if someone opens the container with a dangerous amount of radioactive material that is in a dispersible form. Powders, gases and liquids, and volatile, combustible, water soluble and pyrophoric materials are all dispersible.
- Could arise from 'inhalation' for radioactive material in a plume from a fire or explosion (e.g. from a radiological dispersal device).

II.11 It should be noted that there is the potential for amounts that are a very small fraction (e.g. 1/100) of the D-values given in TABLE II.1 to be dangerous. This would be the case in the event of intentional ingestion of radioactive material or intentionally exposing oneself to a radioactive source.

Risks to emergency workers

II.12 There will be little or no health risks to emergency workers provided that in taking response actions near any hazardous material they are using personal protective equipment , such as the use of respiratory protection against material released (e.g. in a fire or explosion) and use of protective clothes. Limited stays (such as for rescues) near a radioactive source or material would probably not be dangerous. Medical staff who are treating and those who are transporting exposed or contaminated individuals can do so safely provided that they protect themselves by use of universal precautions against infections such as surgical gloves and masks.

Other concerns

II.13 Radiological emergencies involving radioactive material in D-values amounts are very unlikely to result in any detectable increase in the incidence of cancer among the exposed population.

II.14 Public concern about any event involving radioactive material should always be duly considered, regardless of the hazard indicator. Significant adverse (and unwarranted based on the radiological health hazard) public actions have been taken in the past, although the levels of contamination and exposure were not dangerous. Such actions have included artificially terminating pregnancies, stigmatizing individuals who arrived from the affected area and rejecting products from the affected area.

Public warnings and/or instructions for radiological emergencies

II.15 For a radiological emergency involving possible public exposure, the public should be provided (as appropriate) with the following advice:

— Those who left the site without being assessed or instructed as to further actions should be instructed:

- to wash hands before drinking, eating, smoking or touching the face;
- to shower and change clothes if it can be done safely;
- to place the clothes that were took off in a plastic bag and keep them for later contamination monitoring and cleaning; and
- to go to the place specified by authorities to be assessed and be given further recommendations;

— Everybody who handled those who injured must go to the place specified by authorities for individual monitoring and decontamination, if needed

— Everybody who transported victim(s) must go to the place specified by authorities for individual monitoring, monitoring of vehicles and decontamination, if needed;

II.16 If an airborne radioactive release is suspected, people within about 1 km of the site of the emergency (if not evacuated) should be advised:

— To remain indoors till further announcement;

— To stop consumption, distribution of non-essential food (e.g. vegetables grown outside), directly collected drinking water, animal feed and commodities other than food that may have been contaminated until monitoring has been performed;

— That an announcement of the monitoring results will follow;

— Not to let children play on the ground;

— To wash hands before eating;

— To avoid dusty areas or activities resulting in the creation of dust;

— Not to be concerned about those evacuated (it is not dangerous to be near them); and

— Not to go to the site to volunteer to help — if assistance is needed, announcements will be made.

II.17 If a dangerous source is lost or stolen, the public should be provided (as appropriate) with the following information:

(1) Time and location of loss of control over the source;

(2) The governmental organization leading and coordinating the response;

(3) The details of the request for help in finding this dangerous source;

(4) A description and, if possible, illustration or drawing of the item;

(5) Advice that:

— The item is very dangerous and if found should not be touched, and everyone should be kept at least 10 metres away from it;

— Any persons who think they may have seen the item should immediately report this to *[specify]*;

— Any persons who have touched or been near the item should contact *[specify]*.

II.18 Medical practitioners should be alerted to the possibility that patients may present themselves with symptoms of radiation exposure (e.g. burns with no apparent cause, i.e. the person does not remember being burned).

II.19 Scrap metal dealers are also asked to be alert.

TABLE II.1. D-VALUES (TBq) [49]

Source and material[a]		
Radionuclide	D_1[b]	D_2[c]
H-3	UL[d]	2.E+03[e]
C-14	2.E+05	5.E+01
P-32	1.E+01	2.E+01
S-35	4.E+04	6.E+01
Cl-36	3.E+02	2.E+01[f]
Cr-51	2.E+00	5.E+0
Fe-55	UL[d]	8.E+02
Co-57	7.E-01	4.E+02
Co-60	3.E-02	3.E+01
Ni-63	UL[d]	6.E+01
Zn-65	1.E-01	3.E+02
Ge-68	7.E-02	2.E+01
Se-75	2.E-01	2.E+02
Kr-85	3.E+01	2.E+03
Sr-89	2.E+01	2.E+0
Sr-90 (Y-90)[g]	4.E+00	1.E+00
Y -90	5.E+00	1.E+01[h]
Y-91	8.E+00	2.E+0
Zr-95 (Nb-95m/Nb-95)[g]	4.E-02	1.E+01
Nb-95	9.E-02	6.E+01
Mo-99 (Tc-99m)[g]	3.E-01	2.E+01
Tc-99m[h]	7.E-01	7.E+02
Ru-103 (Rh-103m)[g]	1.E-01	3.E+01
Ru-106 (Rh-106)[g]	3.E-01	1.E+01
Pd-103 (Rh-103m)[g]	9.E+01	1.E+02
Cd-109	2.E+01	3.E+01
Te-132 (I-132)[g]	3.E-02	8.E-01[h]
I-125	1.E+01	2.E-01
I-129	UL[d]	UL[d,f]
I-131	2.E-01	2.E-01[h]
Cs-134	4.E-02	3.E+01
Cs-137 (Ba-137m) [g]	1.E-01	2.E+01
Ba-133	2.E-01	7.E+01
Ce-141	1.E+00	2.E+01
Ce-144 (Pr-144m, Pr-144)[g]	9.E-01	9.E+00
Pm-147	8.E+03	4.E+01
Eu-152	6.E-02	3.E+01
Eu-154	6.E-02	2.E+01

Source and material[a]		
Radionuclide	D_1[b]	D_2[c]
Gd-153	1.E+00	8.E+01
Tm-170	2.E+01	2.E+01
Yb-169	3.E-01	3.E+01
Re-188	1.E+00	3.E+01
Ir-192	8.E-02	2.E+01
Au-198	2.E-01	3.E+01
Hg-203	3.E-01	2.E+00
Tl-204	7.E+01	2.E+01
Po-210	8.E+03	6.E-02
Ra-226 (progeny)[g]	4.E-02	7.E-02
Th-230	9.E+02	7.E-02[f]
Th-232	UL[d]	UL[d,f]
U-232	7.E-02	6.E-02[f]
U-235 (Th-231)[g]	8.E-05	8E-05[i]
U-238	UL[d]	UL[d,f]
U natural	UL[d]	UL[d,f]
U depleted	UL[d]	UL[d,f]
U enriched 10-20%	8E-04[i]	8E-04[i]
U enriched > 20%	8E-05[i]	8E-05[i]
Np-237 (Pa-233)[g]	3.E-01[j]	7.E-02
Pu-238	3.E+02[i]	6.E-02
Pu-239	1.E+00[i]	6.E-02
Pu-239/Be[k]	1.E+00[i]	6.E-02
Pu-240	4.E+00[i]	6.E-02
Pu-241 (Am-241)[g]	2.E+03[i]	3.E+00
Pu-242	7.E-02[i]	7.E-02[f]
Am-241	8.E+00	6.E-02
Am-241/Be[k]	1.E+00	6.E-02
Cm-242	2.E+03	4.E-02
Cm-244	1.E+04	5.E-02
Cf-252	2.E-02	1.E-01

[a] The amount of material in the public domain, if not under control (i.e. because of allowing removal of shielding or allowing dispersal accidentally or intentionally by a nuclear security event), that could give rise to doses resulting in permanent injury that decreases the quality of life.

[b] The D_1-value is the activity of a radionuclide in a source that if uncontrolled, but not dispersed (i.e. it remains encapsulated), might result in an emergency that could reasonably be expected to cause severe deterministic health effects.

[c] The D_2-value is the activity of a radionuclide in a source that if uncontrolled and dispersed might result in an emergency that could reasonably be expected to cause severe deterministic health effects

[d] ULmeans ‘unlimited quantity’. Emergency planning for dealing with radiological consequences is not recommended.

[e] Assumes that skin absorption doubles the absorbed dose from inhalation.

[f] Emergencies involving these amounts of these radionuclides may result in airborne concentrations in excess of the concentrations posing immediate danger to life or health for chemical toxicity, and arrangements for dealing with these

risks are warranted.

[g] The D-values were calculated in consideration of both the parent and important decay products (radionuclides shown in parentheses) that are present after up to ten years. Decay products with a half-life of less than one year can be assumed to be in equilibrium with their parents.

[h] Does not pose a long term concern as it is short lived radionuclide and within one month or less the radiological hazard will be greatly diminished.

[i] There is no immediate radiological hazard but the D-value was established on the basis of the criticality hazard.

[j] The D-value represents a radiological and criticality hazard.

[k] Neutron generator.

Appendix III

TYPICAL EMERGENCY PREPAREDNESS CATEGORIES FOR DIFFERENT HAZARDS

III.1 TABLE III.1 provides a summary of the typical hazards and associated emergency preparedness categories of selected facilities and activities.

TABLE III.1. TYPICAL EMERGENCY PREPAREDNESS CATEGORIES FOR SELECTED FACILITIES AND ACTIVITIES

Facility or Activity	Hazard summary	Typical emergency preparedness category[a]
Facilities manufacturing or using radioisotopes for industry, medical purposes or scientific research		
Radiopharmaceutical manufacturing	**Off-site**: No potential for deterministic effects. A small potential for a release warranting emergency response actions (e.g. monitoring) in the vicinity of the facility.	III
	On-site: Severe deterministic effects very unlikely on the site, but doses in excess of occupational limits are possible. Major fires at facilities and loading dock fires appear to represent the greatest potential for a release resulting in on-site doses in excess of the generic criteria provided in table II.2 of GSR Part 7 [2][b]. The hazard will be a function of inventory and volatility. Explosions, tornadoes, spills and leaks represent small risks	
Radiopharmacies	**Off-site**: No potential for a release warranting urgent protective actions or early protective actions[b].	III
	On-site: No potential for a release resulting in on-site doses in excess of the generic criteria provided in table II.1 of GSR Part 7 [2][b].. Very small potential for exposures above occupational dose limits.	
Hospitals	**Off-site:** No potential for a release warranting urgent protective actions or early protective actions[b].	III
	On-site: Severe deterministic effects possible for staff if sealed sources (e.g. brachytherapy sources or radiation beams) are misused or are not controlled and secured. In addition, radioactive medication and diagnostic drugs can represent a hazard if not properly controlled and administered.	
Sealed source manufacturing	**Off-site**: No potential for deterministic effects. A small potential for a release warranting emergency response actions (e.g. monitoring) in the vicinity of the facility.	III
	On-site: Severe deterministic effects possible for staff during the manufacturing process due to loss of shielding, ingestion or inhalation. A major facility fire appears to represent the greatest potential for a release resulting in on-site doses in excess of the generic criteria provided in table II.2 of GSR Part 7 [2][b], The hazard will be a function of inventory and volatility.. Explosions, tornadoes, spills and leaks represent small risks.	

TABLE III.1. TYPICAL EMERGENCY PREPAREDNESS CATEGORIES FOR FACILITIES AND ACTIVITIES

Facility or Activity	Hazard summary	Typical emergency preparedness category[a]
Research laboratories	**Off-site**: Unless large quantities of radioactive or fissile material are stored or used in a single location, there is no potential for exposures warranting urgent protective actions.	III
	On-site: Potential for severe deterministic effects. This will be site specific.	
Warehousing and burial of low level waste	**Off-site:** No potential for exposures warranting urgent protective actions for burial operations for low level waste.	III
	On-site: No potential for exposures resulting in on-site doses in excess of the generic criteria provided in table II.1 of GSR Part 7 [2][b]. . If the waste contains radioiodine, a major fire involving waste in a warehouse may result in a release leading to more than occupational exposure dose limits. Protective actions and other response actions will be warranted onsite.	
Depleted uranium products	**Off-site:** No potential for an exposure warranting urgent protective actions or early protective actions. Potential for deaths following a UF_6 release due to chemical toxicity of HF (product of a UF_6 release). The potential is a function of the UF_6 inventory. Greatest risk appears to be ruptures of heated tanks containing many tonnes UF_6.	III or IV
	On-site: No potential for on-site doses in excess of the generic criteria provided in table II.1 of GSR Part 7 [2][b]. There is a potential for internal contamination of workers for variety of events.	
— Sterilization irradiators — Industrial radiography — Teletherapy (external beam radiotherapy (EBRT)) — High and medium dose rate brachytherapy — Category 1 and 2 sources in Ref. [50]	**Off-site:** If controlled, no potential for exposures warranting urgent protective actions; if uncontrolled (lost or stolen), potential for fatal exposure in minutes if unshielded and for severe tissue damage if held.	III or IV[c]
	On-site: Localized exposure sufficient for fatal doses in minutes if source unshielded.	
— Gauges — Well logging — Category 3 sources in Ref. [50]	**Off-site:** If controlled, no potential for exposures warranting urgent protective actions; if uncontrolled (lost or stolen), potential for fatal exposure if unshielded and for severe tissue damage if held.	III or IV[c]
	On-site: Potential for fatal exposure if unshielded.	
— Moisture density gauge — Static eliminator — Tritium exit signs — Pu pacemaker — Consumer products — Category 4 and 5 sources in Ref. [50]	**Off-site:** No potential for deterministic effects. No potential for exposure warranting urgent protective actions.	IV
	On-site: No potential for deterministic effects. Little or no potential for exposure warranting protective actions and other response actions. Actions to be taken are very limited (e.g. communication)	

TABLE III.1. TYPICAL EMERGENCY PREPAREDNESS CATEGORIES FOR FACILITIES AND ACTIVITIES

Facility or Activity	Hazard summary	Typical emergency preparedness category[a]
Fuel cycle		
Uranium mining and milling	**Off-site:** No potential for a release warranting urgent protective actions or early protective action. Contamination warranting taking protective actions and other response actions (e.g. water contamination) could result from failures of tailing ponds.	III
	On-site: Small potential for exposure warranting protective actions and other response actions.	
Yellow cake processing	Same as uranium mining and milling. There is a potential for internal contamination of workers on the site for variety of events.	III
UF_6 conversion plants	**Off-site:** Potential for deaths following a UF_6 release due to chemical toxicity of HF (product of a UF_6 release). The potential is a function of the UF_6 inventory. Greatest risk appears to be ruptures of heated tanks containing many tonnes UF_6.	III [d]
	On-site: Same as off-site.	
Enrichment plants	Same as UF_6 conversion plants.	III [d]
Fuel fabrication using uranium	**Off-site:** Risk for UF_6 same as for UF_6 conversion plants. Potential for exposure warranting urgent protective actions or early protective actions and other response action from criticality accidents if the fissile material is processed in an unshielded location within 200–500 m of the site boundary.	II or III
	On-site: Risk for UF_6 same as for UF_6 conversion plants. Potential for deterministic effects and exposure warranting urgent protective actions and early protective actions from criticality accidents on the site.	
Fuel fabrication using plutonium	**Off-site:** Potential for exposure warranting urgent or early protective actions and other response action from criticality accidents if the fissile material is processed in an unshielded location within 200–500 m of the site boundary. Large fires or explosions could result in doses off the site (near the facility) in excess of the generic criteria provided in table II.2 of GSR Part 7 [2][b]. This will be a function of the inventory.	II or III
	On-site: Potential for deterministic effects and doses from criticality accidents warranting urgent protective actions. Fires and explosions could result in doses from inhalation warranting urgent protective actions.	
Fresh fuel (not irradiated)	**Off-site and on-site**: No potential for exposure warranting urgent protective actions or early protective action.	III[g]

TABLE III.1. TYPICAL EMERGENCY PREPAREDNESS CATEGORIES FOR FACILITIES AND ACTIVITIES

Facility or Activity	Hazard summary	Typical emergency preparedness category[a]
Spent fuel, pool storage	**Off-site**: For damage to fuel in a pool (underwater), no potential for doses warranting urgent protective actions. If the fuel in the pool is totally uncovered, doses in excess of the generic criteria for taking protective actions and other response actions may be possible. Distance of concern depends on inventory. If a pool containing fuel discharged from a reactor core within the past few months is drained, severe deterministic effects are possible. The potential and the distances of concern depend on quantities and pool design.	I, II or III
	On-site: For damage to fuel in a pool (underwater), doses from ^{85}Kr in the pool area could warrant urgent protective actions. For a drained pool, the dose from the direct shine from the pool could be several sieverts per hour (Sv/h) near the pool. If fuel is uncovered, the dose near the pool could result in severe deterministic effects.	
Spent fuel, dry cask storage	**Off-site**: No potential for release warranting urgent protective actions or early protective actions.	III
	On-site: If shielding is lost, direct shine dose could result in doses in excess of the generic criteria provided in table II.2 of GSR Part 7 [2][b].	
Reprocessing of spent fuel	**Off-site:** Small potential for doses from criticality accidents warranting protective actions and other response actions (depending on location of criticality). Large fires or explosions could result in doses warranting urgent protective actions, early protective actions and other response actions several kilometres from the facility, depending on the inventory and the volatility of the radionuclides. Ruptures of large liquid storage tanks could result in contamination that would warrant extensive emergency response actions. This will be a function of inventory and volatility.	I, II or III
	On-site: Potential for severe deterministic effects and doses from criticality accidents warranting urgent protective actions. Fires and explosions could result in inhalation doses warranting urgent protective actions and could result in severe deterministic effects. If shielding is lost, direct shine dose could result in severe deterministic effects and therefore warrant protective and other response actions.	

TABLE III.1. TYPICAL EMERGENCY PREPAREDNESS CATEGORIES FOR FACILITIES AND ACTIVITIES

Facility or Activity	Hazard summary	Typical emergency preparedness category[a]
Reactors (power, ship, research)		
Reactors >100 MW(th)	**Off-site**: Emergencies involving severe core damage have the potential to cause severe and even fatal deterministic effects. Doses warranting precautionary protective actions and urgent protective actions are possible up to 5 km from the facility. Deposition resulting in doses warranting protective action and other response actions (e.g. relocation) is possible. Urgent and early protective actions to protect the food chain and water supplies, prevent ingestion of contaminated food, milk and drinking water and to prevent inadvertent ingestion at great distances from the facility may be warranted. An emergency not involving core damage has only a small potential for warranting protective actions and other response actions.	I or II
	On-site: For emergencies involving core damage, doses sufficient to result in severe and even fatal deterministic effects are possible.	
Reactors 2 – 100 MW(th)	**Off-site**: Doses due to inhalation of short lived iodine warranting urgent protective actions, early protective actions and other response actions are possible if cooling of the core is lost (core melt).[e]	II
	On-site: Potential for doses warranting urgent protective actions if fuel cooling is lost. If shielding is lost, direct shine dose could result in severe deterministic effects.	
Reactors <2 MW(th)	**Off-site:** No potential for doses in excess of the generic criteria provided in table II.2 of GSR Part 7 [2][b].	III
	On-site: Potential for doses warranting urgent protective actions, from inhalation (depending on design) if fuel cooling is lost. If shielding is lost, direct shine dose could result in severe deterministic effects.	
Transport		
Excepted packages UN 2910 UN 2911 UN 2909 UN 2908	These shipments contain only minor amounts of radioactive material. There is no risk of any radiological consequences warranting protective actions. Ground contamination resulting from an emergency may require decontamination.	IV

TABLE III.1. TYPICAL EMERGENCY PREPAREDNESS CATEGORIES FOR FACILITIES AND ACTIVITIES

Facility or Activity	Hazard summary	Typical emergency preparedness category[a]
Industrial packages UN 2912 UN 3321 UN 3322 UN 2913	These packages contain only qualified 'low specific activity' materials or qualified 'surface contaminated objects'. Protective actions and other response actions may be warranted, however, in the vicinity of a damaged package, since industrial packages are not designed to survive accidents and the only external radiation limit on the unshielded but qualified contents is 10 mSv/h at a distance of 3 m. Ground contamination resulting from an emergency may require decontamination.	IV
Type A packages UN 2915 UN 3332	The activity allowed for Type A packages limits the radiological hazard. Doses warranting protective actions and other response actions are however possible beyond the immediate vicinity of the package. Ground contamination resulting from an emergency would require decontamination.	IV[f]
Type B packages [B(U) and B(M)] UN 2916 UN 2917	Type B packages normally contain large amounts of radioactive material. Type B packages have been designed to withstand all credible land and sea transport accidents. The radioactive content of a Type B package shipped by air is restricted. For 'low dispersible radioactive material', the limit is as authorized by the competent authority for the package design. For other material: if it is special form, the restriction is 3000 A_1 or 100 000 A_2, whichever is lower; if it is other than special form, 3000 A_2 (Ref. TS-R-1) [48]. Doses in excess of the generic criteria provided in table II.2 of GSR Part 7 [2][b] are considered possible in an air accident but not credible in land or surface mode transport. However, in the event of an emergency, this should be confirmed by monitoring.	IV[f]
Type C packages UN 3323	Type C packages normally contain large amounts of radioactive material. Type C packages have been designed to withstand all credible land and sea accidents and most credible air transport accidents. Doses in excess of the generic criteria provided in table II.2 of GSR Part 7 [2][b] are not considered credible. However, in the event of an emergency, this should be confirmed by monitoring.	IV[f]

TABLE III.1. TYPICAL EMERGENCY PREPAREDNESS CATEGORIES FOR FACILITIES AND ACTIVITIES

Facility or Activity	Hazard summary	Typical emergency preparedness category[a]
Special arrangements UN 2919	Shipments of non-fissile or excepted fissile radioactive material transported under special arrangements require seven days prior notification to the competent authorities of each State involved. In an emergency, doses in excess of the generic criteria provided in table II.2 of GSR Part 7 [2][b] are possible and protective actions and other response actions may be warranted. Ground contamination resulting from the emergency may require decontamination.	IV[f]
Packages containing fissile material UN 2977 UN 3324 UN 3325 UN 3326 UN 3327 UN 3328 UN 3329 UN 3330 UN 3331	Industrial, Type A, Type B and Type C packages may all contain fissile material. Such packages containing fissile material are designed with the contents limited, so as to maintain sub-criticality during both normal and emergency conditions during transport. The risk summary is therefore the same as that for the relevant Industrial, Type A, Type B or Type C package. Type IF, Type AF, Type B(U)F or Type B(M)F packages that are involved in an air accident and contain only fissile UF_6 may release UF_6 with its associated chemical hazard. However, packages containing only UF_6 have no risk of any radiological consequences requiring protective actions. Ground contamination resulting from the emergency may require decontamination.	IV[f]
Packages containing UF_6 UN 2978	Packages containing non-fissile or fissile excepted quantities of UF_6 that are involved in an air accident may release UF_6 with its associated chemical hazard. There is no risk of any radiological consequences requiring protective actions. Ground contamination resulting from the emergency may require decontamination.	IV[d]
Other		
Nuclear weapon accident (Pu dispersal)	If there is a fire or explosion resulting in dispersal of Pu from a nuclear weapon, deterministic effects are possible from inhalation of the plume or re-suspension of deposited material within about 1 km. The area of significant contamination could be of the order of a square kilometre. It may not be possible to detect dangerous levels of airborne contamination with common radiation survey instruments.	IV
Lost/stolen dangerous source	Lethal doses are possible for persons handling an unshielded dangerous source (see Ref. [11] and **Appendix II**). Lethal doses and considerable contamination resulting in doses warranting urgent protective actions, early protective actions and other response actions are possible from a ruptured source, or from use of a radiological dispersal device or radiological exposure device. A considerable area may be contaminated owing to dispersal by human activities.	IV

TABLE III.1. TYPICAL EMERGENCY PREPAREDNESS CATEGORIES FOR FACILITIES AND ACTIVITIES

Facility or Activity	Hazard summary	Typical emergency preparedness category[a]
Contamination from a significant transboundary release	Deposition leading to doses warranting urgent and early protective actions (such as relocation) or other response actions; and restrictions on and/or protection of the food-chain and water supplies, prevention of ingestion of contaminated food, milk and drinking water or prevention of inadvertent ingestion is possible at great distances from a facility in category I or II.	IV, V
Re-entry of a nuclear powered satellite	The risk is very small, and it would be virtually impossible to limit the area of concern so that protective actions and other response actions could reasonably be taken. The handling of debris could result in deterministic effects.	IV
Import of contaminated food or material	**Off-site:** Uncontrolled (unknowing) use of contaminated steel and other products could result in doses in excess of the occupational dose limits (very small risk) but it is very unlikely that generic criteria provided in table II.2 of GSR Part 7 [2]b could be exceeded. There is a potential for imported contaminated food that it could exceed the generic criteria for food and other commodities provided in generic criteria provided in table II.3 of GSR Part 7 [2][b].	IV

[a] The method described in the section on emergency preparedness categories (EPC), paras. 2.88. – 2.101 should be used for determining the emergency preparedness category.

[b] The generic criteria for use in emergency preparedness and response are provided in Appendix II in Ref. [2].

[c] Emergency preparedness category IV: mobile dangerous source.

[d] The chemical toxicity due to a UF_6 release is far more important than the radiation dose, even for highly enriched uranium. A lethal concentration of HF (due to chemical toxicity) may be possible off the site. Emergency arrangements should be developed to protect against all types of hazards (including radiological and chemical).

[e] For research reactors, because of the great variations in the design and operation of the installations, a site-specific analysis should be performed to determine whether there is sufficient inventory and energy to result in a significant airborne release off the site.

[f] Transport packages that comply with international regulations [48] are not considered dangerous sources owing to their design and content limits, provided that they are properly controlled and only removed from their packaging under properly supervised conditions. However, if they are lost, stolen or inadvertently removed from their packaging (in an uncontrolled way), they may be considered a dangerous source (see **Appendix II**).

[g] Fresh fuel (non-irradiated) doesn't represent a radiological hazard. Emitted radiation does not go beyond the zirconium tubes with pressed uranium pellets. However, considering potential use of fresh fuel some limited emergency arrangements may still be warranted to address perceived hazard and concerns and normal industrial and workplace safety for hazards associated with chemical toxicity and other non-radiological hazards associated with the practice. Such limited arrangements may include notification of local authority and IAEA about an emergency, communication to the public to mitigate non-radiological consequences, monitoring on the site to ensure that relevant operational criteria are not exceeded.

Appendix IV

EMERGENCY CLASSES FOR EMERGENCIES AT FACILITIES AND ACTIVITIES IN CATEGORIES I-V

IV.1. TABLE IV.1 describes the abnormal facility conditions that correspond to each class of facility emergency listed in the para. 5.14 of the GSR Part 7 [2], together with the immediate actions that should be initiated on and off the site upon declaration of one of these types of emergency.

IV.2. TABLE IV.2 describes the conditions on the site that correspond to activity in category IV, together with the immediate actions that should be initiated upon declaration of this type of emergency class.

IV.3. EALs should be developed for the abnormal conditions that correspond to each type of emergency (see para. 3.47).

IV.4. States with EPC V should apply urgent protective actions and other response actions as described in TABLE IV.1 for facilities in category I and II.

IV.5. States affected by a transboundary emergency but not categorised as EPC V should apply relevant response actions as described in TABLE IV.1 for facilities in category I and II.

TABLE IV.1. CLASS DESCRIPTION FOR EMERGENCIES AT FACILITIES

Emergency class description	Response actions	Response actions
	Emergency preparedness category I and II facilities	Emergency preparedness category III facilities
General emergency Events resulting in an actual or substantial risk of an atmospheric release or radiation exposure due to a criticality or loss of shielding requiring implementation of urgent protective actions off the site. This could be: — Actual or projected[a] damage to the reactor core or large amounts of recently discharged fuel (see *TABLE 1. SUGGESTED CRITERIA FOR DETERMINING EMERGENCY PREPEREDNESS CATEGORIES* FOR *FACILITIES* AND ACTIVITIES); — Actual damage to barriers or critical safety systems that would result in a release (e.g. of reprocessing waste) or criticality that would warrant taking precautionary protective action off the site; — Potential or actual criticality near the facility boundary; — Detection of radiation levels off the site warranting the implementation of urgent protective actions; — Nuclear security event resulting in an inability to monitor or control critical safety systems needed to prevent a release or exposure that could result in doses off the site that warrant urgent protective actions.	Operator and on-site: — Take life saving actions and give first aid on the site; — Notify off-site officials; — Recommend protective actions in accordance with emergency plan and as described in **Appendix X**; — Mobilize the emergency services if needed; — Evacuate non-essential personnel and visitors or provide them with special on-site sheltering, and account for all persons on the site; — Consider relocation to the backup emergency operations facility; — Provide protection from hazardous conditions for on-site emergency response personnel and for those arriving from off the site; — Take action to mitigate the consequences of the emergency, including requesting off-site assistance; — Provide technical assistance to the facility control room; — Conduct off-site monitoring near the facility and provide results to the radiological monitoring and assessment centre (see **Appendix VII***)* — Activate the full response coordinated under a unified command and control system ;[b] — Establish continuous communication with off-site officials; — Establish, with off-site officials, a unified command and control system (see **Appendix VII**); — Conduct, with off-site officials, joint media briefings at the public information centre (see **Appendix VII**).	Not applicable

TABLE IV.1 CLASS DESCRIPTION FOR EMERGENCIES AT FACILITIES (cont.)

Emergency class description	Immediate response actions,	Immediate response actions
	Emergency preparedness category I and II facilities	Emergency preparedness category III facilities
		Not applicable
	Off-site: Within the PAZ and the UPZ: — Implement urgent protective actions as described in **Appendix X** in accordance with the plan taking into account the information provided by the facility; — Establish the radiological monitoring and assessment centre (see **Appendix VII**), conduct monitoring in and around the UPZ and revise protective actions based on OILs; — Activate the full response coordinated under a unified command and control system;[b] — Provide radiation protection for emergency workers and helpers; — Ensure that all relevant governmental agencies are informed; — Notify the IAEA and all relevant States; — Establish provision to monitor and decontaminate evacuees and manage the medical response and initial treatment, and consult experts on the treatment of persons with severe overexposures; — Initiate joint media briefings at the public information centre with on-site officials (see **Appendix VII**). Within the EPD and ICPD (area in which food and water contamination may warrant restrictions): — Issue instructions to protect water supplies[c] and for farmers to protect crops and put animals on stored feed as appropriate; — Restrict consumption of food and distribution or use of feed and commodities other than food with possible contamination until it has been monitored; — Conduct monitoring to determine where relevant OILs (OIL3, OIL5, OIL6 and OIL7 for LWR) could be exceeded and to provide appropriate recommendations for protection	

TABLE IV.1. CLASS DESCRIPTION FOR EMERGENCIES AT FACILITIES (cont.)

Emergency class description	Immediate response actions,	Immediate response actions
	Emergency preparedness category I and II facilities	Emergency preparedness category III facilities
Site area emergency Events resulting in a major decrease in the level of protection for those on the site and near the facility. This could be: — A major decrease in the level of defence in depth provided for the core of a reactor or actively cooled fuel (see TABLE 1); — A major decrease in protection against an accidental unshielded criticality; — Conditions such that any additional failures could result in a general emergency; — Doses off the site approaching the generic criteria for urgent protective action [2]; — Nuclear security events with the potential to disrupt the performance of critical safety functions or to result in a major release or severe exposure.	Operator and on-site: — Take life saving actions and give first aid on the site; — Notify off-site officials; — Recommend that preparations be made to implement protective actions in accordance with emergency plan and as described **Appendix X**; — Mobilize the emergency services if needed; — Evacuate non-essential personnel and visitors or provide them with special on-site sheltering, and account for all persons on the site; — Provide protection from hazardous conditions for on-site emergency response personnel and for those arriving from off the site; — Activate the full response coordinated under a unified command and control system;[b] — Take action to mitigate the consequences of the emergency, including requesting off-site assistance; — Provide technical assistance to the facility control room; — Conduct off-site monitoring near the facility and provide results to the radiological monitoring and assessment centre (see **Appendix VII**); — Establish continuous communication with off-site officials; — Conduct, with off-site officials, joint media briefings at the public information centre (see **Appendix VII**); — Reassess the classification and revise if warranted.	Not applicable

TABLE IV.1. CLASS DESCRIPTION FOR EMERGENCIES AT FACILITIES (cont.)

Emergency class description	Response actions,	Response actions
	Emergency preparedness category I and II facilities	Emergency preparedness category III facilities
Site area emergency		Not applicable
	Off-site: — Prepare to implement urgent protective actions as described in **Appendix X** in accordance with the plan taking into account the information provided by the facility; — Alert the population in the PAZ or UPZ, advising them to remain attentive for further instructions; — Activate the full response coordinated under a a unified command and control system;[b] — Provide radiation protection for emergency workers; — Provide firefighting, police or medical services in support of the facility if requested; — Establish the radiological monitoring and assessment centre (see **Appendix VII**) and conduct monitoring in and around the UPZ, and revise the classification as appropriate; — Ensure that all relevant governmental agencies are informed; — Notify the IAEA and all relevant States; — Establish provision to manage the medical response and initial treatment, and consult experts on the treatment of persons with severe overexposures; — Initiate, with on-site officials, joint media briefings at the public information centre (see **Appendix VII**). Within the EPD and ICPD (area where food and water contamination may warrant restrictions: — In accordance with the plan issue instructions to protect water supplies[c] and for farmers to protect crops and put animals on stored feed as appropriate.	

TABLE IV.1. CLASS DESCRIPTION FOR EMERGENCIES AT FACILITIES (cont.)

Emergency class description	Immediate response actions,	Immediate response actions
	Emergency preparedness category I and II facilities	Emergency preparedness category III facilities
Facility emergency Event resulting in a major decrease in the level of protection for on-site personnel; however, these events cannot evolve into a general or site area emergency warranting the implementation of protective actions off the site. For emergency preparedness category I and II facilities, this could be: — A fuel handling emergency; — An in-facility fire or other emergency not affecting safety systems; — Nuclear security event resulting in hazardous on-site conditions but with no potential to result in a criticality or release off the site that would warrant urgent protective actions.	Operator and on-site: (see Ref. [51]) for further guidance for radiotherapy facilities): — Activate the emergency response plan; — Take life saving actions and give first aid on the site; — Notify off-site officials and mobilize emergency services if needed; — Evacuate non-essential personnel and visitors from the potentially hazardous area and account for all persons on the site; — Monitor on-site personnel for contamination and ensure that contaminated individuals or items do not leave the site without authorization; — Provide first aid, register, decontaminate, estimate exposures and take injured and exposed individuals for treatment; — Confirm that off-site protective actions are not needed; — Provide protection from hazardous conditions for on-site and off-site emergency response personnel; — — Take actions to mitigate the emergency and to provide technical assistance to control room or operating staff; — Establish continuous communication with off-site officials; — Activate response coordinated under a unified command and control system;[b] — Conduct, with off-site officials, joint media briefings at the public information centre (see **Appendix VII**); — Reassess the classification and revise if warranted.	Same response actions as described for EPC I and II are applicable for category III facilities. Additionally, the following actions should be taken by the operator and on-site: —Establish the inner cordoned off area ; to prevent entry to the area —Check and ensure security and control of other sources, if applicable;

TABLE IV.1. CLASS DESCRIPTION FOR EMERGENCIES AT FACILITIES (cont.)

Emergency class description	Immediate response actions,	Immediate response actions
	Emergency preparedness category I and II facilities	Emergency preparedness category III facilities
Facility emergency For facilities in category III, this could be: — A major decrease in the level of defence in depth provided for the core of a small reactor (see TABLE 1); — Loss of shielding or control of a large gamma emitter or spent fuel; — Rupture of a dangerous source; — A criticality away from the site boundary; — High doses on the site approaching generic criteria for urgent protective action [2]; — Emergencies resulting in significant exposure or contamination of the public or staff on the site; — Nuclear safety event potentially resulting in hazardous on-site conditions.	Off-site: — Conduct monitoring around the facility to confirm that off-site actions are not needed; — Activate the response coordinated under a a unified command and control system;[b] — Ensure that relevant governmental agencies are informed; — Provide fire, police or medical services in support of the facility if requested; — Provide initial treatment for the injured and consult experts to determine a treatment strategy for those with overexposures; — Initiate, with on-site officials, joint media briefings at the public information centre (see **Appendix VII**).	

TABLE IV.1. CLASS DESCRIPTION FOR EMERGENCIES AT FACILITIES (cont.)

Emergency class description	Immediate response actions,	Immediate response actions
	Emergency preparedness category I and II facilities	Emergency preparedness category III facilities
Alert		
Events involving an unknown or significant decrease in the level of protection of the public or on-site personnel.[d]	Operator and on-site: — Activate the emergency response plan; — Take life saving actions and give first aid on the site; — Notify off-site officials; — Activate, by using the unified command and control system under an emergency response commander, the appropriate part of the response needed to analyse and resolve the condition resulting in the alert or to reduce the potential hazard; — Conduct off-site monitoring near the facility (if appropriate); — Implement actions to mitigate the consequences of the event and to provide technical assistance to control room or operations staff (if required); — Initiate, with off-site officials, joint media briefings at a public information centre if the alert receives media or public attention. Off-site: — Increase readiness; — Implement the minimum components of a unified command and control system; — Ensure that all relevant governmental agencies are informed; — Provide fire, police or medical services in support of the facility if requested; — Initiate, with on-site officials, joint media briefings at the public information centre if the alert receives media or public attention.	Same response actions as described for EPC I and II are applicable for category III facilities. Additionally, the following actions should be taken by the operator and on-site: — Check and ensure security and control of other sources, if applicable;

[a] Indicated by a loss of critical safety functions needed to protect the core or large amounts of recently discharged fuel.
[b] Unified command and control system as described in Ref [13].
[c] Typically only small open water supplies or water supplies that use rainwater are at risk.
[d] Such events may involve release barriers, critical safety systems, instrumentation, staff, natural occurrences, and fires or nuclear security events.

TABLE IV.2. CLASS DESCRIPTION FOR EMERGENCIES FOR ACTIVITIES IN EPC IV [a]

Emergency class description	Response actions to be taken on the site
Other nuclear or radiological emergency Emergency in unforeseen location that covers a broad type of emergencies as described in TABLE 1)	— If the origin of contamination or exposure (actual or potential) is known operator, if applicable, or first responder notifies local officials; — If contamination or exposure is identified or detected but the origin is unknown, local officials should be notified and actions to be taken to find the origin; Once the origine is identified apply the following actions: — Take life saving actions and give first aid on the site; — Establish the inner cordoned off area ; to prevent entry to the area and secure the source; — Evacuate public from the potentially hazardous area and account for all persons on the site;[b] — Check and ensure security and control of other sources, if applicable; — Establish of an emergency response command post; — Ensure that relevant governmental agencies are informed; — Provide fire, law inforcement or medical services to the site, if relevant; — Monitor potentially affected public for contamination, when relevant and ensure that contaminated individuals or items do not leave the site without authorization; — Provide first aid, register, decontaminate, estimate exposures and take injured and exposed individuals for treatment; — Asseess the situation and take necessary protective actions needed. — Initiate media briefings at the public information centre if the emergency receives media or public attention;

[a] The table doesn't cover transnational emergency that is not in category V arising from a nuclear or radiological emergency in another State although they represent Category IV level of hazard.

[b] If emergency triggered by nuclear security event is suspected, evacuation as well as other emergency response actions and overall response should consider that offenders may still be present among the public at the emergency site.

Appendix V

RESPONSE TIME OBJECTIVES

V.1. This appendix provides response time objectives for implementing selected critical response functions or tasks in emergency for facilities in emergency preparedness categories (hereinafter referred to as EPC) I, II, III, activities or acts in EPC IV and areas in EPC V. Once established, they should, be part of the performance objectives for a response capability and should be used as key performance indicator (KPI) as part of the evaluation criteria for exercises [Ref.[2], para. 6.33].

V.2. These time objectives were developed on the assumption that:

(a) severe conditions warranting urgent protective action on the site can occur within minutes;

(b) emergencies resulting in severe conditions can be classified and off-site officials can be notified within minutes [39];

(c) releases can occur from a facility in EPC I that require the implementation of urgent protective action to prevent deterministic effects within the PAZ within one or two hours;

(d) monitoring within the UPZ may be warranted within hours following a release to identify locations where additional protective actions (early protective actions) may be needed;

(e) the news media will become aware of any emergency early on and will become a major source of information for the public within hours.

V.3. It is also assumed that:

(a) emergencies occurring in EPC I facilities are managed at national level.

(b) emergencies occurring in EPC II facilities are managed at local or regional level, the national level could be requested to take over or to provide support, if requested.

(c) emergencies occurring in EPC III facilities are managed by the operating organisation itself. However, the local, regional and national authorities should be immediately notified to enable communication with the public and the media. If requested by the operating organisation, local, regional and/or national authorities could take over or provide support.

(d) most emergencies in EPC IV are managed at local or regional level, the national level could take over or provide support, if requested. Certain nuclear security events (e.g. terrorist attacks) will most likely be managed at the national level.

(e) emergencies affecting a neighbouring country with areas in EPC V will be manage as emergencies occurring at EPC I facilities or at EPC II facilities, accordingly, considering that the time reference point should be the time when notification received from the operator or an authority in the neighbouring State.

V.4. Response time objectives for facilities and activities in EPC I - IV are relative to the identification of the emergency conditions; response time objectives for local/regional and national authorities are relative to the time of the notification.

V.5.

[39] This should be accomplished as soon as possible. Experience demonstrates that this goal can be achieved within 15 minutes of detection of the emergency [Ref. 25].

V.6. TABLE V.1 to TABLE V.5 (and *FIG. V. 1* to *FIG. V.5*) provide response time objectives for all five emergency preparedness categories. The decision to select specific numerical values for the response time objectives remains the responsibility of the relevant national authority. The provided response layout and time objectives should be adapted to the national and local conditions (e.g. available national, regional and local resources and capabilities, protection strategy, emergency response organizations and response structure to deal with the identified hazard).

TABLE V.1. RESPONSE TIME OBJECTIVES FOR EPC I

Element/Task	Facility response (time after detection of emergency conditions)	Local / Regional response (time after being notified)	National response (time after being notified)
Classify emergency and declare the emergency class	<15 min		
Activate the facility emergency response plan (**ERP**)	<15 min		
Activate the emergency centre (**EC**) and operational support centre (**OSC**) of the facility	<15 min		
Initiate mitigatory actions and protective actions on-site	<15 min		
Initiate contingency measures on site (if nuclear security event is suspected)	<15 min		
Notify local/regional authorities within the **PAZ** and **UPZ**	<30 min		
Notify national authority	<30 min	<15 min (if not done by facility)	
Recommend urgent protective actions based on emergency classification to off-site authorities	<30 min		
Activate on-site damage control teams	<30 min		
Request support from off-site emergency services (if needed)	<30 min		
Emergency centre (**EC**) and operational support centre (**OSC**) are fully operational	<30 min		
Activate technical support centre (**TSC**)	<30 min		
Notify States with territories within the **PAZ** and **UPZ**	<45 min		
Technical support centre (**TSC**) is fully operational	< 1 h		
Provide technical assistance to those responding on-site (if requested)	< 1 h		
Complete implementation of protective actions on-site	<1 h		
Conduct environmental monitoring on-site and near the facility (PAZ)	<1 h		
Activate **ERPs** off-site (local/national) and emergency operations facility (**EOF**)		<15 min	<15 min
Notify appropriate law enforcement authorities (if nuclear security event is suspected)			<15 min
Support on-site response (e.g. fire brigades, police, medical assistance) (if requested)		<30 min	
Decide on urgent protective actions in PAZ and UPZ		<30 mins	
Advise local authorities			<30 min
Notify all States with territories within the UPZ (if not done by the facility), **EPD** and **ICPD**			<30 min
Warn, inform, and instruct the public, initiate urgent protective actions in **PAZ** and **UPZ**		<1 h	

Element/Task	Facility response (time after detection of emergency conditions)	Local / Regional response (time after being notified)	National response (time after being notified)
Activate the public information centre (**PIC**) to coordinate (between the facility and off-site officials) press releases		<1 h	<1 h
Activate monitoring teams (local/national)		<1 h	<2 h
Request assistance from national authority (if needed)		<2 h	
Notify the IAEA			<2 h
Decide on protective actions in **EPD** and **ICPD** and instruct the public			<4 h
Initiate environmental monitoring		<2 h	<6 h
Emergency operations facility (**EOF**) is fully operational (all organizations represented)		<4 h	<6 h
Radiological monitoring and assessment centre (**RMAC**) is fully operational		<6 h	<12 h
Emergency Management System is fully operational		<12 h	<24 h
Request international assistance (if needed)			<24 h

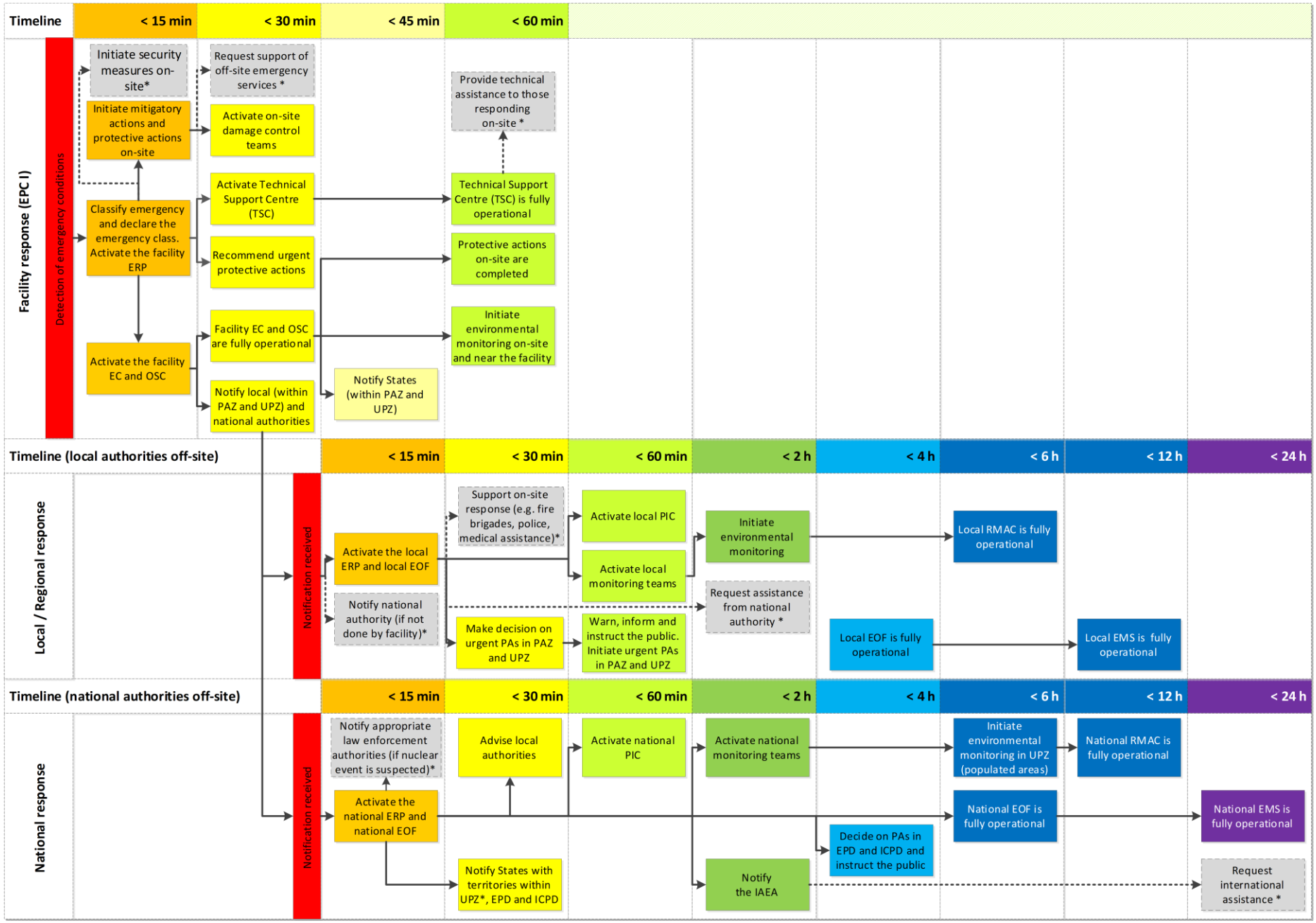


FIG. V. 1. Response time objectives for EPC I

TABLE V.2. RESPONSE TIME OBJECTIVES FOR EPC II

Element/Task	Facility response (time after detection of emergency conditions)	Local/Regional response	National response
		(time after being notified)	
Classify emergency and declare the emergency class	<15 min		
Activate the facility emergency response plan (**ERP**)	<15 min		
Activate the emergency centre (**EC**) and operational support centre (**OSC**) of the facility	<15 min		
Initiate mitigatory actions and protective actions on-site	<15 min		
Initiate contingency measures on site (if nuclear security event is suspected)	<15 min		
Notify local/regional authorities within the **UPZ**	<30 min		
Notify national authority	<30 min	<15 min (if not done by facility)	
Recommend urgent protective actions based on the emergency classification to off-site authorities	<30 min		
Activate on-site damage control teams	<30 min		
Request support from off-site emergency services (if needed)	<30 min		
Emergency centre (**EC**) and operational support centre (**OSC**) are fully operational	<30 min		
Activate technical support centre (**TSC**)	<30 min		
Notify States with territories within the **UPZ**	<45 min		
Technical support centre (**TSC**) is fully operational	< 1 h		
Provide technical assistance to those responding on-site (if requested)	<1 h		
Complete implementation of protective actions on-site	<1 h		
Conduct environmental monitoring on-site and near the facility	<1 h		
Activate **ERPs** off-site (local / national) and emergency operations facility (**EOF**)		<15 min	<15 min
Notify appropriate law enforcement authorities (if nuclear security event is suspected)			<15 min
Support on-site response (e.g. fire brigades, police, fire brigades, medical assistance) (if requested)		<30 min	
Make decision on urgent protective actions in UPZ		<30 min	
Advise local authorities			<30 min
Notify all States within the **UPZ** (if not done by the facility), EPD and ICPD			<30 min
Warn, inform and instruct the public, initiate urgent protective actions in UPZ		<1 h	
Activate the public information centre (**PIC**) to coordinate (between the facility and off-site officials) press releases		<1 h	<1 h
Activate monitoring teams (local / national)		<1 h	<2 h
Request assistance from national authority (if needed)		<2 h	
Notify the IAEA			<2 h
Decide on protective actions in **EPD** and **ICPD** and instruct the public			<4 h
Initiate environmental monitoring		<2h	<6 h
Emergency operations facility (**EOF**) is fully operational (all organizations represented)		<4 h	<6 h

Element/Task	Facility response (time after detection of emergency conditions)	Local/Regional response	National response
		(time after being notified)	
Radiological monitoring and assessment centre (**RMAC**) is fully operational		<6 h	<12 h
Emergency Management System is fully operational		<12 h	<24 h
Request international assistance (if needed)			<24 h

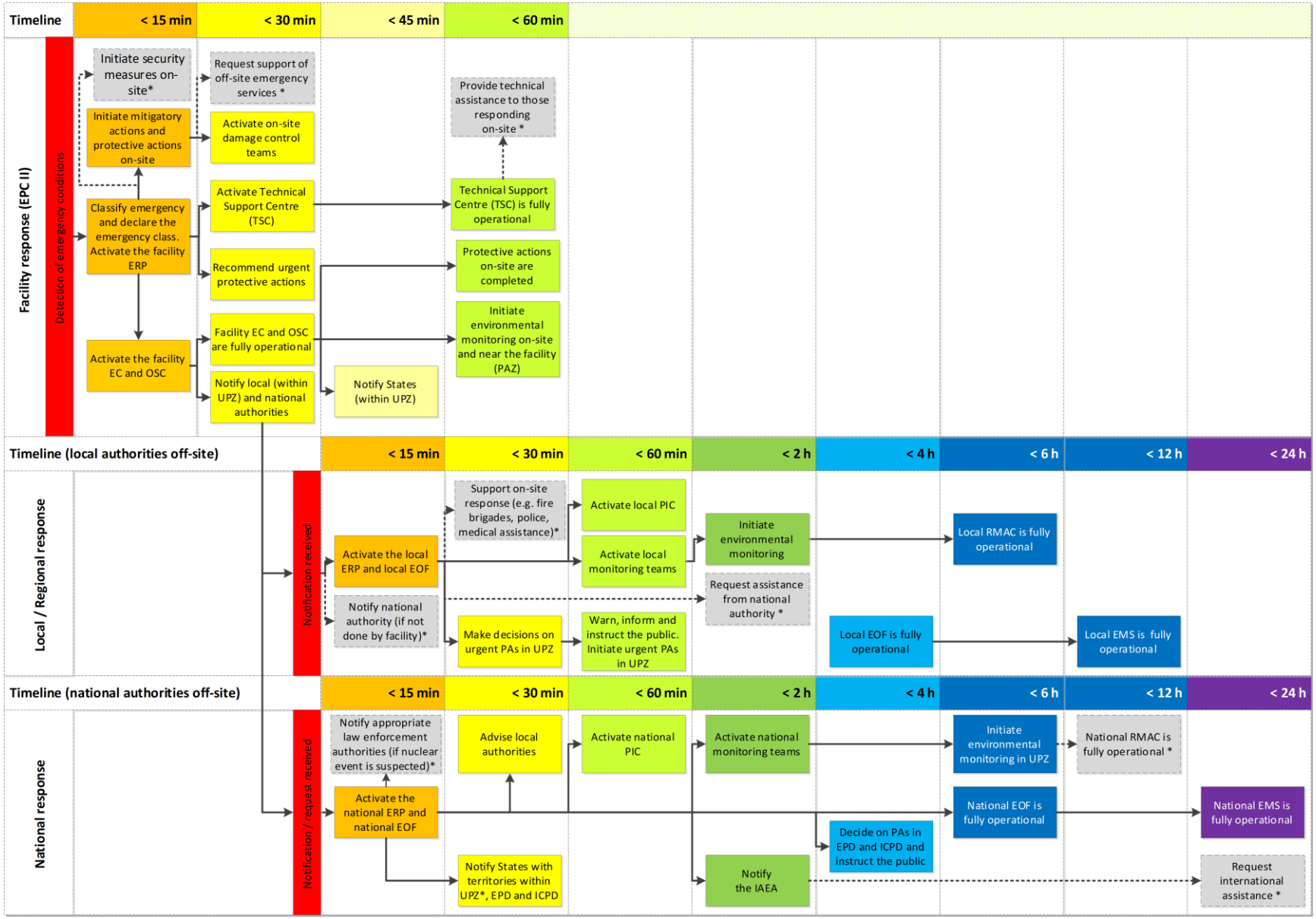


FIG. V.2. Response time objectives for EPC II

TABLE V.3. RESPONSE TIME OBJECTIVES FOR EPC III

Element/Task	Facility response	Local/ Regional response	National response
	Time after detection of emergency conditions	Time after notification	
Classify emergency and declare the emergency class	<15 min		
Activate the facility emergency response plan (**ERP**) and facility emergency management team (EMT)	<15 min		
Initiate mitigatory actions and protective actions on the site	<15 min		
Take life-saving actions and provide first aid (if required)	<15 min		
Initiate contingency measures on site (if nuclear security event is suspected)	<15 min		
The facility emergency management team (EMT) is fully operational	<30 min		
Notify local/regional authorities	<30 min		
Hazardous areas are evacuated and secured	<30 min		
Activate on-site damage control teams	<30 min		
Request support of off-site emergency services (if needed)	<30 min		
Initiate monitoring on-site and near the facility	<1 h		
Complete implementation of protective actions on-site	<1 h		
Request additional support from local authorities, if needed	<1 h		
Activate the off-site local/ regional **ERP**		<15 min	
Establish local/regional Emergency Response Command Post (**ERCP**)		<15 min	
Notify national authority		<30 min	
Activate relevant components of the national **ERP**			<15 min
Notify appropriate law enforcement authorities (if nuclear security event is suspected)			<15 min
Emergency services support on-site response (e.g. fire brigades, police, medical assistance) (if needed)		<30 min	
Activate the public information centre (**PIC**) to inform the public		<1 h	<2 h (if needed)
Activate monitoring teams		<1 h	
Make decision on response actions (if any)		<1 h	
Advise local authority			<1 h
Initiate environmental monitoring around the facility to confirm no protective actions are required		<2 h	
Request support from national authority (if needed)		<2 h	
Instruct the public		<2 h	
Emergency Response Command Post (**ERCP**) is fully operational (all organizations represented)		<4 h	
Provide assistance to local authorities (if requested)			<4 h
Radiological monitoring and assessment centre (**RMAC**) is fully operational (if needed)		<6 h	
Emergency Management System is fully operational (if needed)		<12h	

Element/Task	Facility response	Local/ Regional response	National response
	Time after detection of emergency conditions	Time after notification	
Notify the IAEA, if relevant			<12h
Request international assistance (if needed)			<24h

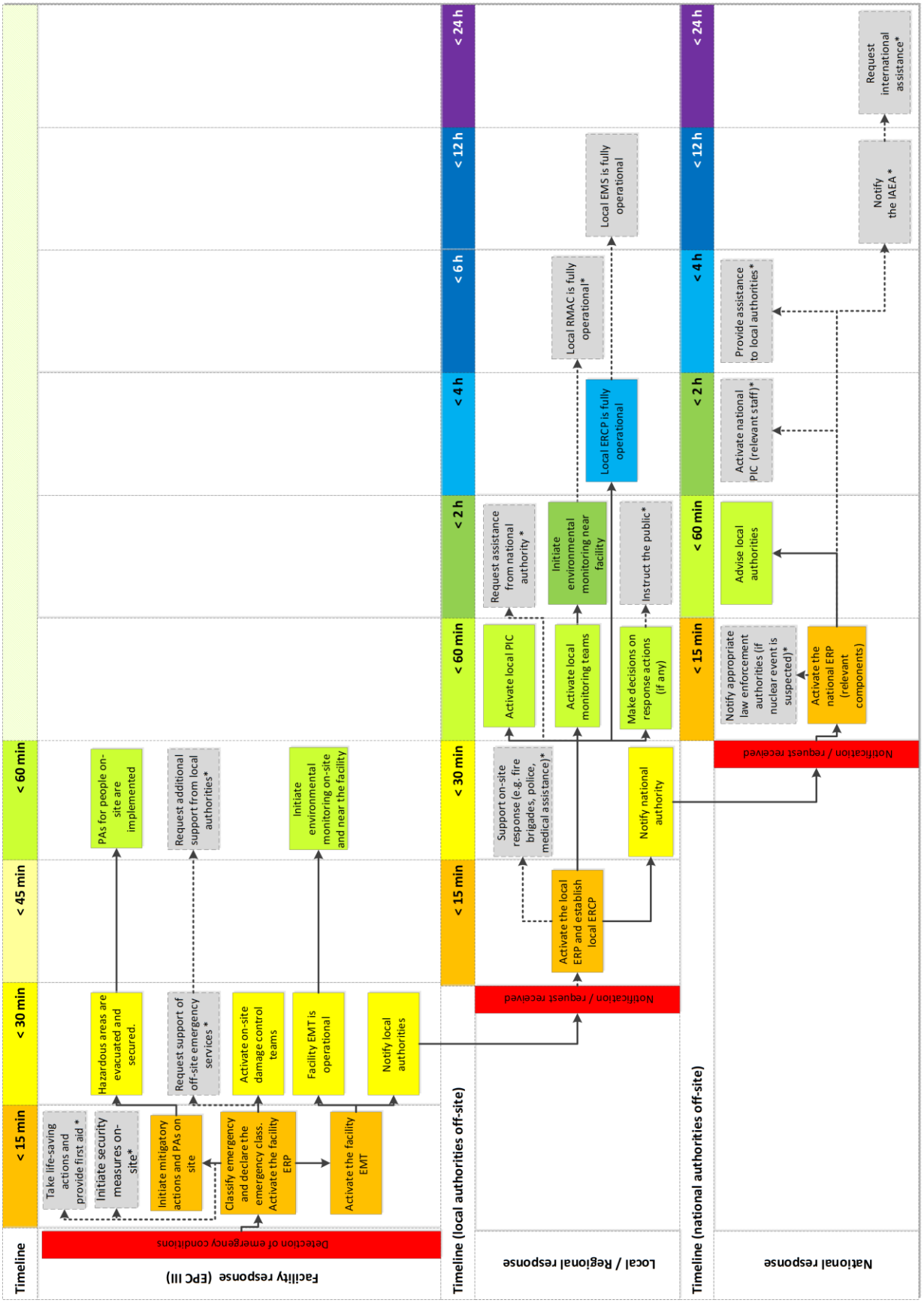


FIG. V.3. Response time objectives for EPC III

TABLE V.4. RESPONSE TIME OBJECTIVES FOR ACTIVITIES AND ACTS IN EPC IV

Element/Task	Operating organisation[a] or first responder's response	Local/Regional response	National response
	Time after detection of emergency conditions or arrival of first responders at the site	Time after being notified	
Identify type of radiological emergency.	<15 min		
Activate the emergency response plan (**ERP**)	<15 min		
Activate the Emergency Response Command Post (**ERCP**) (applicable only for first responder's response)	<15 min		
Initiate mitigatory actions and protective actions on site.	<15 min		
Take life-saving actions and provide first aid (if required)	<15 min		
Initiate contingency measures on site (if nuclear security event is suspected)	<15 min		
Notify local/regional authorities	<30 min		
Hazardous area is cordoned off. and secured.	<30 min		
Request support of off-site emergency services (if needed)	<30 min		
Initiate monitoring on site and around or request support in radiological assessment	<1 h		
Adjust cordon off area based on monitoring results (if applicable)	< 2 h		
Request assistance from local authorities (if needed)	<2 h		
Activate off site local/regional **ERP**		<15 min	
Establish local/regional Emergency Response Command Post (**ERCP**), if not done by first responders		<15 min	
Notify national authority		<30 min	
Activate relevant components of the national **ERP**			<15 min
Notify appropriate law enforcement authorities (if nuclear security event is suspected)			<15 min
Emergency services support on-site response (e.g. fire brigades, police, medical assistance) (if requested by operating organisation[a])		<30 min	
Make decision on PAs in the site vicinity (if any)		<30 min	
Advise to local authorities			<30 min
Warn, inform and instruct the public, initiate protective actions in the site vicinity (if needed)		<1 h	
Activate the public information centre (**PIC**) to inform the public		<1 h	<2 h (if needed)
Activate monitoring teams		<1 h	
Initiate environmental monitoring to assess the situation		<2 h	
Request assistance from national authority (if needed)		<2 h	
Emergency Response Command Post (**ERCP**) is fully operational (all organizations represented)		< 4 h	
Provide assistance to local authorities (if requested)			<4 h
Notify the IAEA and potentially affected States (if transnational impact possible)			<4 h

Element/Task	Operating organisation[a] or first responder's response	Local/Regional response	National response
	Time after detection of emergency conditions or arrival of first responders at the site	Time after being notified	
Radiological monitoring and assessment centre (**RMAC**) is fully operational (if needed)		<6 h	
Emergency Management Structure/System is fully operational (if needed)		<12 h	
Request international assistance (if needed)			<24 h

[a] The same level of response is expected from facility or location at which there is a significant likelihood of encountering a dangerous source

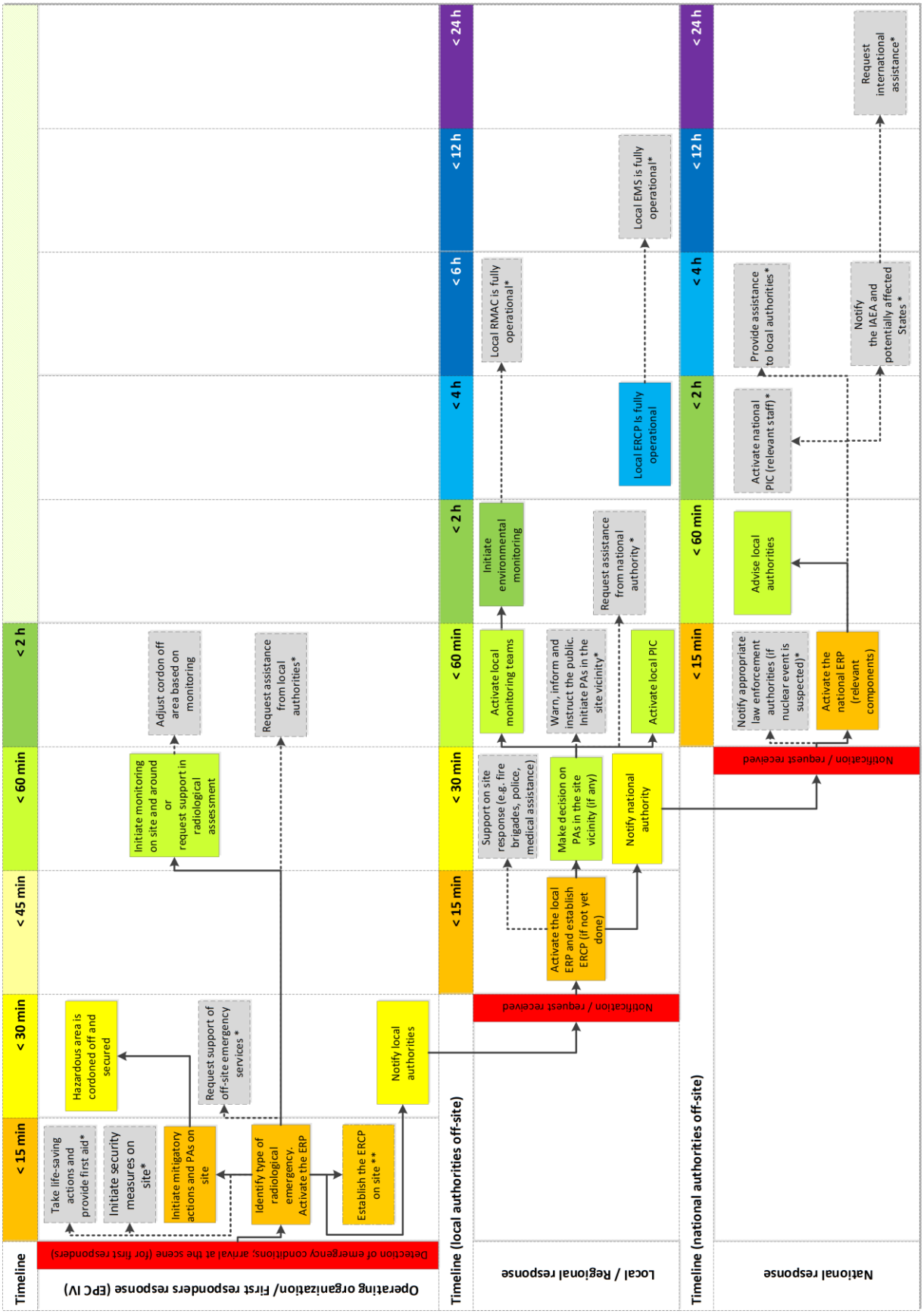


FIG. V.4. Response time objectives for EPC IV

TABLE V.5.RESPONSE TIME OBJECTIVES FOR AREAS IN EPC V

Element/Task	Facility response	Local/ Regional response	National response
		(time after being notified)	
Activate **ERPs** off-site (local / national) and emergency operations facility (**EOF**)		<15 min	<15 min
Decide on urgent protective actions in UPZ		<30 mins	
Support local authorities			<30 min
Warn, inform and instruct the public, initiate urgent protective actions in **UPZ**		<1 h	
Activate the public information centre (**PIC**) to coordinate press releases		<1 h	<1 h
Activate monitoring teams (local / national)		<1 h	<2 h
Inform the IAEA about protective actions taken			<2 h
Decide on protective actions in **EPD** and **ICPD** and instruct the public			<4 h
Request assistance from national authority (if needed)		<2h	
Initiate environmental monitoring (populated areas of UPZ)		<2h	
Asssist with environmental monitoring			<6 h
Emergency operations facility (**EOF**) is fully operational (all organizations represented)		<4 h	<6 h
Radiological monitoring and assessment centre (**RMAC**) is fully operational		<6 h	<12 h
Emergency Management System is functional		<12 h	<24 h
Request international assistance (if needed)			<24 h

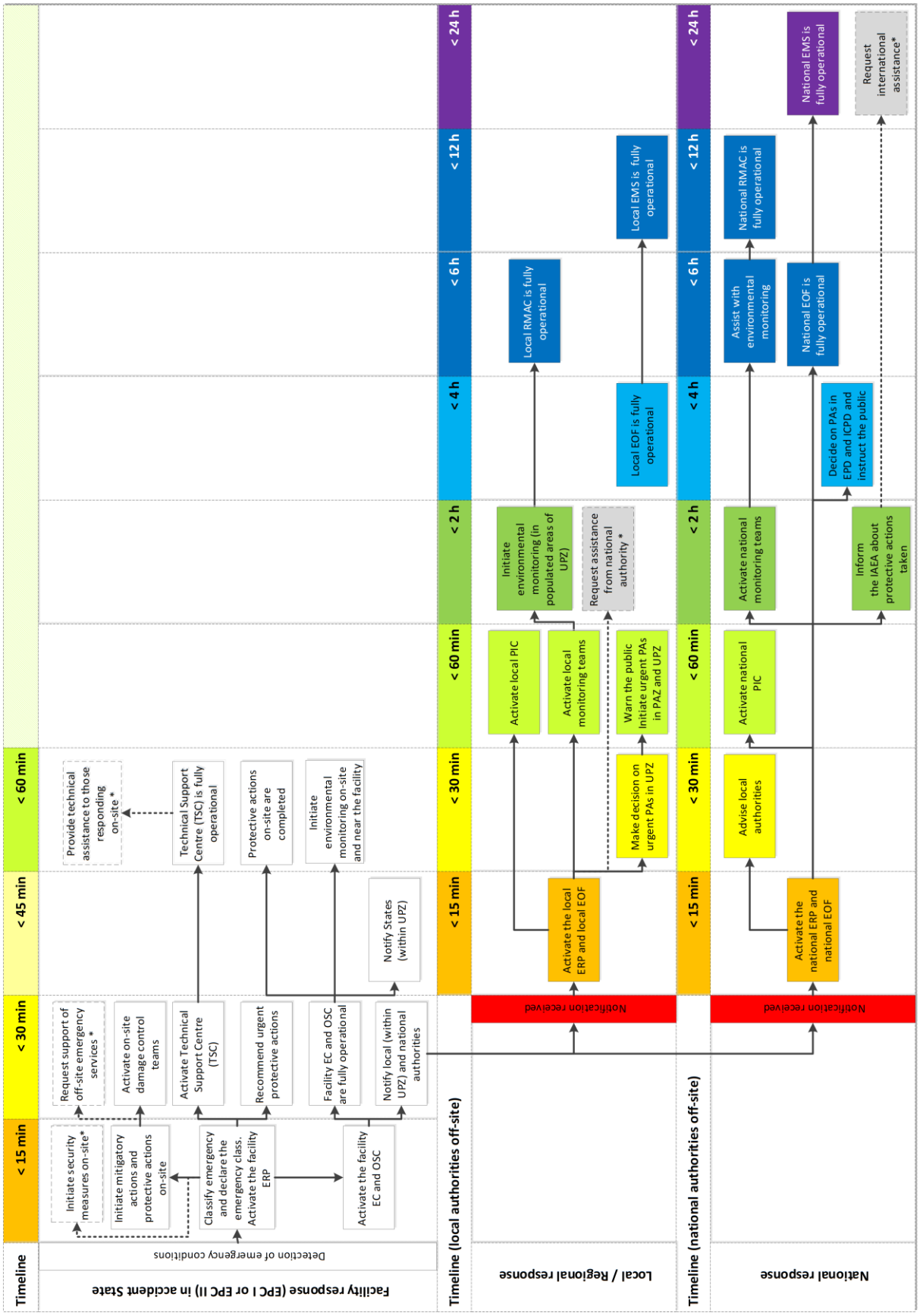


FIG. V.5. Response time objectives for EPC V

Appendix VI

AREAS, EMERGENCY PLANNING ZONES AND EMERGENCY PLANNING DISTANCES

EMERGECNY PREPAREDNESS CATEGORIES III AND IV (RADIOLOGICAL EMERGENCIES)

VI.1. TABLE VI.1 provides suggestions for the approximate radius of the inner cordoned off area in a radiological emergency. The layout example of the seen of radiological emergency and established safe distances are shown in *FIG.VI.1*. **Appendix X** discusses the protective actions that are justified within these areas.

TABLE VI.1. SUGGESTED RADIUS OF THE INNER CORDONED OFF AREA (SAFETY PERIMETER) FOR RADIOLOGICAL EMERGENCY

Situation	**Initial inner cordoned off area (safety perimeter)**
Initial determination — outside	
Unshielded or damaged potentially dangerous source[a]	30 m radius around the source
Major spill from a potentially dangerous source	100 m radius around the source
Fire, explosion or fumes involving a dangerous source	300 m radius
Suspected bomb (possible radiological dispersal device), exploded or unexploded	400 m radius or more to protect against an explosion
Conventional (non-nuclear) explosion or a fire involving a nuclear weapon (no nuclear yield)	1000 m radius
Initial determination — inside a building	
Damage, loss of shielding or spill involving a potentially dangerous source	Affected and adjacent areas (including floors above and below)
Fire or other event involving a potentially dangerous source that can spread radioactive material throughout the building (e.g. through the ventilation system)	Entire building and appropriate outside distance as indicated above
Expansion based on radiological monitoring	
OIL2 in Table 8 in GSG-2 [3]	Wherever these levels are measured

[a] See **Appendix II**.

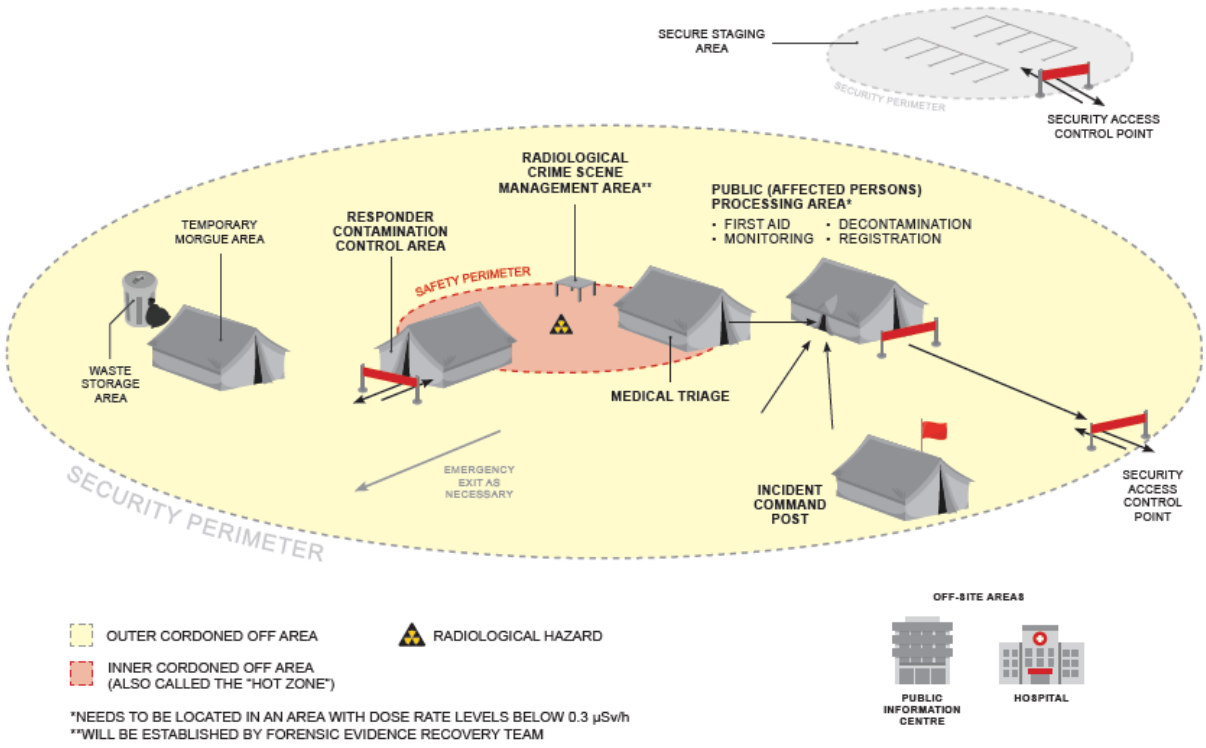


FIG.VI.1. Areas established by first responders

FACILITIES IN EMERGENCY PREPEREDNESS CATEGORIES I AND II

VI.2. The off-site emergency planning zones and emergency planning distances for effective decision making on and taking urgent protective actions and other response actions in the emergency should be identified and established in the preparedness stage as one of the outcomes of the justified and optimized national protection strategy. The sizes of the emergency planning zones and emergency planning distances should be commensurate with the hazard identified and with the potential consequences of any postulated emergency.

VI.3. TABLE VI.2 provides suggestions for the sizes of the off-site emergency planning zones and emergency planning distances for facilities in emergency preparedness categories I and II given in terms of the radius of a circle around the facilities. The distances in TABLE VI.2 are suggested based on a general analysis and with due recognition of the great uncertainties involved. They should be adjusted to meet site-specific local conditions. However, boundaries that are more than a factor of two less than or greater than the recommended ranges given in TABLE VI.2 should be avoided, unless it is justified and supported by detailed analysis, because it could reduce the effectiveness of the associated protective actions and other response actions.

VI.4. Each State should carry out an independent analysis to determine sizes of its own emergency planning zones and emergency planning distances that are appropriate in view of the specifics of the State, provided that the analysis: (a) addresses the full range of possible emergencies, including those of very low probability, as required by the GSR Part 7 (Ref. [2], para. 4.20); and (b) is carried out with the goal of meeting the requirements for establishing these zones as established in the Requirements 9 of GSR Part 7 (Ref. [2], para. 5.38).

VI.5. The sizes of the emergency planning zones and distances should be determined taking into account the characteristics of the site and surrounding areas. The information to be considered includes environmental conditions (e.g. geographic situation, geology, climate), population density, types of land use (e.g. urban, recreational, industrial, agricultural), infrastructural conditions (e.g. roads, airports and railways, location of other industrial facilities), economic and social aspects, as well as any external events that could hinder the establishment of complete emergency arrangements at the latest at the preparedness stage if the installation were in place and best prior to operation for new installation [52, Req. 13].

VI.6. The actual boundary of the emergency planning zones should not be a circle but should be established to conform to physical and geographical features such as roads, rivers or administrative boundaries, as illustrated in *FIG. 5*, so that the public and those responding to the emergency can easily identify them.

VI.7. Emergency planning zones and distances should not stop at national boundaries.

VI.8. The sizes of the emergency planning zones and distances should be revised with the change of the hazard (e.g. modifications in the design of nuclear power plant). Periodical review of the boundary of the off-site areas may be necessary based on the new information available (e.g. change of local conditions).

VI.9. Making advanced arrangements within the sizes suggested in TABLE VI.2 is considered as justified in order to ensure an effective response and adequate protection of the public. In a particular emergency, protective actions and other response actions may be warranted only in a small part of the suggested radii. However, for sever emergencies, protective actions might need to be taken beyond the size suggested, therefore arrangement should be made for the extendibility of the emergency response beyond the areas of the emergency planning zones and distances to deal with such actual emergencies.

TABLE VI.2. SUGGESTED SIZES FOR THE OFF-SITE EMERGENCY PLANNING ZONES AND EMERGENCY PLANNING DISTANCES

Facilities	Precautionary action zone (PAZ) radius[a,c,d]	Urgent protective action planning zone (UPZ) radius [b,c,d]	Extended planning distance (EPD)[e]	Ingestion and commodities planning distance (ICPD)
Emergency preparedness category I facilities				
Reactors ≥ 1000 MW(th) $\left[\frac{A}{D}\right]_2$ from **Appendix II** is ≥ 10^5 [f]	3–5 km	15–30 km	100 km	300 km
Reactor 100–1000 MW(th) $\left[\frac{A}{D}\right]_2$ from **Appendix II** is ≥ 10^4–10^5 [f]	3–5 km	15–30 km	50 km	100 km
Emergency preparedness category II facilities				
Reactors 10–100 MW(th) $\left[\frac{A}{D}\right]_2$ from **Appendix II** is ≥ 10^3–10^4 [f]	None	0.5–5 km	10 km	20 km
Reactors 2–10 MW(th) $\left[\frac{A}{D}\right]_2$ from **Appendix II** is ≥ 10^2–10^3 [f]	None	0.5 km	2 km	5 km
Fissionable mass is possible within 500 m of site boundary	None	0.5–1 km	None	None

[a] The suggested radii are the approximate distances for which the RBE weighted absorbed dose to the red marrow or the fetus from inhalation will not exceeded the generic criteria given in Table II.1 in GSR Part [2].

[b] The suggested radii are the approximate distances for which the committed effective dose from inhalation or the equivalent dose to the fetus following inhalation by the pregnant woman will not exceed the generic criteria in Table II.2 in GSR Part [2].

[c] The source term (release) used for reactor emergencies is based on the maximum expected release characteristics (e.g. release of 10% of the volatile fission products [30, 31], a ground level release, release duration of 10 hours) that could potentially lead to severe deterministic effects or to stochastic effects off the site.

[d] The radii were selected on the basis of calculations performed with the RASCAL 4.3 computer model [53]. For the purpose of the calculation, typical meteorological conditions, an exposure to cloud shine and inhalation for 10 hours and one day of ground shine are assumed, and the centreline dose to a person outside is calculated.

[e] The suggested radii are the approximate distances for which the total effective dose will not exceed the generic criteria in Table II.2 in GSR Part [2].

[f] Assuming that 10% of the inventory is released to the atmosphere [30, 31].

[g] The radial distance (500 m) is the distance at which the generic criteria in Table II.2 in GSR Part [2] is exceeded, on the assumption that the building containing the criticality (fissile material) does not provide significant shielding and that the criticality results in 10^{19} fissions [54]. This includes the dose due to external irradiation (gamma and neutron) and was calculated using the RASCAL 4.3 model [53]

Precautionary action zone (PAZ)

VI.10. The PAZ, which only applies to facilities in EPC I, is defined by GSR Part 7 [2] as an area for which arrangements shall be made for taking urgent protective actions and other response actions, 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), in order to avoid or to minimize severe deterministic effects.

VI.11. The suggested sizes for the PAZ are based on the methodology provided in Ref. [55] and expert judgement made in consideration of the following:

1. Dose rates that could be fatal within a few hours were observed at these distances during the Chornobyl accident.
2. Precautionary urgent protective actions taken within this radius before any significant release will avert doses exceeding the generic criteria for taking protective actions and other response actions under any circumstances to avoid or to minimize severe deterministic effects (Table II.1 in Ref [2]) for the range of emergencies postulated for the facility.
3. The maximum reasonable radius for the PAZ is assumed to be 5 km because: (a) it provides a reduction in dose by a factor of about ten in comparison with the dose on the site [55]; (b) it is considered the practical limit of the distance to which substantial sheltering or evacuation can be promptly implemented before or shortly after a radioactive release;
4. Implementing precautionary urgent protective actions to a larger radius might reduce the effectiveness of the actions for the people nearer the site who are at the greatest risk.

Urgent protective action planning zone (UPZ)

VI.12. The UPZ, which applies to facilities in EPC I and II, is defined by GSR Part 7 [2] as an area for which arrangements shall 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), and after a release occurs, on the basis of monitoring and assessment of the radiological situation off the site, in order to reduce the risk of stochastic effects. Any such actions shall 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.

VI.13. The suggested sizes of the UPZ are based on the methodology provided in Ref. [55] and expert judgement made in consideration of the following:

Emergency preparedness category I facilities

1. Urgent protective actions taken within this radius before or shortly after significant release will avert doses exceeding the generic criteria for taking urgent protective actions and other response actions to reduce the risk of stochastic effects (Table II.2 in Ref [2]), for the range of emergencies postulated for the facility.
2. The practical limit for the radial distance within which to conduct monitoring and to implement appropriate urgent protective actions within a few hours following a significant release (i.e. urgent response phase) on the basis of the OILs.
3. At these radial distances there is a reduction in dose by a factor of approximately ten in comparison with the expected doses at the PAZ boundary.

4. This distance provides a substantial base for the expansion of response efforts and gradual evacuation to mitigate traffic congestion or 'shadow evacuations'[40].

Emergency preparedness category II facilities

Atmospheric release

1. Urgent protective actions taken within this radius before or shortly after significant release will avert doses exceeding the generic criteria for taking urgent protective actions and other response actions to reduce the risk of stochastic effects (Table II.2 in Ref [2]), for the range of emergencies postulated for the facility
2. A distance of 0.5 km was selected as the smallest radius, in consideration of possible wake effects caused by buildings. The suggested radius for the UPZ are assumed to be 0.5-5 km and 0.5 km with accordance of thermal power of reactors as the result of scaled down of the radius of the category I facilities proportionally.

Fissionable mass (criticality)

1. Urgent protective actions taken shortly after a criticality will avert doses exceeding the generic criteria for taking urgent protective actions and other response actions to reduce the risk of stochastic effects (Table II.2 in Ref [2]), for the range of emergencies postulated for the facility.

2. The radiological risk due to a criticality is dominated by the external dose due to gamma and neutron radiation.

3. The off-site doses due to past criticality accidents have not warranted urgent protective actions beyond a distance of 0.5–1 km.

Extended planning distance (EPD)

VI.14. The EPD, which applies to facilities in EPC I and II, is defined by GSR Part 7 [2] as area for which arrangements shall be made to conduct monitoring and assessment of the radiological situation off the 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.

VI.15. The suggested sizes of the EPD are based on expert judgement made in consideration of the following:

Emergency preparedness category I facilities

1. Early protective actions taken within this radius following any significant release will avert doses exceeding the generic criteria for taking early protective actions and other response

[40] Shadow evacuation is unofficial spontaneous evacuation undertaken by members of the public who are located outside the area where evacuation is officially recommended. This type of evacuation has the potential to impede and delay the evacuation from the higher priority areas.

actions to reduce the risk of stochastic effects (Table II.2 in Ref [2]), for the range of emergencies postulated for the facility

2. The practical limit for the radial distance within which to conduct monitoring and to implement appropriate early protective actions within a few weeks following a significant release (i.e. during the early response phase) on the basis of the OILs.
3. Depositions that could result in doses exceeding the criteria for taking early protective actions to reduce the risk of stochastic effects (Table II.2 in Ref [2]) were observed at similar distances during the Chornobyl accident [55].
4. Adequate planning within this distance provides a substantial basis for the expansion of monitoring, if found to be necessary.

Emergency preparedness category II facilities

1. EPD is sufficient to locate hotspots following a significant release causing exposures off the site with doses exceeding criteria for taking early protective actions to reduce the risk of stochastic effects (Table II.2 in Ref [2]) .

Ingestion and commodities planning distance (ICPD)

VI.16. ICPD applies to facilities in EPC I and II and is defined by GSR Part 7 [2] as area for which arrangements shall be made to take response actions (1) for protecting the food chain and water supply as well as for protecting commodities other than food from contamination following a significant radioactive release and (2) for protecting the public from ingestion of food, milk and drinking water and from the use of commodities other than food with possible contamination following a significant radioactive release.

VI.17. The ICPD is suggested to be established to a distance to which experience and analysis indicate that a release could result in contamination of produce, rainwater, milk from grazing animals and commodities that if not restricted could result in doses in excess of those warranting restrictions in accordance with the generic criteria in in Table II.3 in GSR Part 7 [2].

Appendix VII

EMERGENCY RESPONSE FACILITIES OR LOCATIONS

VII.1. Emergency response facilities or locations are predefined facilities or locations needed to support the emergency response. Emergency response facilities or locations should be established to perform the functions listed in this Appendix.

VII.2. There are two different types of emergency response facilities or locations: those established in advance and those established at the time of the emergency. In both cases the functions of and operational conditions and requirements for the facilities or locations should be carefully considered, and necessary advance preparations should be made. Facilities or locations established in advance (e.g. emergency operations facility for categories I, II and V) are designed, built and equipped to support their functional and operational requirements. If the facility or location is to be established at the time of an emergency (e.g. emergency response command post for category IV), advance preparations should be made to find a suitable location and to establish the centre rapidly under field conditions. These preparations should include: developing site selection criteria; assigning the responsibility for acquiring a site during an emergency; establishing a team for setting up the emergency facility; and also, having procured and prepared in advance equipment (e.g. generators), supplies and other items needed to establish the emergency response facility in the field. Establishing such an emergency response facility under field conditions shall be exercised.

VII.3. A list of emergency response facilities or locations needed to support the functional requirements for each category are listed in TABLE VII.1 and described in TABLE VII.2 and TABLE VII.3. The emergency response facilities or locations may go by different names and may be collocated (with the exception of the control room); meaning that several functions may be performed from a single emergency response facility or location provided that performance of these functions is not impaired. Depending on the severity of the emergency, emergency facilities may be emergency locations and vice versa. *FIG.VII.1*and *FIG.VI.1* show the generic layout of the emergency response facilities and locations.

VII.4. Each emergency response facility or location should be:

- Designed to support the functions that take place within it (as specified in TABLE VII.2 and TABLE VII.3);
- Usable under emergency conditions;
- Integrated into the unified command and control system.

VII.5. The steps in developing and establishing an adequate emergency response facility or location are the following:

a. Determine the functions of the emergency response facility or location;

b. Determine the relationship to other emergency response facilities and locations, areas or functions in the response system (with the objective of reaching complementarity between functions and avoiding unnecessary interferences between functions);

c.Determine the conditions under which the emergency response facility or location must function (e.g. environmental and radiological conditions); and

d. Determine the needs for space, light, power, communication and other environmental needs for each emergency response facility or location, including ventilation, food and water supplies and sanitary and sleeping arrangements; and

e. Analyse the organization of the facility or location;

f. Assess the flows (e.g. of people, information, samples) associated with each position within the emergency response facility or location;

g. Determine the workstation requirements for each position;

VII.6. TABLE VII.2 and TABLE VII.3 refers the following provisions that shall be implemented for the emergency response facilities and locations:

(a) to support the command and control arrangements necessary to allow all required accident management measures to be undertaken to control and mitigate the consequences of postulated accident conditions;

(b) to operate during protracted events for the full duration of the response;

(c) to operate in case of damaged infrastructure (e.g. power backups);

(d) to radiologically monitor personnel moving in and out of the facility or location;

(e) to perform contamination control;

(f) to provide needed protection as emergency workers[41] for those in and working from the emergency facility or location;

(g) to ensure security;

(h) to maintain communication capabilities in case of damaged infrastructure or overload of the networks with other on and off-site emergency response facilities or locations and response personnel;

(i) to use seismically robust emergency response facilities and that are protected from other natural hazards (e.g. wild fires, floods);

(j) to provide road access under emergency conditions;

(k) to accommodate the number of emergency responders assigned; and

(l) to meet human needs (e.g. with food, water and sanitary and sleeping arrangements) if the emergency response facility may be isolated for an extended period during an emergency (this might be the function of a separate and additional emergency facility).

(m) to operate under the full range of possible on-site conditions affecting the response to postulated emergencies, to include those of very low probability [i.e. unavailability of instruments, unavailability of power from the plant or offsite grid, as well as hazardous conditions affecting response personnel, to include environmental (e.g. high temperatures and hazardous gases), security (e.g. criminal acts) and radiation issues (to include external dose rates and airborne, surface and water contamination)] by making use of a hardened support infrastructure (e.g. power backups, filtering, shielding, ventilation, equipment);

(n) to monitor and control contamination for those entering the emergency facility;

(o) to provide needed protection from radiological and other hazardous conditions postulated during an emergency for those leaving the emergency facility;

[41] Ensure that those that may be exposed over occupational guidelines are designated as emergency workers; are instructed on the risk, actions to protect themselves and accepted this designation.

(p) to display relevant near real-time data available from robust sources of information (e.g. plant conditions or monitoring network data).

(q) to have access to design and safety analysis data. The availability of information should not depend upon electronic storage or indexing.

(r) to operate in those areas were radiation levels do not warrant hardened infrastructure (located beyond the UPZ);

(s) to monitor radiation levels;

(t) to relocate to pre-designated backup emergency response facilities and locations (pre-staged with the essential infrastructure to allow basic operations) located beyond the EPD if warranted due to radiological conditions; and

(u) to assure the adequacy of public access roads.

VII.7. These general provisions shall be complemented by the additional provisions given in TABLE VII.2 and TABLE VII.3.

VII.8. Consideration shall be made for emergency response facilities in category I where there is the potential for an emergency affecting multiple units and/or multiple sites.

TABLE VII.1 RECOMMENDED EMERGENCY RESPONSE FACILITIES OR LOCATIONS

Emergency response facility or location	Emergency preperedness category				
	I	II	III	IV	V
On-site					
Control room	✓	✓			
Supplementary control room	✓	✓			
Emergency centre	✓	✓			
Operational support centre	✓	✓			
Technical support centre	✓	✓			
Assembly point	✓	✓			
Off-site					
Emergency operations facility [a]	✓	✓			✓[d]
Emergency response command post [b c]			✓	✓	
Public information centre	✓	✓	✓[f]	✓[f]	✓
Radiological monitoring and assessment centre	✓	✓	✓[f]	✓[f]	✓
Response organization emergency operations centre	✓	✓	✓	✓	✓
Staging and storage location	✓	✓	✓[f]	✓[f]	✓
Triage area	✓[h]	✓[h]	✓[f]	✓[f]	✓[h]
Backup laboratory(ies)	✓	✓			✓
Reception centres	✓	✓		✓[f]	✓
Designated hospital(s)	✓	✓	✓	✓[e]	✓
Notification point(s)	✓	✓	✓		
Warning point [g]				✓	✓
Forensic evidence and crime scene management area				✓[i]	
Public processing area				✓[i]	
Responder contamination control area				✓[i]	
Temporary morgue area				✓[i]	
Waste storage area				✓[i]	
Emergency exit corridor				✓[i]	

[a.] Pre-established for categories I and II

[b.] Established at the time of the emergency for categories III and IV.

[c.] Function performed typically in the emergency operations facility for category I and II

[d.] A single national emergency facility would probably be established for an emergency involving major contamination.

[e.] A hospital anywhere in the State

[f.] Not at a prepared location, location identified at the time of the emergency

[g] Warning point may be collocated with one of the national notification points.

[h] Would probably be established at the reception centers for categories I and II.

[i] Applicable for radiological emergencies.

TABLE VII.2. DESCRIPTION OF ON-SITE EMERGENCY RESPONSE FACILITIES OR LOCATIONS

Emergency facility/location	Functions	Provisions as given in Paragraph VII.6	Additional provisions
Control room	For the operational control of the facility, detection and classification of the emergency, and activation of the response organization. Its functions are not related to the direct operational control of the facility. Safety functions should be transferred to other facilities as soon as possible.	a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q	Access to data needed to detect and classify an emergency and to implement mitigatory actions; and provided with security to prevent unauthorized access. With the beginning of an emergency the number of responsibilities of the control room will increase significantly (such as diagnosis, mitigation, management and off-site notification), which should be transferred to other facilities as soon as possible, to prevent congestion in the control room and relieve the control room from peripheral duties.
Supplementary control room	For operational control of the facility in case the control room is lost.	a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q	Basic instrumentation and controls to perform a normal shutdown and basic equipment with the essential elements to implement mitigatory actions (e.g. manuals, special tools and keys); and provided with security to prevent unauthorized access.
Emergency centre	Management of the total on-site response. Typically staffed by the director of the on-site response. Its main purpose is to coordinate all onsite response while ensuring that the control room is only dedicated to the operational control of the facility.	a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q	Access to the information required to coordinate on-site response and control onsite personnel deployed offsite; reliable communications with on-site emergency response facilities and the offsite 'emergency operations facility'.
Operational support centre (OSC)	Operational control of personnel performing tasks within and near the facility (e.g. environmental monitoring, health physics, damage control and firefighting support).	a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q	Located within the facility security boundary; secure and reliable communications with the control room, with teams in the facility and with off-site responders (e.g. fire services); with sufficient room to assemble, equip and prepare teams; ready access to equipment, instruments and protective equipment and clothing needed by response teams.
Technical support centre (TSC)	Technical support for the control room operators in mitigating the consequences of the emergency.	a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q	Secure and reliable communications with the control room and with outside sources of technical support (e.g. facility vendor); access to plant data, information and tools needed to develop strategies for dealing with sever emergencies.

Emergency facility/location	Functions	Provisions as given in Paragraph VII.6	Additional provisions
Assembly point	Locations where non-essential personnel at the facility are assembled, accounted for and sheltered or evacuated.	a, c, g, h, i, j, l, m, o, p, s, u	Located (one or more) within the facility security boundary with sufficient room for on-site nonessential (non-response) staff (including construction workers or other non-permanent personnel). Easily accessible, provides some protection against a release or exposure, and is continuously monitored.

TABLE VII.3. DESCRIPTION OF OFF-SITE EMERGENCY RESPONSE FACILITIES AND LOCATIONS

Emergency facility/location	Functions	Provisions as given in paragraph VII.6	Additional provisions
Emergency operations facility (EOF)	Coordination of the off-site and on-site response to an emergency warranting off-site protective actions. Typically staffed by emergency response commander who is directing the off-site response and representatives of the on-site response and off-site response organizations. It is an equivalent of emergency response command post for EPC III-IV	a, b, c, d, e, f, g, h, i, j, k, l, r, s, t, u	Access to the information required to coordinate on-site and off-site response decisions; reliable communications with on-site and off-site emergency response facilities and locations and organizations. This emergency response facility should be pre-established for categories I and II. Located beyond the UPZ and if located within the EPD provisions made in advance for relocation to a predestinated backup emergency response facility well beyond the EPD if warranted due to radiological conditions.
Emergency response command post (ERCP)	Location from where all off-site response activities (and on site response activities for emergencies in EPC IV) are directed. It is the location of the emergency response commander and support staff.	a, b, c, d, e, f, g, h, i, j, k, l, r, s, t, u	For category I or II it will typically be located within the emergency operations facility. For other emergencies, it should be established at the time of the emergency and located in an area that is secure, safe and convenient for directing of on site operations.
Backup laboratory(ies)	Analysis of radioactive samples from the facility, environmental samples, bioassay samples or reading of	a, b, c, d, e, h, i, j, k, l, r, s, t, u	It should be in a secure location beyond the EPD.

Emergency facility/location	Functions	Provisions as given in paragraph VII.6	Additional provisions
	thermoluminescence dosimetry (TLDs) badges.		
Designated hospital(s)	For providing treatment to exposed and/or contaminated individuals.	a, b, c, d, e, h, i, j, k, l, r, s, t, u	Provision — made in advance — for treating contaminated/exposed people including provisions for contamination control and access control.
Notification point(s)	The emergency response facility and location where notification of an nuclear or radiological emergency at a facility in category I, II or III is received and from which the appropriate off-site response is initiated. It should be the emergency response facility used to receive notification of and to initiate the off-site response to conventional emergencies (e.g. fires).	a, b, c, d, e, f, g, h, i, j, k, l, r, s, t, u	It should be continuously operational (24 hours a day, 7 days a week) and in a secure location, and should have a redundant power supply and secure communications. It should have immediate and continuous communication with the off-site decision maker(s) for all the emergency planning zones and emergency planning distances. If located within the emergency planning zones, it should be habitable during an emergency at the associated category I or II facility.
Warning point	The single facility that is set up to receive emergency notifications and information from other States and IAEA at all times. It should promptly respond to incoming notifications, warning messages, requests for assistance or requests for verification of a message from the IAEA. The facility through which the competent authority is contacted by the IAEA.	a, b, c, d, e, f, g, h, i, j, k, l, r, s, t, u	Continuously operational (24 hours a day, 7 days a week), in a secure location, with redundant power, secure communications and prompt access to speakers of English. The communication means for receiving notifications (e.g. fax machines, phones) from the IAEA and other States should be continuously operational and frequently monitored.
Public information centre (PIC)	Coordination of all information released to the news media concerning the emergency by the facility, local a and national authorities. Staffed by representatives of all these organizations.	a, b, c, d, e, h, i, j, k, l, r, s, t, u	For category IV (radiological emergencies), located in the vicinity of the emergency with space and infrastructure to support use by the news media and for conducting media briefings. For facilities in category I and II, it is a predestinated emergency response facility outside the UPZ where provision, made in advance, for relocation to a

Emergency facility/location	Functions	Provisions as given in paragraph VII.6	Additional provisions
			predesignated backup emergency response facility well beyond the EPD if warranted due to radiological conditions. Can be located within the emergency operations facility (for EPC I, II and V).
Radiological monitoring and assessment centre (RMAC)	Coordination of the radiological monitoring, sampling and assessment provided by all response organizations (facility, local governments, national governments) and providing assessed information to support off-site decision making.	a, b, c, d, e, f, g, h, i, j, k, l, r, s, t, u	Robust communications and information about the various monitoring, sampling and assessment capabilities. A number of individual locations should be identified in advance and provided with the necessary communications in case the root cause of the emergency is wide spread. If located within the EPD, provision, made in advance, for relocation well beyond the EPD if warranted due to radiological conditions.
Reception centres	Locations for the initial reception, monitoring, decontamination and registration of the evacuated members of the public.	a, b, c, d, e, h, i, j, k, l, r, s, t, u	Located in an existing building (e.g. a school). For facilities in category I and II, it should be beyond the EPD. Arrangements for provision of humanitarian support (e.g. food, housing).
Staging and storage locations	Locations used to collect and organize additional resources (e.g. material, specialists and volunteers), from national and international sources, as they arrive in the vicinity of the emergency. Also used to store and assure availability of mobile equipment such as power sources, pumps and heat exchangers.	a, b, c, d, e, h, i, j, k, l, r, s, t, u	Locations identified at the time of an emergency. Should be in a location that will remain habitable, will not interfere with other ongoing response actions and can be secured.
Triage area	Field location where medical and radiological triage is performed, first aid is provided and affected persons are prepared for being taken to hospital.	a, b, c, d, e, h, i, j, k, l, r, s, t, u	For category III and IV location to be identified at the time of an emergency. Would probably be established at the reception centers for categories I and II. Should be a safe and secure location near the site with access for medical transport.

Emergency facility/location	Functions	Provisions as given in paragraph VII.6	Additional provisions
Response organization emergency operations centres	Facilities established by various response organizations from which the organization's support for the response is directed. Such emergency response facility should be established by the regulatory body, ministries with responsibility for radiological or conventional response, local governments, corporate headquarters for the facility, national laboratories with expertise and the response organization for radiological assessment.	a, b, c, f, g, h, i, j, k, l, r, t, u	Provision for effective coordination with the response of the Unified Command and Control System.
Forensic evidence and crime scene management area	Location consisting of the forensic evidence processing centre (location for the supervised processing, recording, examination and photography of items and evidence recovered from the scene) and forensic evidence storage area (location for the secure storage of evidence recovered from the scene and for maintenance of the continuity and integrity of evidence).	TBC a, b, c, d, e, h, i, j, k, l, r, s, t, u	Located adjacent to the inner cordoned off area within the outer cordoned off area.
Public processing area	Location consisting of the triage/first aid area, registration area, public monitoring / decontamination area. At this location the following tasks are performed: - processing and registering the public evacuated from the inner cordoned off area;	TBC a, b, c, d, e, h, i, j, k, l, r, s, t, u	Located within the outer cordoned off area with access for medical transport. Ambient dose rates in the area need to be at levels close to background levels.

Emergency facility/location	Functions	Provisions as given in paragraph VII.6	Additional provisions
	- medical triage, first aid and preparation of victims for transport; and - monitoring and decontamination of the public evacuated from the inner cordoned off area.		
Responder contamination control area	Location for the control of contamination from response personnel wearing appropriate PPE entering and leaving the inner cordoned off area.	TBC a, b, c, d, e, h, i, j, k, l, r, s, t, u	Located at the end of exit corridor coming from boundary of the inner cordoned off area and away from the public processing area.
Temporary morgue area	Location for the dignified storage of deceased persons whose bodies may be contaminated or have not been released by the forensic evidence management team.	TBC a, b, c, d, e, h, i, j, k, l, r, s, t, u	May be located in a tent or existing facility that is secured within the outer cordoned off area away from the view of the general public.
Waste storage area	Location where potentially contaminated items (e.g. clothing) are stored.	TBC a, b, c, d, e, h, i, j, k, l, r, s, t, u	Located within the outer cordoned off area that is secured and preferably in a structure to prevent the spread of contamination (e.g. by wind or rain).
Emergency exit corridor	A path for injured individuals to rapidly leave the cordon area without going through exit corridor to receive urgent medical treatment.	TBC a, b, c, d, e, h, i, j, k, l, r, s, t, u	Direct path from the inner cordoned off area to security perimeter.

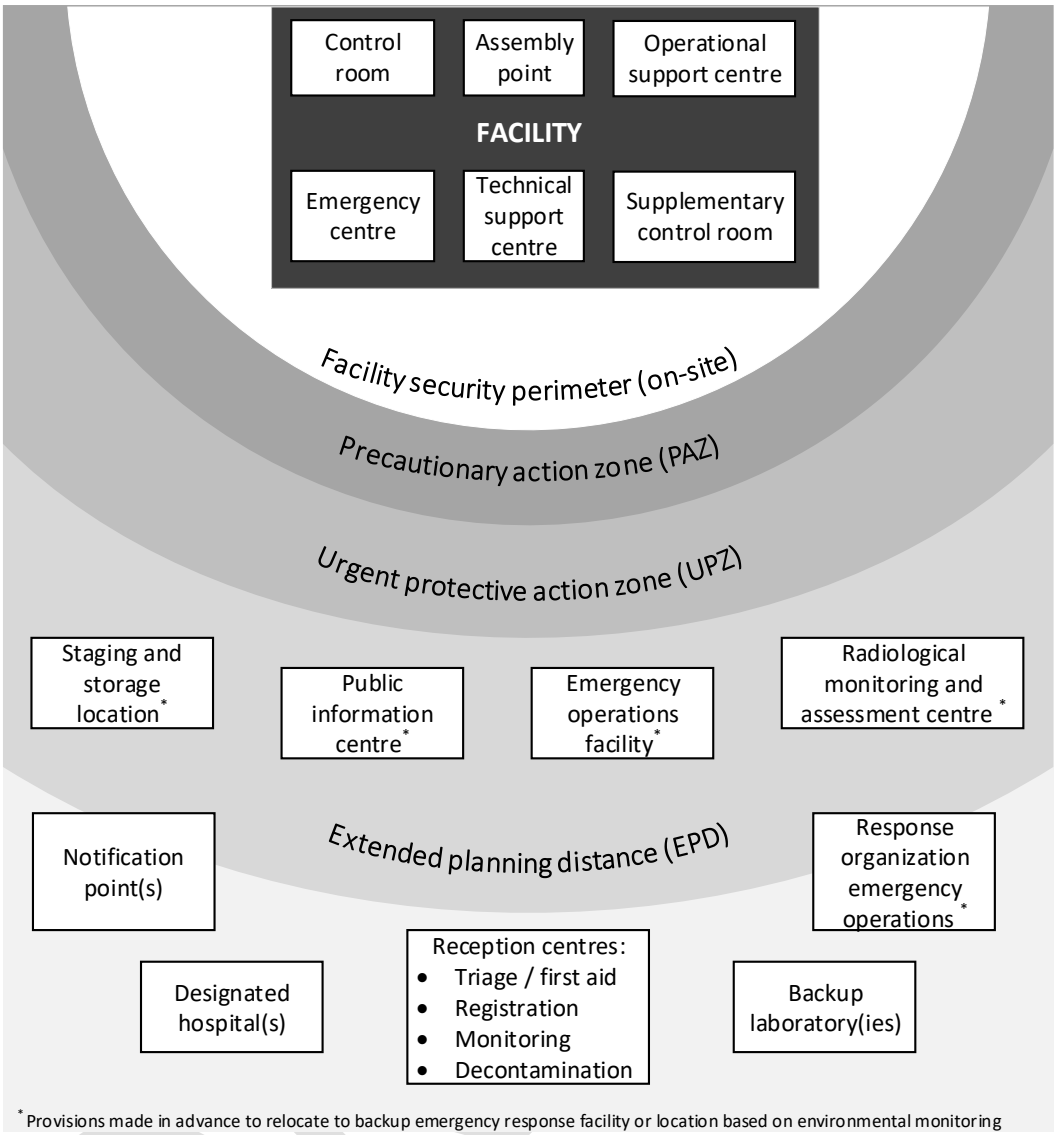


FIG.VII.1. Layout of the emergency response facilities and locations for a category I facility.

Appendix VIII

GUIDANCE ON GENERIC CONTENT IN EMERGENCY PLANS AND PROCEDURES

VIII.1. This appendix provides guidance on the type of content that should, at a minimum, be included in emergency plans and procedures. While the content described here should be included within the set of plans and procedures, the structure of the plans and procedures will depend on national or local considerations, particularly where plans and procedures are part of an all-hazards approach.

VIII.2. The plan should contain information that the constituent teams and response organisation organizations covered by the plan need in order to be able to ensure effective response to develop their own consistent and compatible plans, procedures and other arrangements.

EMERGENCY PLANS

Introductory information in the plan

VIII.3. The emergency plan should begin with a *cover page* that identifies the plan, its version number (including date) and who has approved or signed off on the plan.

VIII.4. The plan should describe the *scope* of the emergency plan in terms of which types of scenarios are covered by the plan and at which level the plan applies (for example, at the facility level, local/reginal level or national level).

VIII.5. The plan should specify a *lifetime period* for which the emergency plan is applicable and identify conditions which should lead to its revision.

VIII.6. The agreed *objectives of the response* should be included in the plan. The objectives of the response should be guided by the goals of emergency response as described in GSR Part 7[2].

VIII.7. The plan should provide a *list of all responding organizations* and describe their main response roles and responsibilities.

VIII.8. The plan should list all the *relevant legal documents* (e.g. national laws, decrees, acts, guidelines or agreements) that underpin the plan and that define responsibility for planning, decisions and actions governing the response to nuclear or radiological emergencies.

VIII.9. The plan should include a *list of all related plans, procedures and documents*. This should include a description of how this nuclear and radiological emergency plan relates to plans at other levels (facility, local, regional or national), to the plans of other response organizations and to other emergency plans that may be used along with it, including those for response to conventional emergencies and security events. A complete list of all the supporting documents should be provided in an appendix to the emergency plan.

VIII.10. The *planning basis* for the response arrangements should be summarised in the plan. This should include a summary of the results of the hazard assessment; a list of all facilities in emergency preparedness category I, II and III; a list all facilities and locations at which there is a significant likelihood of encountering a dangerous source that is not under control; and a description of all off-site emergency planning zones and emergency planning distances where protective actions and other response actions will be required.

VIII.11. The plan should include the *concepts of operations* for those emergency scenarios covered by the plan.

Logistical arrangements

VIII.12. The plan should briefly describe the *emergency response facilities* that may be used during a response.

VIII.13. The plan should describe the *communications systems* to be used during an emergency, which should include provision to ensure compatibility with those used by other response organizations and resilience (back-up) arrangements.

VIII.14. The plan should describe the *logistical and other support arrangements*, including for prompt procurement of necessary supplies and services, as well as rest, refreshment and other support facilities for responders. The plan should describe the resources of government and other organizations that will be made available under the plan.

Coordination

VIII.15. The plan should set out the *relationships and coordination arrangements* between the different elements of the response, including the different levels of response and the various response organizations. This may be illustrated, for example, by an organigram or flow diagram.

VIII.16. The plan should describe the *decision-making process* and *information exchange arrangements* between teams and responding organizations.

VIII.17. Describe the system and *arrangements for gathering, sharing, and use of information* arising from the emergency and its response. Outline the broad specification for the information requirements at each coordination centre, available data sources and for the flows of information between teams, organizations or coordination centres. This should include the arrangements for the review, collation, prioritisation and presentation of large amounts of incoming data and information into a format that aids timely decision making and the sharing of key information with other teams, responding organizations and levels of response.

Emergency response

VIII.18. Describe the national *response arrangements* to perform the response functions listed below, providing an appendix with detailed information needed by other organizations to develop compatible response arrangements. Identify which organizational component (role, team or organization) within the response organization will be responsible for all or part of the performance of these functions.

Identifying and notifying nuclear or radiological emergency and activating an emergency response and request for assistance

VIII.19. Describe the arrangements and process for notification, activation, and deployment of response resources. This should include how decisions will be made to activate or deploy the response. Describe arrangements to receive and authenticate the notification (for example, via designated 24/7 warning points or duty staff).

Emergency operations management

VIII.20. The plan should describe the system used to manage the response, including the unified command and control system. The plan should set out who (role, team or organization) leads on the response and how authority would be transferred if required.

VIII.21. The plan should establish the engagement rules, duties and working methods for the responding individuals, teams or organizations (depending on the level of the plan).

VIII.22. The plan should include the arrangements for shift changes of responding personnel.

Functional areas

VIII.23. The plan should summarise the arrangements for each of the relevant functional areas, including which organization is responsible for leading on the area and what the site, local, regional or national-level response is, as appropriate to the specific plan:

- Taking mitigatory action
- Taking urgent protective actions and other response actions
- Assessing and anticipating emergency conditions, exposures and potential exposures, radioactive releases and releases of other hazardous materials.
- Providing instructions, warnings and relevant information to the public
- Protecting emergency workers and helpers
- Managing the medical response
- Communicating with the public and media
- Monitoring, sampling and analysis
- Taking early protective actions and other response actions
- Mitigating the non-radiological consequences
- Requesting, providing and receiving international assistance
- Crime scene preservation
- Recovery operations
- Managing radioactive waste
- Financing of operations and compensation
- Terminating an emergency
- Analysing the emergency and the response

Emergency preparedness

VIII.24. The plan should describe the preparedness arrangements which are needed to develop and maintain the capability to respond to an emergency. It should identify which organizational component (role, team or organization) within the response organization will be responsible for all or part of the performance of these functions.

Authorities and responsibilities

VIII.25. The plan should outline the arrangements for developing and maintaining the preparedness arrangements, including the supporting infrastructure.

Organization

VIII.26. The plan should establish the arrangements for ensuring adequate response resources (including trained response personnel) are maintained.

Coordination

VIII.27. The plan should include the arrangements for continual coordination with other planning efforts at the local, regional, national or international level, as appropriate to the specific plan.

Plans and procedures

VIII.28. The plan should describe the arrangements for the production, approval, distribution and maintenance of the plan and supporting procedures and documents.

Logistical support and facilities

VIII.29. The plan should include the arrangements for ensuring the availability of the logistical support and facilities needed to execute the plan. A list of the resources available and the teams/organizations that provide them should be maintained and included with the plan, for example as an appendix or supporting document.

Training

VIII.30. The plan describe the arrangements for ensuring adequate training for personnel responding under the plan, including the development of a multi-year training programme and periodic review of training needs.

Drills and exercises

VIII.31. The plan should assign responsibility for the developing of a multi-year programme for drills and exercises, for the preparation and conduct of emergency preparedness trainings, drills and exercises, and the review of exercises. The plan should specify the periodicity of exercises (see **Appendix IX**).

Quality assurance and review of plans

VIII.32. The plan should outline the arrangements to ensure a high degree of availability and reliability of al personnel, training, supplies, equipment, communication systems and facilities necessary to perform the functions specified in the plan.

VIII.33. The plan should describe the arrangements to maintain, review and update the plan, procedures and other arrangements and to regularly incorporate lessons learned from research, operating experience (such as response to emergencies) and emergency drills and exercises.

Supporting information

VIII.34. The plan should include a list of all references included in the plan, and all supporting procedures and documents.

VIII.35. A list of abbreviations and a glossary of terms should be included in the plan. These terms should be used consistently in all related plans and procedures in order to promote co-ordination. Where possible, the terms used by the organizations involved in the response to conventional emergencies should be adopted.

VIII.36. The list of individuals/organizations that the plan is distributed to be should included in the plan. This should include all individuals/organizations that are parties to the plan or that will be developing response arrangements that need to be consistent with the plan.

VIII.37. Supplementary information which gives more details on certain aspects of the emergency plan should be included in an appendix to the plan, particularly information that requires frequent updating. Examples of information that may be included in this section are:

- List of all authorities involved in the response, their responsibilities and their capabilities
- Table of national and international legal agreements that govern the response.
- A list or summary of relevant national guidance used in development of the plan.
- Emergency planning maps

- A list of emergency response facilities and specialized radiological resources
- List of supporting documentation/plans
- A summary of key information needed by other planners to develop compatible plans and procedures.

VIII.38. Sample tables of contents for site-level and national plans are given in the next section. Further examples of outline plans are given in Ref. [20].

PROCEDURES

VIII.39. The procedures developed to support and supplement the plan should provide details on how to perform the necessary preparedness and response actions.

VIII.40. A standard format and structure should be used for all procedures falling under one plan.

VIII.41. The procedures should, at a minimum, include the following information.

Introductory information

VIII.42. The emergency procedures should begin with a *cover page* that identifies the procedure (by title and a document code), its version number (including date), next review date, number of pages and who was responsible for preparing and approving the procedure.

VIII.43. Each page of the procedure should include the procedure title/document code, page number, total number of pages, version number and date.

VIII.44. The first page of the procedure should clarify the purpose and applicability of the procedure (for example, procedure to be used to notify local authority of declaration of a general emergency).

VIII.45. The procedures should identify which roles or teams responsible for performing the procedure and any specific prior training needs should be highlighted in the procedure.

VIII.46. The procedures should identify which equipment or other documents are needed to perform the procedure, where these can be sourced and any limitations of the technique or equipment.

VIII.47. The procedure should identify which role or team is responsible for maintaining the procedure and any equipment required for the procedure.

VIII.48. A glossary of terms should be included in the procedures

VIII.49. Any hazards associated with the procedure should be highlighted in the procedure and any protective equipment or measures to be used should be noted.

Steps in the procedure

VIII.50. For complex procedures, a short summary of the process or method should be included before the detailed steps are set out. A process map or flow chart may be helpful to provide an overview of the procedure.

VIII.51. The procedure should be described in a step by step manner, in the sequence in which they should be performed.

VIII.52. The description of the procedure should include any checks (for example of the equipment or operating conditions) that should be performed before, during or after the procedure.

VIII.53. The steps should include direction on what information and data to record and where this should be recorded.

Maintenance of the procedure

VIII.54. The procedure should list who (roles, teams and organizations) should be sent a copy of the procedure.

VIII.55. Who is responsible for reviewing and updating the procedure should be included in the procedure, as well as specifying the frequency of reviews. The manner of testing the procedure should also be noted (for example through a drill, exercise, witnessed performance of the procedure or other audit).

Attachments

VIII.56. The procedure should have any supporting documents either referenced at the end of the procedure or appended to it, such as reference documents, worksheets, equipment manuals, contact lists, reporting templates or checklists.

Appendix IX

TYPICAL TRAINING PROGRAME AND TYPICAL EXERCISE PROGRAMME

TYPICAL TRAINING PROGRAMME

IX.1. The training programme is targeted to provide individuals who hold a role in emergency preparedness and response with the capability and competence necessary to undertake that role effectively. The training programme can include classroom and practical instruction and could involve practice undertaking the role.

IX.2. The training programme should include provision for:

- Classroom based training;
- Practical training;
- 'on the job' or 'just in time training'; and
- Assessment of capability and competence as appropriate.

IX.3. Simulation is a crucial component of training. It reveals whether the individual chosen or volunteered for a specific role has the required attributes to efficiently undertake that role, which may only become apparent during simulation. For example, the emergency response commander role can involve a significant amount of stress, and requires immediate decision-making skills. The classroom-based training and, in particular, practical sessions may show that specific individuals would be more effective undertaking different roles.

IX.4. Training should be given by trainers who have themselves been trained and shown to be competent at training other people.

IX.5. The training programme should be compiled based on information from a training needs analysis including assessment of what type of training and assessment methods is necessary. Each emergency response role identified in the emergency plan should be assessed and appropriate training developed and provided.

IX.6. The training needs will vary for individual roles:

a) Roles that are critical to an efficient and effective emergency response (e.g. emergency response commanders, plant recovery engineers, radiological assessor and communications specialists) will require the most formal level of training and assessment. Typically, training programmes for these individuals should include:
    - Classroom based training in the specific role, covering the expectations of how the role should be carried out;
    - Classroom based training about the emergency response plan, including the responsibilities of each emergency response organisation, function and role, how these organisations and functions communicate and are coordinated and work together to achieve the best outcome;
    - Classroom based training about relevant technical matters including, for example, the effects and potential consequences of ionising radiation and the various options and resources available to mitigate the consequences.

- Practical training in simulated emergency conditions that:
    - allow the trainee to practice the role without the pressure of an exercise or actual emergency situation, and
    - allow assessment of the trainee's competence and capability to undertake the role for which they are being trained.

b) Some emergency response roles may not require all types of training (classroom and practical) and assessment. For example, in contrast to the command and control roles that requires capability and competence to respond to unexpected and high stress situations, those providing administrative support may be undertaking activities very similar to those they usually undertake, and a specific assessment of capability may not be necessary. Nevertheless, all involved in the response should practice in advance.

c) There are also those for whom it is not possible to provide training in advance of the emergency. Typical examples would be non-designated in advance emergency workers or helpers, who volunteer at the time of an emergency, and who may undertake a wide range of roles in support of the emergency response. In these cases, such individuals should be provided with 'just in time training' to the extent possible. The training programme should identify, so far as is reasonably practical, these types of roles at the preparedness stage and have prepared material and arrangements to give the necessary training at short notice. Applicability of "just in time training" should be tested with a representative group.

IX.7. The practical training should take place in either simulated facilities (for example, mock ups of the area where an emergency may occur, control room simulators) or in the actual emergency response facilities (for example, the emergency centre where trainee emergency controller can respond to simulated emergencies, or areas where access points can be simulated).

IX.8. Assessment can take different forms proportionate to the demands of the role and how critical that role is to effective and efficient emergency response. Assessment methods can include written or verbal examinations in classroom training, assessment by experienced individuals in practical training. However, any assessment methods used should take account of the demands of the role.

IX.9. TABLE IX.1 gives an example training matrix that shows how the different types of training and assessment methods may apply to the different emergency response roles.

TABLE IX.1. EXAMPLE TRAINING MATRIX

Role / Type of training & assessment	Emergency helpers	Administrative support	Personnel protection	Technical assessment	Liaison with other response organisations	Provision of information to the public	Command and decision making
Type of training							
Technical training	[a]	[a]	✓	✓	[a]	✓	✓
Training on the emergency plan		✓	✓	✓	✓	✓	✓
Human behaviour training		✓	✓			✓	✓
Classroon based training			✓	✓		✓	✓
Practical training		✓	✓	✓	✓	✓	✓
'Just in time' training	✓						
Assessment methods							
Written or verbal assessment			✓	✓	✓	✓	✓
Observational assessment						✓	✓

[a] Optional (based on the task to be undertaken).

TYPICAL EXERCISE PROGRAMME

IX.10. In contrast to the training programme, the purpose of the exercise programme is primarily to:

- gain confidence that all organisations involved in the emergency response will work together effectively and in coordinated manner;
- demonstrate and gain confidence that individuals can carry out their assigned roles effectively in as near to real emergency conditions as practicable; and
- Identify areas where the emergency plan and procedures can be improved.

IX.11. The exercise may test part or all of an emergency response plan.

IX.12. Because the primary purpose of exercise is to give confidence in the overall ability of the emergency response organisations to respond to an emergency, the emergency exercise should not be separated from training or practice. Where a role holder does not undertake the role as expected, the preparedness for an emergency in general and the effectiveness of the training programme in particular may be brought into question.

IX.13. As with the training programme, the exercise programme should commensurate and be proportionate to the nature and magnitude of the identified hazards. Typically, where the consequences of an emergency could be significant and widespread, the exercise programme will, as appropriate, involve all relevant organisations and agencies, including international organisations. Where the consequences are likely to be low or over a limited area only, it may be appropriate for only local response organisations and agencies to take part in the exercise programme.

IX.14. A typical exercise programme should consist of four broad levels:

- Level 1: Only the facility or location where the emergency can occur is involved in the exercise;
- Level 2: The facility or location where the emergency can occur and response organisations local to the facility are involved in the emergency exercise;
- Level 3: The facility or location where the emergency can occur, local and national response organisations are involved in the emergency exercise, and
- Level 4: The facility or location (if applicable) where the emergency can occur, local, national response organisations and international organisations are involved in the emergency exercise.

IX.15. TABLE IX.2 summarises the typical extent of emergency exercises for each emergency preparedness category and should be used as an example when establishing the exercise programme based on the results of hazard assessment.

IX.16. The frequency of the exercise in various levels will vary, with Level 1 exercises taking place frequently (dependent on the type of facility or location, this could be annually) and Level 4 exercises taking place infrequently (e.g. once per year using a selected facility).

IX.17. The emergency exercise scenario should:

- Be as realistic as possible (a scenario that is not realistic will result in those taking part not treating it seriously), and
- Include challenging and unexpected events to test the response (any emergency will almost certainly not be what was expected).

IX.18. Information concerning the exercise scenario, location and timings should be kept limited to a distribution as reasonably practicable.

IX.19. The exercise conditions should be as realistic as possible, with all normal emergency response venues used (rather than mock ups). This also aids familiarity with the resources available in the event of a real emergency.

IX.20. The emergency exercise programme should include provision for independent evaluation of the effectiveness of the response and therefore how adequate are existing emergency response arrangements and capabilities. This will typically include provision of immediate feedback after the completion of the exercise, followed by written or oral feedback at a later date, provided by both evaluators and players.

TABLE IX.2. TYPICAL EXTENT OF EXERCISE PROGRAMME FOR DIFFERENT EMERGENCY PREPAREDNESS CATEGORIES

Emergency preparedness category / Exercise Level	I	II	III	IV	V
Level 1 – Facility/location only	✓ (Every 6 month)	✓ (Annualy)	✓ (Annualy)		
Level 2 – Faclity/location and local response organisations	✓ (Annually)	✓ (Biennially)	✓ (Biennially)	✓ [a] (Annualy)	
Level 3 – Facility/location, local and national response organisations	✓ (Biennially)	✓	✓	✓ [a] (Biennially)	✓ [a] (Biennially)
Level 4 – Facility/location, local, national response organisations and international organisations	✓ (Every 4 years)				✓ [a] (Every 4 years)

[a] Ussualy national and/or local response organisations only.

IX.21. The purpose of the immediate feedback is to capture observations whilst they are fresh in attendees minds, plus identify any major issues and immediate improvements that need to be made, The purpose of the written feedback is to summarise all observations that need to be addressed in a considered and appropriate manner.

IX.22. Typically, the outcome of exercises should be assigned a rating by the independent evaluators:

- An effective demonstration (or "Excellent") – The exercise has given confidence that the response to an emergency will be effective;
- A partially effective demonstration (or "Satisfactory") – Some areas have been identified where improvements should be made, and improvements need to be made, and
- Not an effective demonstration (or "Unsatisfactory") – The exercise has not demonstrated the response to an emergency will be effective.

IX.23. Typically, the rating assigned to an exercise should drive further action. What tasks are needed is dependant on the magnitude of the area for improvement. For effective demonstrations, further formal action will not be needed, although routine improvements may still be identified. For partially effective demonstrations, formal action to improve specific aspects will be necessary, along with a further limited exercise to demonstrate that those necessary improvements have been made. For those exercises that are considered not to be an effective demonstration, formal action to improve areas of concern will be necessarily followed by a further full-scale exercise.

Appendix X

URGENT PROTECTIVE ACTIONS IN THE INNER CORDONED OFF AREA AND OFF THE SITE

EMERGENCY PREPAREDNESS CATEGORY III AND IV (RADIOLOGICAL EMERGENCIES)

X.1. For radiological emergencies like transport emergencies, found abandoned sources, radiological dispersal devices, contamination or accidents involving a nuclear weapon, the following urgent protective actions should be promptly taken before any monitoring results becomes available.

X.2. Within the inner cordoned off area (inside the safety perimeter; see *FIG.VI.1*) the following actions should be implemented:

- Perform life saving actions (they should not be delayed on account of possibly elevated levels of radiation) and provide medical aid to those who are injured;
- Evacuate the public or provide substantial sheltering if safe evacuation is not possible;
- Register and monitor those evacuated and determine whether decontamination is needed;
- Estimate the dose to those who were evacuated to determine if a medical examination or counselling and follow-up are warranted;

X.3. Public should be warned about the emergency and instructed on certain actions to be taken in response to the emergency. Recommendations on public warnings and instructions that should be issued in the event of radiological emergency with involvement of dangerous sources are given in **Appendix II**. The public should also be advised of what to do if they are concerned that they may have been contaminated and of where to get additional information.

X.4. All emergency workers involved in response should be provided with appropriate protective and monitoring equipment. If airborne contamination is suspected they should be given necessary respiratory protection. Doses received by emergency workers should be monitored and recorded by the radiological assessor at the site.

X.5. Any female worker who is pregnant or who might be pregnant should be warn about the risks of severe deterministic effects to a fetus arising from an exposure of grater than 100 mSv equivalent dose to the fetus and instructed to avoid working within the cordoned off area. They need to be excluded from taking actions if these actions could result in an equivalent dose to the embryo or fetus exceeding 50 mSv for the full period of in utero development.

X.6. More detailed information on other response actions that should be taken during a radiological emergency is provided in Ref [20]

EMERGECNY PREPEREDNESS CATEGORIES I, II and V

X.7. Urgent protective actions for facilities in category I and II are shown in TABLE X.1.All off-site actions described in the table are also applicable to the areas in category V.

TABLE X.1. URGENT PROTECTIVE ACTIONS FOR EMERGENCY PREPAREDNESS CATEGORY I AND II FACILITIES

Emergency Preparedness Category	Urgent protective actions and other response actions
I	General emergency: - Instruct those within the PAZ to immediately take a pre-distributed iodine thyroid blocking (ITB) agent[a] and reduce inadvertent ingestion[b]; Promptly and safely evacuate them (in all directions) to beyond the UPZ; - Instruct those within the UPZ to remain indoors (sheltering in place) until evacuation, to take iodine thyroid blocking agents[a] and reduce inadvertent ingestion[b]; - Evacuate those within the UPZ beyond this zone as soon as possible but without delaying evacuation of the public within the PAZ; - Provide those within the PAZ and UPZ who cannot be safely evacuated[c] with substantial sheltering[d] (i.e. shelter in large buildings) for up to two days and instruct them to listen to the radio, television or to check online for further instructions; - Instruct those provided with sheltering within the PAZ and UPZ that they evacuate to the beyond the UPZ, on the basis of the conditions at the facility or the monitoring and assessment of the radiological situation off the site; - Instruct those within the EPD to reduce inadvertent ingestion[b] until the deposition levels are assessed; - Provide instructions on how to protect food chain and water supply as well as commodities from contamination within the ICPD; - Within the EPD and ICPD restrict consumption, sale and distribution of non-essential food, milk and drinking water as well as use of commodities with possible contamination until concentration levels have been assessed using OIL values; - Restrict access to the evacuated area and areas where sheltering is recommended; - Register and monitor those evacuated and determine whether decontamination or medical treatment is needed; estimate the dose to those who were in the PAZ and UPZ to determine if a medical examination or counselling and follow-up are warranted.
II	General emergency: - Provide those within the UPZ with substantial sheltering[d] (i.e. shelter in large buildings) for up to two days and instruct them to listen to the radio, television or to check online for further instructions; If no substantial sheltering is available instruct them to remain indoors and shutdown the windows and doors; - Instruct the public sheltered within the UPZ that they reduce inadvertent ingestion and evacuate to the beyond the UPZ, on the basis of the conditions at the facility or the monitoring and assessment of the radiological situation off the site; - Promptly conduct monitoring of the UPZ to determine where OILs could be exceeded and to evacuate if appropriate; - Provide instructions on how to protect food chain and water supply as well as commodities from contamination within the ICPD;

Emergency Preparedness Category	Urgent protective actions and other response actions
	- Restrict consumption and distribution of non-essential food, milk and drinking water as well as use of commodities with possible contamination within the ICPD until concentration levels have been assessed using OIL values; - Restrict access to the evacuated area and areas where sheltering is recommended; - Monitor the people evacuated and determine whether decontamination or medical treatment is needed; estimate the dose to those who were in the UPZ to determine if a medical examination or counselling and follow-up are warranted.
I and II	Site area emergency: - Instruct those within the PAZ to remain indoors (sheltering in place); to listen to the radio, television or to check online for further instructions;[e] - Instruct those within the in UPZ to reduce inadvertent ingestion[b]; - Provide instructions on how to protect food chain and water supply as well as commodities from contamination within the UPZ. - Promptly conduct monitoring of the UPZ to determine where OILs could be exceeded and to evacuate if appropriate;

[a] If this will not delay evacuation.

[b] Advised (a) to wash hands before drinking, eating, smoking or touching the face; (b) not to let children playing on the ground; (c) not to do activities that could result in the creation of dust that could be ingested or inhaled.

[c] 'Safely evacuating' means not endangering the lives of those being evacuated. Patients and those requiring specialized care should be evacuated beyond the EPD in order to ensure multiple evacuations is not required.

[d] Substantial sheltering is provided by large multistorey structures without any special features (TABLE III-1)

[d] Applicable only for facilities in category I.

REFERENCES

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Convention on Early Notification of a Nuclear Accident, and Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, Legal Series No. 14, IAEA, Vienna (1987)

[2] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL CIVIL AVIATION ORGANIZATION, INTERNATIONAL LABOUR ORGANIZATION, INTERNATIONAL MARITIME ORGANIZATION, INTERPOL, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, THE PREPARATORY COMMISSION FOR THE COMPREHENSIVE TEST BAN TREATY ORGANIZATION, UNITED NATIONS ENVIRONMENTAL PROGRAMME, UNITED NATIONS OFFICE FOR THE CO-ORDINATION OF HUMANITARIAN AFFAIRS, WORLD HEALTH ORGANIZATION, WORLD METEOROLOGICAL ORGANIZATION, Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSR Part 7, IAEA, Vienna (2015).

[3] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR OFFICE, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSG-2, IAEA, Vienna (2011).

[4] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL CIVIL AVIATION ORGANIZATION, INTERNATIONAL LABOUR ORGANIZATION, INTERNATIONAL MARITIME ORGANIZATION, INTERPOL, OECD NUCLEAR ENERGY AGENCY, UNITED NATIONS OFFICE FOR THE COORDINATION OF HUMANITARIAN AFFAIRS, WORLD HEALTH ORGANIZATION, WORLD METEOROLOGICAL ORGANIZATION, Arrangements for the Termination of A Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSG-11, IAEA, Vienna (2018).

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Arrangements for Communication with the Public in Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSG-14, IAEA, Vienna (2020).

[6] INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, Occupational Radiation Protection IAEA Safety Standards Series No. GSG-7, IAEA, Vienna (2018).

[7] INTERNATIONAL ATOMIC ENERGY AGENCY, WORLD HEALTH ORGANIZATION, Generic Procedures for Medical Response during a Nuclear or Radiological Emergency, EPR-MEDICAL 2005, IAEA, Vienna (2005).

[8] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Forensics in Support of Investigations, IAEA Nuclear Security Series No. 2-G (Rev. 1), IAEA, Vienna (2015).

[9] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5), IAEA Nuclear Security Series No. 13, IAEA, Vienna (2011).

[10] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Security Recommendations on Radioactive Material and Associated Facilities, IAEA Nuclear Security Series No. 14, IAEA, Vienna (2011).

[11] INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Safety Glossary: Terminology Used in Nuclear Safety and Radiation Protection: 2018 Edition, IAEA, Vienna (2018).

[12] EUROPEAN COMMISSION, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, WORLD HEALTH ORGANIZATION, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, IAEA Safety Standards Series No. GSR Part 3, IAEA, Vienna (2014).

[13] INTERNATIONAL ATOMIC ENERGY AGENCY, Preparedness and Response for a Nuclear or Radiological Emergency Combined with Other Incidents or Emergencies, EPR-Combined Emergencies 2020, IAEA, Vienna (2020)

[14] INTERNATIONAL ATOMIC ENERGY AGENCY, Leadership and Management for Safety, IAEA Safety Standards Series No. GSR Part 2, IAEA, Vienna (2016).

[15] INTERNATIONAL ATOMIC ENERGY AGENCY, Application of the Management System for Facilities and Activities, IAEA Safety Standards Series No. GS-G-3.1, IAEA, Vienna (2006).

[16] INTERNATIONAL ATOMIC ENERGY AGENCY, The Fukushima Daiichi Accident, 6 vols, IAEA, Vienna (2015)

[17] INTERNATIONAL ATOMIC ENERGY AGENCY, Leadership, Human Performance and Internal Communication in Nuclear Emergencies, IAEA Nuclear Energy Series No. NT-T-1.5, IAEA, Vienna (2018).

[18] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5), IAEA Nuclear Security Series No. 13, IAEA, Vienna (2011).

[19] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Security Recommendations on Radioactive Material and Associated Facilities, IAEA Nuclear Security Series No. 14, IAEA, Vienna (2011).

[20] INTERNATIONAL ATOMIC ENERGY AGENCY, Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency, EPR-METHOD 2003, IAEA, Vienna (2003) (under revision).

[21] INTERNATIONAL ATOMIC ENERGY AGENCY, Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. SSR-1, IAEA, Vienna, (2019).

[22] INTERNATIONAL ATOMIC ENERGY AGENCY, Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-3.2, IAEA, Vienna (2002, under revision).

[23] INTERNATIONAL ATOMIC ENERGY AGENCY, Seismic Hazards in Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. SSG-9, IAEA, Vienna (2010).

[24] INTERNATIONAL ATOMIC ENERGY AGENCY, WORLD METEOROLOGICAL ORGANIZATION, Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. SSG-18, IAEA, Vienna (2011).

[25] INTERNATIONAL ATOMIC ENERGY AGENCY, External Human Induced Events in Site Evaluation for Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-3.1, IAEA, Vienna (2002).

[26] INTERNATIONAL ATOMIC ENERGY AGENCY, Volcanic Hazards in Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. SSG-21, IAEA, Vienna (2012).

[27] INTERNATIONAL ATOMIC ENERGY AGENCY, Considerations in the Development of a Protection Strategy for a Nuclear or Radiological Emergency, EPR-Protection Strategy XXXX, IAEA, Vienna (under development).

[28] INTERNATIONAL ATOMIC ENERGY AGENCY, National Nuclear Security Threat Assessment, Design Basis Threats and Representative Threat Statements, Nuclear Security Series NSS No. XX, IAEA, Vienna (in publishing).

[29] INTERNATIONAL ATOMIC ENERGY AGENCY, Risk Informed Approach for Nuclear Security Measures for Nuclear and Other Radioactive Material out of Regulatory Control, Nuclear Security Series NSS No. 24-G, IAEA, Vienna (2015).

[30] US NUCLEAR REGULATORY COMMISSION, Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants, NUREG-1150, USNRC, Washington, DC (1990).

[31] US NUCLEAR REGULATORY COMMISSION. State-of-the-Art Reactor Consequence Analysis (SOARCA) Report. NUREG-1935 Draft for Comment USNRC, Washington, DC (2012).

[32] INTERNATIONAL ATOMIC ENERGY AGENCY, Security of Nuclear Information, Nuclear Security Series NSS No. 23-G, IAEA, Vienna (2015).

[33] INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Response to a Nuclear or Radiological Emergency at Research, EPR-Research Reactor 2011, IAEA, Vienna (2011).

[34] INTERNATIONAL ATOMIC ENERGY AGENCY, Operations Manual for Incident and Emergency Communication, EPR-IEComm 2019, IAEA, Vienna (2020).

[35] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Yanango, IAEA, Vienna (2000).

[36] INTERNATIONAL ATOMIC ENERGY AGENCY, Preparedness and Response for an Emergency during the Transport of Radioactive Material, IAEA Safety Standards Series No. GSG-XX, IAEA, Vienna (in publishing DS469).

[37] INTERNATIONAL ATOMIC ENERGY AGENCY AND OECD/NUCLEAR ENERGY AGENCY, INES: The International Nuclear and Radiological Event Scale User's Manual, 2008 Edition, IAEA, Vienna (2013)

[38] INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Response and Assistance Network, EPR-RANET 2018, IAEA, Vienna (2018).

[39] INTERNATIONAL ATOMIC ENERGY AGENCY, The Chernobyl Accident: Updating of INSAG-1: INSAG-7: a Report by the International Nuclear Safety Advisory Group, IAEA, Vienna, (1992).

[40] UNITED NATIONS, Sources and Effects of Ionizing Radiation, Report to the General Assembly (with scientific annexes), United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 2008), Volume II, Scientific Annexes C, D and E, New York (2011).

[41] UNITED NATIONS, Sources and Effects of Ionizing Radiation, Report to the General Assembly (with scientific annexes), United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 2013), Volume I, Scientific Annex A, New York (2014).

[42] INTERNATIONAL ATOMIC ENERGY AGENCY, Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency, EPR-Exercise XXXX, IAEA, Vienna (XXXX, under revision).

[43] UNITED NATIONS, Sources and Effects of Ionizing Radiation, Report to the General Assembly (with scientific annexes), United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 2000), Volume II, Scientific Annex J, Exposures and effects of the Chernobyl Accident, New York (2000).

[44] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Goiânia, IAEA, Vienna (1988).

[45] INTERNATIONAL ATOMIC ENERGY AGENCY, Lessons Learned from the Response to Radiation Emergencies (1945–2010), EPR-Lessons Learned 2012, IAEA, Vienna (2012).

[46] INTERNATIONAL ATOMIC ENERGY AGENCY, Preparedness and Response for an Emergency during the Transport of Radioactive Material, IAEA Safety Standards Series No. GSG-XX, IAEA, Vienna (2018) (DS469; in development).

[47] INTERNATIONAL ATOMIC ENERGY AGENCY, Remediation Process for Areas Affected by Past Activities and Events, IAEA Safety Standards Series No. GSG-XX, (revision of WS-G-3.1; DS468; in development).

[48] INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, 2009 Edition, IAEA Safety Standards Series No. TS-R-1, IAEA, Vienna (2009).

[49] INTERNATIONAL ATOMIC ENERGY AGENCY, Dangerous Quantities of Radioactive Material (D-values), EPR-D-VALUES 2006, IAEA, Vienna (2006).

[50] INTERNATIONAL ATOMIC ENERGY AGENCY, Categorization of Radioactive Sources, IAEA Safety Standards Series No. RS-G-1.9, IAEA, Vienna (2005).

[51] INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANISATION, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, Radiation Protection and Safety in Medical Uses of Ionizing Radiation, IAEA Safety Standards Series No. SSG-46, IAEA, Vienna (2018).

[52] INTERNATIONAL ATOMIC ENERGY AGENCY, Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. SSR-1, IAEA, Vienna (2019).

[53] NUCLEAR REGULATORY COMMISSION, RASCAL 4: Description of Models and Methods, NUREG-1940 Supplement 1, NRC, Washington, DC (2015).

[54] NUCLEAR REGULATORY COMMISSION, An Updated Nuclear Criticality Slide Rule, NUREG/CR-6504, NRC, Washington, DC (1998).

[55] INTERNATIONAL ATOMIC ENERGY AGENCY, Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor, EPR-NPP Public Protective Actions 2013, IAEA, VIENNA (2013)

Annex I

SUPPORTING INFORMATION FOR EMERGENCY PLANNING ZONES SIZES IN Appendix VI

REACTOR

I-1 For research reactors, owing to the wide variations in their design and operation, a facility specific analysis should be performed to determine whether sufficient inventory and energy could be contained in the reactor to result in a significant airborne release off the site in an accident. The methods described in Ref. [I–1] could be used.

I-2 For facilities in category I, calculations [I–2, I–3] were performed on the assumption of core melt and early containment failure.

I-3 For reactors with power levels less than 100 MW(th), calculations on the assumption of average meteorological conditions do not project doses that would lead to any early deaths off the site (>250 m), and thus these reactors fall into category II. The calculations were performed by using Refs [I–2, I–3].

I-4 For category II, it was assumed the reactor has been operating at this power level sufficiently long to build up the ^{131}I inventory close to 10 PBq/ MW(th) [I–2, I–3].

I-5 Severe core damage and therefore a major off-site release is not considered credible for reactors with power levels below 2 MW(th), and thus these reactors fall into category III.

SPENT FUEL

I-6 Calculations [I–2, I–3] indicate that people off the site could suffer severe deterministic effects owing to a release resulting from a Zircaloy® fire (an exothermic $Zr + H_2O$ reaction) in a large amount of spent reactor fuel. Such a reaction might be possible in densely stored fuel that has been discharged from a reactor core in the past year. Zircaloy® fires are unlikely unless the fuel in the pool is substantially uncovered [I–4].

I-7 Calculations [I–2 to I–4] indicate that doses warranting urgent protective actions off the site might be possible if a large amount of spent reactor fuel reaches temperatures in excess of 1000°C, resulting in failure of the fuel cladding. Such temperatures are possible only if fuel that is being actively cooled in a pool becomes totally uncovered [I–4].

CRITICALITY

I-8 Calculations [I–2, I–5] show that a criticality farther than about 500 m from the site boundary will not cause shine doses (i.e. doses due to gamma plus neutron radiation) off the site that exceed the recommended generic criteria for taking urgent protective actions and other response actions to reduce the risk of stochastic effects (Table II.2 in Ref.[I-6]). These calculations assume that there is no shielding and a criticality resulting in 1×10^{18} fissions initially, resulting in an effective dose rate from shine (i.e. due to gamma plus neutron radiation) of 1 mGy/h at 0.3 km. It is also assumed that the criticality will continue until there are about 1×10^{19} fissions, resulting in a total off-site dose of 10 mSv. A criticality cannot produce sufficient fission products to result in a significant airborne release. However, the thermal energy (heat) from a criticality may be sufficient to result in a release of radioactive or other hazardous material already present in the vicinity of the criticality (e.g. in the process stream).

REFERENCES TO THE ANNEX I

[I–1] INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Assessment Procedures for Determining Protective Actions during a Reactor Accident, IAEA-TECDOC-955, IAEA, Vienna (1997).

[I–2] NUCLEAR REGULATORY COMMISSION, RASCAL 3.0, Description of Model and Methods, Rep. NUREG-1741, NRC, Washington, DC (2001).

[I–3] NUCLEAR REGULATORY COMMISSION, Response Technical Manual, Rep. NUREG/BR-0150, Vol. 1, Rev. 4, NRC, Washington, DC (1996).

[I–4] NUCLEAR REGULATORY COMMISSION, Regulatory Analysis for the Resolution of Generic Issue 82, Beyond Design Basis Accidents in Spent Fuel Pools, Rep. NUREG-1353, NRC, Washington, DC (1989).

[I–5] NUCLEAR REGULATORY COMMISSION, An Updated Nuclear Criticality Slide Rule, NUREG/CR-6504, NRC, Washington, DC (1998).

[I–6] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL CIVIL AVIATION ORGANIZATION, INTERNATIONAL LABOUR ORGANIZATION, INTERNATIONAL MARITIME ORGANIZATION, INTERPOL, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, THE PREPARATORY COMMISSION FOR THE COMPREHENSIVE TEST BAN TREATY ORGANIZATION, UNITED NATIONS ENVIRONMENTAL PROGRAMME, UNITED NATIONS OFFICE FOR THE CO-ORDINATION OF HUMANITARIAN AFFAIRS, WORLD HEALTH ORGANIZATION, WORLD METEOROLOGICAL ORGANIZATION, Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSR Part 7, IAEA, Vienna (2015). .

Annex II

RADIATION INDUCED HEALTH EFFECTS

II-1. The GSR Part 7 [2] (para. 3.2) present the following practical goals of emergency response in relation to radiation induced health effects:

"(c) To avoid or to minimize severe deterministic effects;

(d) To render first aid, to provide critical medical treatment and to manage the treatment of radiation injuries;

(e) To reduce the risk of stochastic effects."

II-2. This section reviews the important aspects of radiation induced health effects that may result from a nuclear or radiological emergency. Reference [II-1; II-25] provides a further discussion of attributing health effects to ionizing radiation exposure and inferring risks.

DETERMINISTIC EFFECTS

II-3. 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 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 (for example, for bone marrow syndrome) or more grays (Gy) (for example, 6 Gy for gastro-intestinal syndrome) 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 [II-26]. Keeping the doses below these thresholds will prevent deterministic effects. The latest findings on response of normal tissues and organs to ionising radiation and estimates of the threshold doses for acute, fractionated, or chronic exposure can be found in the publications of the International Commission on Radiological Protection [II-26].

II-4. Radiological emergencies in the past have resulted in severe deterministic effects, including fatalities and very serious injuries, among the public [II-2 – II-8]. Severe deterministic effects have also occurred in patients owing to accidental medical overexposure [II-9, II-10].

II-5. Severe deterministic effects have occurred among workers and responders in emergencies at facilities in categories I, II and III [II-11– II-14]. Severe deterministic effects could also result off a site owing to a release of large amounts of radioactive material from facilities in emergency preparedness category I. This hazard is most probably limited to large reactors[42] and facilities where there are large quantities of volatile radioactive material, such as facilities for reprocessing fuel waste.

STOCHASTIC EFFECTS

II-6. 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

[42] In the Chornobyl 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 [II-11]. Fortunately, these dose rates occurred only in uninhabited areas.

are assumed to occur without a threshold level of dose and they include cancers (e.g. thyroid cancer and leukaemia) and hereditary effects.

II-7. Only the acute external exposure of many tens of thousands of people to whole body doses in the range of 100–200 mSv [II-11] or internal exposure of many tens of thousands of children to thyroid doses of the order of 50 mSv [II-15] (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 exposed. Even emergencies that have led to the exposure of very large groups of people (e.g. the Chornobyl 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.[43]

II-8. 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 hereditary 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). However, an increase in the frequency of occurrence of specific cancers in a population who were exposed to radiation as a result of the emergency could be scientifically attributed to radiation exposure by means of epidemiological analysis. 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 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 in the first week or in the first year) 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

[43] 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 Chornobyl accident [II-11]. 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 Chornobyl 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.

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. Further details on arrangements for placing the health hazard in perspective in the event of a nuclear or radiological emergency are provided in Refs [GSG-14 and EPR-NPP PPA].

II-9. One of the important goals of emergency preparedness is to reduce, to the extent practicable, the risk of stochastic effects. Since it is assumed for radiation protection purpose 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 criteria at which various protective actions and other response actions would be justified on radiation protection grounds [GSR Part 7]. Taking protective action at levels significantly below these levels could do more harm than good.

EXPOSURE OF THE EMBRYO OR FOETUS

II-10. 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.[43] 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 [II-17]. 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.[44]

EXPOSURE PATHWAYS

II-11. 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 drinking water, inadvertent ingestion);
– Inhalation from a plume or due to the resuspension of deposited radioactive material;
– Contamination of skin.

II-12. 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

[44] Studies on adverse consequences relating to the Chornobyl 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 [Chornobyl] accident” [II-11].

being carried (e.g. by hand or in pockets) or taken home [II-5–II-8, II-18].[45] 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 patterns, and at least one victim inadvertently ingested an amount of this material with fatal consequences [II-2]. In these emergencies, the most important means of distribution of the radioactive material was human activity.

II-13. Workers in irradiation facilities (category III) have received lethal exposures from being near extremely dangerous unshielded sources[46] [II-12, II-13], in one case for less than a minute [II-19]. Workers have also received fatal doses almost instantaneously from being near an accidental criticality event in a fuel cycle facility [II-14].

II-14. 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.[47] It may be that none of these factors is known with any certainty during an emergency.

II-15. For airborne releases from facilities the significant pathways of exposure for the public are mainly:

a. External gamma radiation from the plume (i.e. cloud shine);

b. External gamma radiation from radioactive material deposited on the ground (i.e. ground shine);

c. Inhalation of radioactive material contained in the plume;[48]

d. Ingestion of contaminated food, milk or drinking water;

e. Deposition of radioactive material on the skin (to a lesser extent).

II-16. The pattern of the radioactive material deposited following an airborne radioactive release is very complex, as was seen following the Chornobyl [II-11, II-20], Fukushima Daiichi [II-24] and Tomsk [II-21] accidents. For facilities in category I, airborne releases have been postulated (e.g. for large reactors [II-23]) or have actually occurred (i.e. in the Chornobyl and Fukushima accident [II-11; II-24]) 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 categories I and II, airborne releases have been postulated or have actually occurred [II-22, II-23] that would result or have resulted in doses over several days sufficient to warrant the implementation of urgent protective actions to prevent severe deterministic effects or reasonably to reduce the risk of stochastic effects.

[45] 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 [II-18].

[46] See TABLE II.1 for the D-values of different radionuclides.

[47] **Appendix II** provides a plain language explanation of the possible impacts of emergencies involving dangerous sources.

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

II-17. There may also be emergencies at some category II facilities that involve unshielded criticalities and that would result in off-site doses (without a significant airborne release[49]) sufficient to warrant the implementation of urgent protective actions within a distance of several hundred metres.

REFERENCES TO THE ANNEX II

[II–1] INTERNATIONAL ATOMIC ENERGY AGENCY, Development of an Extended Framework for Emergency Response Criteria, IAEA-TECDOC-1432, IAEA, Vienna (2005).

[II-2] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Goiânia, IAEA, Vienna (1988).

[II-3] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Tammiku, IAEA, Vienna (1998).

[II-4] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Samut Prakarn, IAEA, Vienna (2002).

[II-5] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Lilo, IAEA, Vienna (2000).

[II-6] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Gilan, IAEA, Vienna (2002).

[II-7] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Istanbul, IAEA, Vienna (2000).

[II-8] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Yanango, IAEA, Vienna (2000).

[II-9] INTERNATIONAL ATOMIC ENERGY AGENCY, Accidental Overexposure of Radiotherapy Patients in San José, Costa Rica, IAEA, Vienna (1998).

[II-10] INTERNATIONAL ATOMIC ENERGY AGENCY, Investigation of an Accidental Exposure of Radiotherapy Patients in Panama, IAEA, Vienna (2001).

[II-11] UNITED NATIONS, Sources, Effects and Risks of Ionizing Radiation: Volume II, Effects (Report to the General Assembly), Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), UN, New York (2000).

[II-12] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in San Salvador, IAEA, Vienna (1990).

[II-13] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Soreq, IAEA, Vienna (1993).

[49] 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.

[II-14] INTERNATIONAL ATOMIC ENERGY AGENCY, Report on the Preliminary Fact Finding Mission Following the Accident at the Nuclear Fuel Processing Facility in Tokaimura, Japan, IAEA, Vienna (1999).

[II-15] JACOB, P., et al., Thyroid cancer risk in Belarus after the Chernobyl accident: Comparison with external exposures, Radiat. Environ. Biophys. 30 (2000) 25–31.

[II-16] GSR Part 7

[II-17] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Pregnancy and Medical Radiation, ICRP Publication No. 84, Pergamon Press, Oxford (2000).

[II-18] INTERNATIONAL ATOMIC ENERGY AGENCY, Lessons Learned from Accidents in Industrial Radiography, IAEA Safety Reports Series No. 7, IAEA, Vienna (1998).

[II-19] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident at the Irradiation Facility in Nesvizh, IAEA, Vienna (1996).

[II-20] INTERNATIONAL ATOMIC ENERGY AGENCY, The International Chernobyl Project, Technical Report: Assessment of Radiological Consequences and Evaluation of Protective Measures, Report by an International Advisory Committee, IAEA, Vienna, (1991).

[II-21] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in the Reprocessing Plant at Tomsk, IAEA, Vienna (1998).

[II-22] US NUCLEAR REGULATORY COMMISSION, Severe Accident Risk: An Assessment for Five US Nuclear Power Plants, Rep. NUREG-1150, USNRC, Washington, DC (1990).

[II-23] US NUCLEAR REGULATORY COMMISSION, Pilot Program: NRC Severe Reactor Accident Incident Response Training Manual, Rep. NUREG-1210, USNRC, Washington, DC (1987).

[II-24] INTERNATIONAL ATOMIC ENERGY AGENCY, The Fukushima Daiichi Accident: Report by the Director General, IAEA, Vienna (2015).

[II-25] UNITED NATIONS, Sources and Effects of Ionizing Radiation, Report to the General Assembly (with scientific annexes), United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 2012), Scientific Annex A, Attributing health effects to ionizing radiation exposure and inferring risks, New York (2015).

[II-26] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, ICRP Statement on Tissue Reactions and Early and Late Effects of Radiation in Normal Tissues and Organs – Threshold Doses for Tissue Reactions in a Radiation Protection Context, ICRP Publication No. 118, Elsevier, Oxford (2012).

Annex III

OVERVIEW OF URGENT AND EARLY PROTECTIVE ACTIONS AND OTHER RESPONSE ACTIONS

III-1. The Annex provides a short overview of the key protective actions and other response actions to be taken in the event of a nuclear or radiological emergency. More detailed guidance on actions is given in Ref. [EPR-Protection Strategy]. The publications comprehensively explains the objectives and role of each action in protection strategy, its applicability domain and strengths, weaknesses and limitations, acceptable duration, timeframe for decision making, decision making criteria, aspects to be considered for implementation in response, lifting or adapting criteria and elaborates on factors to be considered in preparedness.

EVACUATION

III-2. A room, facility or geographic area can be evacuated. Timely evacuation can prevent exposures via all possible exposure pathways and removes individuals from the proximity of the emergency so that they are no longer an immediate concern for response officials.

III-3. Numerous evacuations have been carried out in response to emergencies involving natural, chemical and radiological hazards and terrorist attacks. Studies of these evacuations show [III-1, III-2] that the risks of the evacuation itself for the normal population were smaller than those due to normal travel under similar weather conditions. However, evacuation may be more dangerous for special groups in the population, such as hospital patients, if it is not prepared for adequately. At least the following should considered in preparing for evacuation:

- Criteria supporting decision making;
- Established evacuation routes and traffic control;
- Access control and protection of property;
- Arrangements for special population groups and facilities (e.g. hospitals, prisons);
- Consideration of farm animals and pets;
- Provisions for meeting the human needs of evacuees.

SHELTERING

III-4. Sheltering is relatively easy to implement, but it may not be possible to extend it for long periods of time (not more than 2 days). Sheltering will provide some protection against exposure via all the major exposure pathways during the early response phase of a nuclear or radiological emergency. Sheltering ‘in place’ can also be used whenever individuals in a potential area of risk are instructed to ‘go inside and shut the windows and doors and listen to the radio or television for further instructions’ while further assessments of preparations for evacuation are being made. Sheltering can also be used whenever conditions make evacuation dangerous (e.g. in severe weather conditions).

III-5. The effectiveness of sheltering varies greatly, depending on the characteristics of the radioactive release or the sources of the exposure (e.g. a criticality), the construction of the shelter and the exposure pathway. External exposure can be reduced by a factor of ten by sheltering in a large structure, while a lightweight building provides little protection from external gamma radiation [Ref. XX]. Estimating the protection provided against inhalation of radioactive material in the plume by

sheltering is very complex. For a short release, most buildings will reduce inhalation doses by a factor of two or three. However, the reductions in the inhalation doses resulting from long releases typically decrease rapidly after a few hours as the concentrations of radioactive material in the structure increase. After passage of the plume, the inhalation doses in most structures could even be greater than those outside if some of the contamination from the plume is trapped in the shelter [Ref XX]. Consequently, it should be recommended that normal shelters be ventilated (aired out) after a major release has terminated.[50]

III-6. Because of the great variability of building structures, shelters can be considered as belonging to one of three categories, as shown in TABLE III-1.

III-7. Predetermined shelter locations should be provided with a means of determining whether radiation levels are acceptable (e.g. measuring instruments and criteria for judging the results) and arrangements for meeting human needs.

TABLE III-1. SHELTER TYPES AND USES

Type	Description	Uses and recommendations
Normal	Typical European and North American homes and their basements.	May not provide adequate protection (e.g. from a major airborne plume close to a facility[a] in category I). Should be used in the event of a major release if evacuation is impossible (e.g. in a severe storm) or when preparing to evacuate.
Substantial	Inside halls of large multistorey buildings or large masonry structures away from walls or windows. Estimated protection factor of 10 from external and inhalation dose.	May provide adequate protection for short periods. Can be used as urgent protection for up to a day. However, the effectiveness should be assessed by means of monitoring and users should be provided with instructions on application.
Special	Designed to provide a reduction by a factor of more than 100 in external and inhalation doses.	Provides adequate protection. Should be used as the primary urgent protective measure for the design period of the shelter.

[a] The distances within which shelter is ineffective in reducing the risk of severe deterministic effects should be based on site specific analysis; however, for the most severe emergencies postulated for nuclear power plants, shelter in a typical frame house is projected to provide inadequate protection within about the first 3 km from the site of the emergency.

IODINE THYROID BLOKING

III-8. The uptake by the thyroid gland of radioiodine from inhalation can be reduced by the administration of certain amounts of stable (non-radioactive) iodine which saturates the thyroid. This is called iodine thyroid blocking.

III-9. To achieve maximum effectiveness, stable iodine must be administered before or soon after the intake of radioiodine. The effectiveness of the measure decreases rapidly with delay, and can be reduced to 50% or less if administered 6 hours after a single intake of radioactive iodine. The reduction in the dose to the thyroid gland is only about 20% if stable iodine is given 10 hours after intake, while it falls almost to zero if stable iodine is given 24 hours after the intake of radioiodine [III-3].

III-10. There has been considerable concern about adverse side effects on health from the intake of stable iodine. The WHO, partly on the basis of experience gained from the response to the Chornobyl accident, found the risk of severe adverse side effects to be negligible and intake of stable iodine to be

[50] This is made difficult by the uncertainties associated with projections of the timing (duration) and size of major releases and plume movements, as was seen following the Chornobyl accident in 1986.

both safe and effective [III-4] if the iodine is provided in the correct dosages and those with known severe allergic reaction are excluded. WHO has provided guidance on the appropriate dosages in Ref. [III-4]. These dosages are different for adults and children.

III-11. Emergencies involving core damage at large reactors (category I) can release significant amounts of airborne radioactive iodine (radioiodine) over several days, as was seen in the Chornobyl and Fukushima Daiichi accident. The thyroid gland absorbs and concentrates iodine once it has been inhaled or ingested; thus, the potential exists for large thyroid doses following the occurrence of severe core damage at a large reactor. A large dose to the thyroid can result in deterministic effects in the thyroid gland and radiation induced thyroid cancer. In the event of actual or possible core damage, iodine thyroid blocking should therefore be used:

— To prevent deterministic effects in the thyroid gland (e.g. hypothyroidism);

— To reasonably reduce the risk of stochastic effects (e.g. radiation induced thyroid cancer) from the inhalation of radioiodine within or near the facility.

III-12. The risks of deterministic effects to the thyroid are principally of concern for individuals on the site and for the population close to the site (e.g. within the UPZ).

III-13. To be most effective, stable iodine should be provided before or shortly after an intake of radioiodine (i.e. before or shortly after a radioactive release). Consequently, for emergencies involving severe core damage at reactors of facilities in categories I and II, arrangements should be made to provide iodine thyroid blocking agents promptly (i.e. before or within hours of a release) to individuals who are on the site, to the population within the UPZ, and emergency workers involved in response. In developing these arrangements, at least, the following should be considered:

i. Criteria supporting decision making;

ii. The logistics of storage, restocking and distribution;

iii. The need for instructions to users to ensure that the correct dosages are taken and that individuals with known severe allergies are excluded from the administration of iodine thyroid blocking agents;

iv. Medical follow-up of those with actual or perceived side effects.

III-14. Appropriate arrangements should be made for the continuation of intake of iodine thyroid blocking agents for more than one day if there is:

- Potential for significant releases of radioiodine for several days following the onset of an emergency;
- Potential for inadvertent ingestion after passage of the radioactive plume;
- In-growth of ^{132}I from the decay of ^{132}Te in the environmental contamination following a release.

III-15. Doses to the thyroid, in the vast majority of cases, will not give rise to life threatening effects if individuals are properly treated. However, sever deterministic effects could result from doses to the bone marrow, lungs and other organs. Only substantial sheltering or evacuation can protect these organs. The sheltering or evacuation of people at risk of life threatening doses should therefore not be delayed for the provision of iodine thyroid blocking.

PROTECTION OF THE FOOD CHAIN AND WATER SUPPLY AND RESTRICTION ON CONSUMPTION OF FOOD, MILKAND DRINKING WATER

III-16. Following a major release from a facility in category I or II, one of the primary sources of exposures may be the ingestion of contaminated food,milk or drinking water.[51] Ingestion of radioactive material may also be of concern if an explosion or human activity spreads dispersible material from a dangerous source.

III-17. The Chornobyl accident showed that the contamination of drinking water sources due to an airborne radioactive release might not be a major concern, except if rainwater is being used directly for drinking or cooking.

III-18. Consequently, for facilities in categories I and II (with the potential for an emergency that may result in a major release) arrangements should be made:

1. To instruct the public to protect sources of drinking water (e.g. to disconnect rainwater collection pipes) and to protect important sources of food that may become contaminated;
2. To instruct the public within the ICPD not to consume non-essential locally produced food that may have been contaminated and not to consume milk from animals that may graze on possibly contaminated pastures;
3. Promptly to conduct monitoring and to implement the appropriate restrictions on food, milk and on drinking water within the area where food, milk or water may be contaminated to levels warranting restrictions.

III-19. These arrangements should be developed in consideration of:

- Criteria supporting decision making;
- Instructions for the public and for farmers;
- Availability of replacement foods;
- Operational criteria (i.e. OILs);
- Arrangements for the distribution and processing of food.

PREVENTION OF INADVERTENT INGESTION

III-20. Radioactive material released in the event of the nuclear or radiological emergency (e.g. emergency at the spent fuel pool or intentional or nonintentional distribution of dispersible radioactive material) can be deposited on the ground or other surfaces (e.g. cars, door-handles). Inadvertent ingestion of this deposited radioactive material (e.g. smoking or eating with dirty hands), can be a significant source of exposure. Keeping hands and possibly contaminated objects out of the mouth can prevent inadvertent ingestion of radioactive material and reduce the dose. Individuals can take this action immediately, once they are aware of the hazard.

RELOCATION

[51] The consumption of milk contaminated with radioiodine was the primary cause of an increase in the incidence of thyroid cancers among children following the Chernobyl accident. Radiation induced thyroid cancers due to the Chernobyl accident occurred among people living at different distances from the plant and the vast majority were observed at more than 50 km from the plant. The most effective protective action to prevent or reduce these thyroid cancers would have been to restrict the consumption of potentially contaminated food and milk.

III-21. Relocation is an early protective action that means removal of people in order to avoid longer term exposure from radioactive material deposited on the ground. Areas requiring relocation are typically identified based on environmental monitoring that indicates places where doses to the public may exceed generic criteria for taking early protective actions (Table II.2 in GSR Part 7).

III-22. Relocation may also be required if people are living in areas where essential food and water are contaminated in values when their further consumption may result in doses from all exposure pathways above the generic criteria given in Table II.2 in GSR Part 7 and when replacement of food or water cannot be provided. For an emergency relating to a release from a reactor core or spent fuel, areas within the EPD may require relocation due to hotspots.

III-23. Al least, the following should be taken into account in preparing for relocation:

- Operational criteria supporting decision making on relocation (i.e. OIL2);
- Consideration of farm animals and household pets;
- Access control to the relocated area and protection of property;
- Provisions for meeting the human needs including special population groups and facilities.

RESTRICTION OF ACCESS

III-24. In most nuclear and radiological emergencies, individuals can be protected from the radiological hazards by setting up barriers and maintaining them to ensure that people and vehicles do not enter or exit the area unless authorized to do so and, where necessary, monitored and decontaminated. In the event of radiological emergency, it means establishing secured cordoned off area, for the nuclear emergency at facilities in category I and II it means posing restrictions to access evacuated PAZ and UPZ or relocated areas outside the UPZ (e.g. in EPD).

III-25. This action limits the dispersion of radioactivity outside of the restricted area and allows to control the contamination of and doses to those persons with access to the area (e.g. emergency workers working on area decontamination; evacuated public with temporary access to pick up essential belongings).

III-26. The respiratory protection equipment typically used by firefighters provides good protection against the inhalation hazard for most emergencies involving an airborne release of radioactive material. Skin contamination is not a major threat, provided that simple steps are taken to protect the skin and to prevent inadvertent ingestion. However, conditions on the site of a facility in category I, II or III may be very severe and may require specialized protective equipment.[52] Personnel responding to radiological emergencies should use respiratory protection equipment whenever an inhalation hazard is suspected.

III-27. Improvised respiratory protection (e.g. a wet cloth over the mouth and nose) has been shown to be effective but it has not been demonstrated that the public will apply it effectively during an emergency. Improvised respiratory protection should not be assumed to provide adequate protection from an inhalation hazard and therefore its implementation should not be allowed to interfere with evacuation or sheltering.

[52] In the Chornobyl accident, water contaminated with radioiodine soaked through the protective clothing of the fire-fighters, resulting in beta radiation burns that contributed to several fatalities. In many responses, on-site efforts have been hampered by a lack of protective equipment (e.g. field radiation detection instruments with a high range (e.g 10 Gy/h) or air tanks for self-contained breathing apparatus).

DECONTAMINATION OF INDIVIDUALS

III-28. Significant levels of skin contamination are very rare, and for most emergencies contamination has not presented a health risk. However, skin contamination can have severe adverse psychological and economic effects. In some cases contaminated people have been shunned and medical professionals have refused to treat them. In addition, skin contamination did contribute to the deaths of several on-site responders (firefighters) during the Chornobyl accident in 1986, and the inadvertent ingestion of contaminated particles that were on the skin of persons who were contaminated in the accident in Goiânia, Brazil in 1987 may have been fatal. These accidents illustrate the two scenarios for which prompt decontamination may be important in preventing severe deterministic effects:

i. Those who may have been heavily contaminated by a major airborne radioactive release should be promptly decontaminated to prevent burns to large areas of the skin. This would probably only be an issue for those on the site during a major release from a facility in category I and possibly category II or III.

ii. Those who may have skin contamination that could be hazardous and which could result in inadvertent ingestion (e.g. by touching mouth and face with dirty hands) should be promptly but safely decontaminated. This hazard would most probably be of concern to someone who handled a dangerous source containing dispersible material or something directly contaminated by such a source.

III-29. Contamination by a wide range of radioactive materials is easy to detect; however, criteria are needed to take decision on the need of decontamination and the system should be in place to put health hazard in perspective. Past experience demonstrates that lack of criteria has resulted in unnecessary decontamination, diversion of resources, unwarranted anxiety among the public and loss of equipment or facilities.[53] Consequently, operational criteria should be established to assess levels of contamination on people and equipment.

III-30. Simply changing clothing, showering or washing exposed skin will reduce levels of contamination and prevent the spread of contamination at significant levels. These simple, cost effective decontamination measures should be used even for contamination at lower levels, provided that they do more good than harm, carried out in such a way as to minimize unwarranted anxiety and do not result in the waste or unjustified diversion of resources. In emergencies, especially when large numbers of people are involved, decontamination measures should be limited to these basic measures and only limited (i.e. easy and simple) efforts should be made to control the wastes arising from the decontamination.

PROTECTION OF INTERNATIONAL TRADE

III-31. Nuclear and radiological emergencies that have occurred in the past have had major adverse economic consequences. This was in part because steps were not taken immediately to reassure people, including national and international customers. It should be noted that hazards as reported in the media or as perceived internationally can be as influential as real hazards. Consequently, in the event of a nuclear or radiological emergency (or in the event of reports of such an emergency) that may have or that may be perceived to have an impact on trade, there should be provision for taking measures immediately to ensure that all goods in trade meet international standards. The exemption levels and

[53] Some emergency plans state that vehicles or facilities that are contaminated cannot be used, but do not define what levels of contamination constitute being contaminated.

clearance levels in Ref. [III-5] may be considered as a basis for protecting international trade after an emergency.

MEDICAL MANAGEMENT OF EXPOSED INDIVIDUALS

III-32. Nuclear and radiological emergencies have occurred that warrant taking immediate action to hazard and to identify those who should receive long term medical follow-up.

III-33. .

REFERENCES TO THE ANNEX III

[III–1] ENVIRONMENTAL PROTECTION AGENCY, Evacuation Risks, an Evaluation, EPA-520/6-74-002, EPA, Las Vegas, NV (1974).

[III-2] NUCLEAR REGULATORY COMMISSION, Evaluation of protective action risks, Rep. NUREG/CR-4726, NRC, Washington, DC (1987).

[III-3] IL'IN, L.A., Radioactive iodine in the problem of radiation safety, Atomizad, Moscow (1972) (in Russian) [English translation: US Atomic Energy Commission, Translation series, AEC-tr-7536].

[III-4] WORLD HEALTH ORGANIZATION, Iodine thyroid blocking: guidelines for use in planning for and responding to radiological and nuclear emergencies, WHO, Geneva (2017).

[III-5] INTERNATIONAL ATOMIC ENERGY AGENCY, Application of the Concepts of Exclusion, Exemption and Clearance, IAEA Safety Standards Series No. RS-G-1.7, IAEA, Vienna (2004) – is under revision.

Annex IV

COVERAGE OF REMAINING GSR PART 7 REQUIREMENTS IN IAEA PUBLICATIONS

IV-1. TABLE IV-1presents the list of IAEA most recent publications that provide recommendations or more detailed technical guidance on certain GSR Part 7 requirements that are not addressed in this IAEA Safety Guide.

TABLE IV-1.COVERAGE OF REMAINING GSR PART 7 REQUIREMENTS IN IAEA PUBLICATIONS

Requirement of GSR Part 7	IAEA publication
Requirement 3. Responsibilities of international organizations in emergency preparedness and response	• Joint Radiation Emergency Management Plan of the International Organizations, EPR-JPLAN (2017)
Requirement 5: Protection strategy for a nuclear or radiological emergency	• IAEA Safety Standards Series No. GSG-2, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency (2011) • IAEA Safety Standards Series No. GSG-11, Arrangements for the Termination of a Nuclear or Radiological Emergency (2018) • Considerations in the Development of a Protection Strategy for a Nuclear or Radiological Emergency, EPR-Protection Strategy (2020) • Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor, EPR-NPP Public Protective Actions (2013) • Operational Intervention Levels for Reactor Emergencies and Methodology for Their Derivation, EPR-NPP-OILs (2017) • Operational Intervention Levels for Radiological Emergencies and Methodology for Their Derivation, EPR-RAD-OILs (in development)
Requirement 8: Taking mitigatory actions	• To be developed
Requirement 10: Providing instructions, warnings and relevant information to the public for emergency preparedness and response	• IAEA Safety Standards Series No. GSG-14, Arrangements for Communication with the Public in Preparedness and Response for a Nuclear or Radiological Emergency
Requirement 11: Protecting emergency workers and helpers in an emergency	• IAEA Safety Standards Series No. GSG-11, Arrangements for the Termination of a Nuclear or Radiological Emergency • IAEA Safety Standards Series No. GSG-7, Occupational Radiation Protection
Requirement 12: Managing the medical response in a nuclear or radiological emergency	• Generic Procedures for Medical Response During a Nuclear or Radiological Emergency, EPR-MEDICAL (revision is in printing) • IAEA Safety Standards Series No. GSG-11, Arrangements for the Termination of a Nuclear or Radiological Emergency
Requirement 13: Communicating with the public throughout a nuclear or radiological emergency	• IAEA Safety Standards Series No. GSG-14, Arrangements for Communication with the Public in Preparedness and Response for a Nuclear or Radiological Emergency

Requirement of GSR Part 7	IAEA publication
Requirement 15: Managing radioactive waste in a nuclear or radiological emergency	• IAEA Safety Standards Series No. GSG-11, Arrangements for the Termination of a Nuclear or Radiological Emergency (2018)
Requirement 16: Mitigating non-radiological consequences of a nuclear or radiological emergency and of an emergency response	• IAEA Safety Standards Series No. GSG-11, Arrangements for the Termination of a Nuclear or Radiological Emergency
Requirement 18: Terminating a nuclear or radiological emergency	• IAEA Safety Standards Series No. GSG-11, Arrangements for the Termination of a Nuclear or Radiological Emergency (2018)

CONTRIBUTORS TO DRAFTING AND REVIEW

Assi, M.	International Atomic Energy Agency
Anderson, J.	International Atomic Energy Agency
Buglova, E.	International Atomic Energy Agency
Daniels, M.	International Atomic Energy Agency
Hubbard, L.M.	Sweden
Kaiser, P.	International Atomic Energy Agency
Kouts, K.	International Atomic Energy Agency
Motomitsu, K.	International Atomic Energy Agency
Martinčič, R.	International Atomic Energy Agency
McClelland, V.J.	United States of America
McMahon, C.	Environmental Protection Agency, Ireland
Nestoroska Madjunarova, S.	International Atomic Energy Agency
Oliveira Martins, J	Portuguese Environment Agency, Portugal
Owen, D.	Office for Nuclear Regulation, United Kingdom
Vandecasteele, C.	Federal Agency for Nuclear Control, Belgium
Vilar Welter, P.	International Atomic Energy Agency
Waller, E.	University of Ontario, Canada