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EMERGENCY PREPAREDNESS AND RESPONSE

Considerations in Emergency Preparedness and Response for a State Embarking on a Nuclear Power Programme

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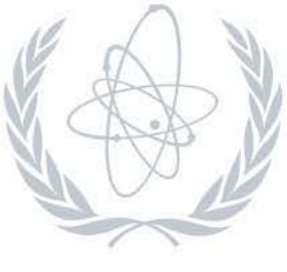

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Considerations in Emergency Preparedness and Response for a State Embarking on a Nuclear Power Programme

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FOREWORD

The aim of this publication is to provide a practical tool for emergency planning for States embarking on a nuclear power programme and to fulfil, in part, functions assigned to the IAEA in the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency ('Assistance Convention'). Under Article 5.a (ii) of the Assistance Convention, one function of the IAEA is to collect and disseminate to State Parties and Member States information concerning methodologies, techniques and available results of research relating to such emergencies.

As established in the publication Preparedness and Response for a Nuclear or Radiological Emergency (IAEA Safety Standards Series No. GS-R-2), the practical goal of emergency response is "to ensure that arrangements are in place for a timely, managed, controlled, coordinated and effective response at the scene, and at the local, regional, national and international level, to any nuclear or radiological emergency". In 2011 the IAEA General Conference, in resolution GC(55)/RES/9, encouraged States "embarking on new nuclear power programmes to take timely and proactive steps, based upon gradual and systematic application of IAEA safety standards, to establish and sustain a strong safety culture". It also "emphasizes the importance for all Member States to implement emergency preparedness and response mechanisms and develop mitigation measures at a national level, consistent with the IAEA's Safety Standards, for improving emergency preparedness and response, facilitating communication in an emergency and contributing to harmonization of national criteria for protective and other actions". This publication, issued in the IAEA Emergency Preparedness and Response Series, is intended to assist on steps to be taken by States embarking on a nuclear power programme to establish effective national capabilities and arrangements of preparedness for and response to a nuclear or radiological emergency (hereinafter referred to as a radiation emergency), which is an important part of the safety infrastructure for a nuclear power programme. If used effectively, it will help a State to develop a capability to adequately prepare for and respond to a radiation emergency after commissioning and operation of its first nuclear power plant as a nuclear facility in threat category I or II.

The IAEA officer responsible for this publication was V. Kutkov of the Department of Nuclear Safety and Security.

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CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

Safety in the operation of a nuclear power plant (NPP) is of great importance for the protection of people, society and the environment in those States considering embarking on a nuclear power programme for the first time, as well as those considering expanding an existing programme. One of the challenges for the governments of those countries is to provide for a robust emergency preparedness and response arrangements and capabilities to enable a timely and effective response in a radiation emergency[1].

The IAEA Safety Standards provide principles, requirements and guidance to help States benefit from international best practices in developing and maintaining their nuclear power programmes. The Fundamental Safety Principles (SF-1) [1] establishes the fundamental safety objective, safety principles and concepts that provide the basis for the Safety Standards. Principle 8, Prevention of accidents and Principle 9, Emergency preparedness and response, directly relate to emergency preparedness and response [1].

The IAEA Safety Requirements GS-R-2 [2] establishes the requirements for an adequate level of preparedness and response to a radiation emergency in any State. Implementation of these international requirements is intended to minimize the consequences of a radiation emergency for people, property and the environment.

This current publication provides subject specific details, guidance and an essential link between the IAEA Safety Standard SSG-16 on Establishing the Safety Infrastructure for a Nuclear Power Programme [3] and essential elements of a framework for preparedness and response for a radiation emergency defined in Safety Requirements No. GS-R-2 [2], Safety Guide No. GS-G-2.1 [4] and No. GSG-2 [5] and the EPR-METHOD publication [6].

The terms used in this publication are defined in the IAEA Safety Glossary [7].

1.2. OBJECTIVE

The objectives of this publication are to assist those States that are considering embarking on a nuclear power programme to develop an adequate level of emergency preparedness and response to radiation emergencies prior to commissioning their first NPP, and to ensure the maintenance of the emergency preparedness and response programme throughout the lifetime of the facility. The intention is to support the Fundamental Safety Principles [1] and the international requirements on emergency preparedness and response formulated in the IAEA Safety Requirements GS-R-2 [2] and the corresponding guidelines of the IAEA Safety Guides No. GS-G-2.1 [4] and No. GSG-2 [5]. Furthermore, this publication is consistent with other IAEA publications developed to provide guidance for States embarking on a nuclear power programme, specifically, NG-G-3.1, Milestones in the Development of a National Infrastructure for Nuclear Power [8], and SSG-16, Establishing the Safety Infrastructure for a Nuclear Power Programme [3].

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[1] In this context, a ‘nuclear or radiological emergency’ will be referred to as a ‘radiation emergency’.

1.3. SCOPE

This publication addresses the elements required for an adequate level of emergency planning, preparedness and response capabilities needed by a State embarking on a nuclear power programme prior to commissioning the NPP.

Development of a nuclear power programme is a major undertaking requiring careful planning, preparation and investment in a sustainable infrastructure that provides legal, regulatory, technological, human, industrial, and financial support to ensure that nuclear material is used exclusively for peaceful purposes and in a safe and secure manner.

To support States embarking on a nuclear power programme or those considering expansion of an existing one, the IAEA published a publication NG-G-3.1, Milestones in the Development of a National Infrastructure for Nuclear Power [8]. This publication addresses phases 1, 2 and 3 in the development of a comprehensive nuclear power programme as defined in NG-G-3.1 [8].

The primary means of preventing and mitigating the consequences of emergencies is the principle of ‘defence in depth’. Defence in depth is primarily achieved through the combination of a number of consecutive and independent levels of protection that would have to fail before harmful effects could be caused to people or to the environment. Protection of the public and the environment is maintained by the first levels of defence in depth, established and maintained during design, construction and operation of the plant. These levels of defence in depth aim to ensure protection from design basis accidents at a nuclear installation. One of the concerns associated with nuclear power is the possibility that a State embarking on a nuclear power programme might not have sufficient capabilities and is therefore not adequately prepared to respond to a radiation emergency caused by severe accident conditions (including as a result of severe damage to the reactor core).

Protecting the public, the environment and property in the event of failure of any level of defence in depth is the most important safety objective. A robust framework for emergency preparedness and response to a radiation emergency forms the last level of defence in depth [9] and as such, must be developed and implemented using best international practices for any State embarking on a nuclear power programme. The establishment of capabilities and arrangements for emergency preparedness and response to severe accident conditions is one of the principal tasks in the development of a national infrastructure for nuclear power. State-of-the-art emergency preparedness and response is a key element to achieve overall plant safety [1].

While nuclear security is not directly addressed in this publication, it must be considered as a potential initiating condition that could result in a radiation emergency. It is dealt with in so far as emergency preparedness and response and nuclear security planning have an effect on one another and must be taken into consideration, each by the other in developing an integrated, comprehensive, and effective nuclear power programme [3].

1.4. APPLICATION

This publication provides recommendations on steps to be taken by States considering embarking on a nuclear power programme. It is imperative to appreciate the necessity to plan practical steps for establishing an effective framework of preparedness for and response to a radiation emergency. This applies both during the early stages of the decision making process

(phase 1), and to establish such framework throughout any subsequent developmental phases after that decision has been made.

This publication needs to be taken into consideration at every phase of development of a nuclear power programme, including phase 1, when professionals in emergency preparedness and response will be expected to advise governmental decision makers, who typically have little or no experience in nuclear technology, on the importance of the emergency preparedness and response, the resources required and the necessity for developing and maintaining robust emergency preparedness and response capabilities.

This publication is intended for States with various levels of capabilities for emergency response. It also considers the initial conditions for establishing of such capabilities when the State may have some experience in the use of radiation technologies in industry, medicine and research, but little or no capabilities for managing the response to a radiation emergency.

The publication is to be used with flexibility by States that may have different levels of development of emergency preparedness and response capabilities. Any State embarking on a nuclear power programme needs to develop levels of arrangements and capabilities for emergency response to the high standard required for Threat category I facilities, in accordance with international requirements [2].[2]

1.5. STRUCTURE

The publication contains three sections and appendices. Section 2 explains key elements of the IAEA Safety Standards for emergency preparedness and response. Section 3 contains guidance on establishing a framework of preparedness and response to a radiation emergency through the phased process described in publications NG-G-3.1 [8], INSAG-22 [10] and SSG-16 [3]. Appendix I presents background information for emergency preparedness and response and includes content from the IAEA Safety Requirements No. GS-R-2 [2], Safety Guides No. GS-G-2.1 [4] and No. GSG-2 [5], EPR-METHOD [6] and EPR-FIRST RESPONDERS [11]. Appendix II provides a site evaluation data requirements list for the purposes of emergency preparedness and response. Appendix III explains the capabilities of international response assistance. Appendix IV provides means for the evaluation of capabilities for emergency preparedness and response. Appendix V contains executive summaries of selected IAEA publications related to emergency preparedness and response. Following the appendices, references, definitions of terms, a list of acronyms and the contributors to drafting and review of the publication are included.

2. INTERNATIONAL REQUIREMENTS FOR EMERGENCY PREPAREDNESS AND RESPONSE

The Safety Fundamentals publication Fundamental Safety Principles, SF-1 [1] contains 10 principles. Principle 9 states that “Arrangements must be made for emergency preparedness and response for nuclear or radiation incidents.”

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[2] The term ‘threat category’ is used here as described in Ref. [2] of the main text and only for the purposes of emergency preparedness and response; this usage does not imply that any threat, in the sense of an intention and capability to cause harm, has been made in relation to facilities, activities or sources.

The supporting Safety Requirements publication, Preparedness and Response for a Nuclear or Radiological Emergency, GS-R-2 [2] establishes the following primary practical goals of response to a radiation emergency:

"(a) To regain control of the situation;
(b) To prevent or mitigate consequences at the scene;
(c) To prevent the occurrence of severe deterministic health effects in workers and the public;
(d) To render first aid and to manage the treatment of radiation injuries;
(e) To prevent, to the extent practicable, the occurrence of stochastic health effects in the population;
(f) To prevent, to the extent practicable, the occurrence of non-radiological effects on individuals and among the population;
(g) To protect, to the extent practicable, property and the environment;
(h) To prepare, to the extent practicable, for the resumption of normal social and economic activity."

This publication also states that the practical goal of emergency preparedness is:

"To ensure that arrangements are in place for a timely, managed, controlled, coordinated and effective response at the scene, and at the local, regional, national and international level, to any nuclear or radiological emergency". [2]

In order to achieve these goals, adequate arrangements and capabilities for emergency preparedness and response are required to be in place at the international, national, local and operator levels [2].

The arrangements established to respond to a radiation emergency need to be consistent with those applied in response to any emergency and provide a framework for all organizations to deliver a coordinated response. The following infrastructural elements are required for providing the capability for efficient response which meets the international requirements [2]: authority, organization, coordination, plans and procedures, logistical support and facilities, training, drills and exercises and quality assurance programme.

Regulations supporting emergency preparedness and response are part of the overall regulation(s) for establishing a nuclear power programme. Regulations are required to clearly allocate responsibilities regarding preparedness for and response to a radiation emergency and for meeting the requirements established in GS-R-2 [2]. They are required to cover the legal basis at least in the following areas: governmental infrastructure for preparedness and response to a radiation emergency, overall organization of emergency preparedness and response, initiation and termination of the response to a radiation emergency, and taking precautionary actions, urgent actions and early protective actions and other actions.

The following parties need to be considered in the allocation of functions and responsibilities in emergency preparedness and response, taking into consideration the fact that one or more functions may be performed by several bodies, e.g. State agencies, the government, the regulatory body, a national coordinating authority, operators or operating organizations and response organizations.

Arrangements for emergency preparedness and response at the national level need to be described in the National Radiation Emergency Plan (NREP). The NREP also needs to

include provisions to respond to a radiation emergency at an international level as stipulated in the international conventions [13]. This plan needs to be part of — or to be harmonized with — a national emergency plan for an integrated response to any variety of hazards. Plans and procedures for response to all hazards need to be structured into a coherent and interlocking system. The radiation emergency plan of the operating organization at the operator level, together with plans of off-site authorities and response organizations at local and national levels, all need to be coordinated and integrated within the NREP [2, 6].

Emergency plans at the operator level (the emergency plan of the operating organization) needs to include at least, arrangements that are consistent with those defined in GS-R-2 [2] and that are compatible with the plans and procedures of all national and local response organizations [6].

3. ESTABLISHING ARRANGEMENTS AND CAPABILITIES FOR EMERGENCY PREPAREDNESS AND RESPONSE FOR A STATE EMBARKING ON A NUCLEAR POWER PROGRAMME

3.1. ESTABLISHING A NUCLEAR POWER PROGRAMME

A nuclear power programme based on a strong foundation of safety needs to be developed in accordance with the guidance proposed by the IAEA in a number of publications [3, 10]. It is important to note that all of these publications provide a structured approach to developing a comprehensive nuclear power programme. As pertains to this publication, that approach is used for emergency preparedness and response.

The overall informational publication for a complete programme is NG-G-3.1, Milestones in the Development of a National Infrastructure for Nuclear Power [8]. This publication presents a high level overview of a complete programme consisting of 19 elements, one of which is emergency preparedness and response, that needs to be developed and enhanced over three development phases leading up to plant operation.

In support of NG-G-3.1 [8] the International Nuclear Safety Group (INSAG) developed INSAG-22, Nuclear Safety Infrastructure for a National Nuclear Power Programme Supported by the IAEA Fundamental Safety Principles [10], which expanded the approach in NG-G-3.1. INSAG-22 [10] defined nuclear safety infrastructure, taking the emergency preparedness and response part to a new level of detail. It included the first three phases defined by NG-G-3.1 and added two more to focus on nuclear safety throughout the lifetime of an NPP.

Following the completion of INSAG-22, the IAEA developed SSG-16, Establishing the Safety Infrastructure for a Nuclear Power Programme [3]. This publication was developed as a safety standards ‘roadmap’ for those States considering developing a nuclear power programme. It prescribes general actions to establish a safety infrastructure for a nuclear power programme. This process is based on the establishment of safety infrastructure, as well as the coordination and harmonization of existing safety infrastructure in 20 major thematic areas, which address the implementation of the IAEA general (1–14) and specific (15–20) safety requirements for the establishment of the safety infrastructure:

(1) National policy and strategy for safety;
(2) Global nuclear safety regime;
(3) Legal framework;

(4) Regulatory framework;
(5) Transparency and openness;
(6) Funding and financing;
(7) External support organizations and contractors;
(8) Leadership and management for safety;
(9) Human resources development;
(10) Research for safety and regulatory purposes;
(11) Radiation protection;
(12) Safety assessment;
(13) Safety of radioactive waste management, spent fuel management and decommissioning;
(14) Emergency preparedness and response;
(15) Operating organization;
(16) Site survey and evaluation;
(17) Design safety;
(18) Preparation for commissioning;
(19) Transport safety;
(20) Interfaces with nuclear security.

Establishing arrangements and capabilities for emergency preparedness and response (thematic area 14 [3]) is one of the principal elements in the development of a national infrastructure for a national nuclear power programme. Emergency planning is a key element of overall plant safety for a State because this provides the last level of defence in depth for protecting the public, the environment and property from a radiation emergency in case such an emergency occurs [1]. The requirements publication GS-R-2 [2] forms the foundation for this subject area and provides detailed requirements for establishing comprehensive national emergency preparedness and response capabilities and arrangements. This publication is supported by Safety Guides [4, 5] and a series of EPR Series publications [6, 11, 14–18, 23] of which this publication is a part.

The process of launching a nuclear power programme, from considering embarking on nuclear power programme and taking a political decision to do so, until the operation of the NPP can take 10–20 years. The roadmap for launching and implementing a nuclear power programme includes three phases, associated with milestones that include certain decision points [3, 10]. These phases with associated milestones are:

Phase 1 – Considerations before a decision to launch a nuclear power programme is taken	milestone 1 – Ready to make a knowledgeable commitment to a nuclear programme
Phase 2 – Preparatory work for the construction of an NPP after a policy decision has been taken	Milestone 2 – Ready to invite bids for the first NPP
Phase 3 – Activities to implement the first NPP	Milestone 3 – Ready to commission and operate the first NPP

Establishing emergency preparedness and response arrangements and capabilities is part of the overall process of establishing a safety infrastructure for a national nuclear power programme.

Safety Guide No. SSG-16 [3] provides a roadmap for establishing a safety infrastructure based on the assumption that the State has little or no experience with nuclear power plants, no regulatory body for nuclear safety to support a nuclear power programme and no operating organization at the beginning of the process. In the early part of phase 1, the State needs to establish a nuclear energy programme implementing organization (NEPIO) [19]. In this phase, specific to emergency preparedness and response, the NEPIO will be tasked to evaluate the status of emergency preparedness and response and provide that information to the government. In phase 2, it is expected that this evaluation will be used as a basis for developing or enhancing the emergency preparedness and response capabilities and arrangements.

It is expected in this publication that the State embarking on a nuclear power programme has experience in the use of radiation technologies in industry, medicine and research, has adopted the basic regulations on radiation safety to support those activities, and a regulatory body exists to oversee radiation safety. It is expected that arrangements and capabilities are in place for managing the response to a radiation emergency involving radioactive materials at facilities from threat category III and activities from threat categories IV and V, and that these arrangements and capabilities are in compliance with the international requirements [2].

It is also expected in this publication that the State has a framework for protecting the public, the environment and property from a conventional emergency of natural or man-made origin, and that a national radiation emergency plan for threat categories III–V is in place as an element of this framework.

3.2. MAIN ELEMENTS OF PREPAREDNESS AND RESPONSE FOR A RADIATION EMERGENCY

The IAEA Safety Standards [2, 4, 5] establish the requirements and guidance for an adequate level of emergency preparedness and response to a radiation emergency in any State. The following are the main elements in developing efficient emergency preparedness and response [2]:

(1) Basic responsibilities;
(2) Assessment of threats[3];
(3) Establishing emergency management and operations;
(4) Identifying, notifying and activating;
(5) Taking mitigatory actions;
(6) Taking urgent protective actions;
(7) Providing information and issuing instructions and warnings to the public;
(8) Protecting emergency workers;
(9) Assessing the initial phase;
(10) Managing the medical response;
(11) Keeping the public informed;
(12) Taking agricultural countermeasures, countermeasures against ingestion and longer term protective actions;
(13) Mitigating the non-radiological consequences of the radiation emergency and the response;

[3] The process of analysing systematically the hazards associated with facilities, activities or sources within or beyond the borders of a State [7].

(14) Conducting recovery operations;
(15) Requirements for infrastructure.

A detailed description of these elements with special attention on those which need to be considered while establishing a nuclear power programme is presented below.

Main element 1. Basic responsibilities

The international requirements [2] require (§3.3) that legislation be adopted to clearly allocate responsibilities for preparedness and response to a radiation emergency. Responsibilities for parties involved in emergency preparedness and response are required to be assigned at different levels of response: for on-site response – at operator level, for off-site response – at local, national and international levels. The IAEA Safety Guide [4] provides details of such assignments. In launching a nuclear power programme, the State needs to enact or amend any nuclear legislation and associated regulations so as to protect the public, environment and property from threats associated with the new activity. The INSAG-22 provides specific guidance on that point [10].

This **Main element 1** concerns the allocation of roles and responsibilities, establishment of a governmental body to act as a national coordinating authority and the development of legislation and basic regulations for emergency preparedness and response to meet requirements from:

- GSR Part 1 §2.2–§2.6 and §2.20–§2.24 [20];
- GS-R-2 §2.1–§2.4, §2.5–§2.6, §3.2–§3.11, §3.14–§3.19, §4.35, §4.37, §4.45, §4.56–§4.65, §4.71, §4.88–§4.90, §4.94, §4.97, §5.2–§5.5, §5.25, §5.26, §5.31–§5.36 and §5.37– §5.39 and Addendum to Annex III [2];
- CODEOC §10, §20(e, v) [21];
- NS-R-2 §2.26, §2.38, §3.8, §5.2, and §5.4 [22].

It is intended for the implementation of guidelines and recommendations from:

- GS-G-2.1 §2.19–§2.22, §3.1–§3.31, §4.15–§4.19, §5.1–§5.6, §6.1–§6.48, Appendix I – Appendix III and Appendix VIII [4];
- GSG-2 §3.1–§3.12, §4.1–§4.7 and Appendix I–Appendix IV [5];
- GS-G-1.1 §3.24 and §3.25 [45];
- EPR-METHOD [6];
- EPR-RANET [23];
- EPR-ENATOM [14].

This element contains, but is not limited to, the following parts which need to be considered while establishing a nuclear power programme:

1.1. Allocation of functions among governmental agencies and jurisdictions involved in preparedness and response to emergencies at facilities of threat category I and II at all levels;
1.2. Operation of a national coordinating authority for developing, maintaining and coordinating arrangements for preparedness and response to emergencies at facilities of threat category I and II;
1.3. Participation in international conventions relevant to emergency preparedness and response area;

1.4. Development of relevant regulations on emergency preparedness and response to emergencies at facilities of threat category I and II.

To develop this element the following tasks also need to be completed for compliance with the IAEA requirements in emergency preparedness and response:

(1) To establish, or identify an existing governmental body or organization to act as a national coordinating authority, one of whose functions is to coordinate the assessment of radiological threats within the State and to coordinate the resolution of differences and incompatible arrangements among the various organizations involved in response to emergencies at facilities of threat categories I and II. Within the national coordinating authority, before planning can begin, a single overall national radiation emergency planning coordinator needs to be designated to:

- ensure that the functions and responsibilities of operators, response organizations and other involved parties are clearly assigned and understood by all concerned;
- ensure that the responsibilities for preparedness and response to a radiation emergency are clearly allocated;
- resolve differences and incompatible arrangements among the various involved parties;
- coordinate the assessment of the radiological threats within the country;
- develop a National Radiation Emergency Plan which integrates preparedness and response to emergencies at facilities and activities of all threats and at all levels;
- coordinate the development of plans and procedures within each level (international, national, local and operator);
- guide the planning process;
- ensure that a review is conducted periodically in order to identify any practice or event that could necessitate an emergency intervention;
- foster the implementation by other countries of measures designed to fulfil the relevant international obligations in accordance with the IAEA requirements;
- act as the contact point for international cooperation to include the international Notification and Assistance Conventions.

(2) To assign clearly the functions and responsibilities of operators, response organizations and other involved parties and ensure they are understood and agreed to by all response organizations.

(3) To establish a regulatory system, including inspection and enforcement functions that provide reasonable assurance that emergency preparedness and response arrangements are in place for all facilities and practices in compliance with the international requirements [2].

(4) To conduct dialogue with neighbouring countries regarding its consideration of embarking on a nuclear power programme.

(5) To ensure that the regulatory body and national coordinating authority have the necessary resources: both funding and staff.

(6) To develop regulations on governmental infrastructure for preparedness and response to a radiation emergency, including:

- A legal basis for establishing and operating national coordinating authority;
- Regulations on allocation, coordination, cooperation and assignment of functions, responsibilities and duties among parties involved in emergency response;
- Regulations on the licensing process specific to emergency preparedness and response.

(7) To develop regulations on the organization of emergency preparedness and response, including:

- Regulations on integrated capabilities for emergency response taking into account:
  - assessment of radiological threats;
  - classification of radiation emergencies and graded approach to response;
  - establishing emergency planning zones around a nuclear or radiation facility;
  - emergency response considerations for siting a nuclear or radiation facility;
  - infrastructure for emergency preparedness and response, including requirements for emergency facilities and their location, equipment, tools and communication systems;
  - identification of responsibilities at all levels of response, cooperation, coordination and assignment of functions among involved parties and integration of them into an effective response capability;
- Regulations on content and structure of radiation emergency plans and implementing procedures at all levels of response;
- Regulations on human resource development, including a training and exercise programme for personnel involved in emergency preparedness and response at all levels of response.

(8) To develop regulations on initiating and terminating a response to a radiation emergency, including:

- Regulations on the classification of a radiation emergency by an operator, and initiating response to an emergency at all levels of response,
- Regulations on the termination of emergency and transition from emergency phase operations to routine long term recovery operations, and transition from emergency exposure situation to normal conditions.

(9) To develop regulations on taking precautionary, urgent and mitigatory protective actions, including:

- Regulations on the criteria for use in preparedness and response for a nuclear or radiological emergency taking into account:
  - criteria for the assessment of radiological threats associated with a nuclear or radiation facility;
  - criteria for the establishment and use of emergency planning zones around a nuclear or radiation facility;
  - generic criteria for use in preparedness and response to a radiation emergency for protecting members of the public and emergency workers;
  - suggested and site-specific operational intervention levels (OILs);
  - facility-specific emergency action levels (EALs) and observables;
  - operational interventional levels for agricultural countermeasures[4];
- Regulations on the dissemination of information to the public prior to, during, and immediately following an emergency.

[4] This includes measures relating to livestock, food production, gardens, forest products, fishing, and water supplies.

Main element 2. Assessment of threats

This element concerns realization of the assessment of radiological threats in the State meeting requirements from GS-R-2 §3.6 – §3.11 [2].

It is intended for the implementation of guidelines and recommendations from:

- GS-G-2.1 §2.19–§2.30, §4.6, §4.11–§4.14, §4.23, §4.25, §4.28, §4.29, §6.1–§6.48, Appendix I – Appendix III [4];
- EPR-METHOD [6].

This element contains, but is not limited to, the following parts which need to be considered by the State prior to embarking on a nuclear power programme:

2.1 Regulations about the assessment of radiological threats in a State;
2.2 Threat assessment in a State performed in accordance with the IAEA Safety Standards GS-R-2 and GS-G-2.1;
2.3 Periodic reassessment of threats.

Main element 3. Establishing emergency management and operations

This element concerns the realization of the allocation of responsibilities through the implementation of a Concept of Operations[5] and an all-hazard approach in planning to meet the requirements from:

- GSR Part 1 §2.20–§2.24 [20];
- GS-R-2 §3.3, §3.4, §4.6–§4.9, §4.11, §4.19, §4.22, §4.31, §4.48–§4.52, §4.79, §4.90, §5.3, §5.6–§5.9, §5.10–§5.12, §5.13 –§5.24 and §5.25–§5.30 [2];
- NS-R-2 §2.32, §2.33 [22];
- NS-R-3 §2.1, §2.2, §2.12, §2.28 and §2.29 [24].

It is intended for the implementation of guidelines and recommendations from:

- GS-G-2.1 §2.22–§2.30, §4.6, §4.11–§4.14, §4.23, §4.25, §4.28, §4.29, §6.1–§6.48, Appendix I – Appendix VIII, and Annex [4];
- EPR-METHOD [6];
- EPR-FIRST RESPONDERS [11];
- EPR-RESEARCH REACTOR [12];
- IAEA-TECDOC-955 [25];
- IAEA Safety Reports Series No. 48 [26];
- INSAG-22 [10];
- SSG-16 [3].

This element contains, but is not limited to, the following parts which need to be considered while establishing a nuclear power programme:

3.1. Assignment of functions, allocation of responsibilities, establishing coordination and providing resources for emergency preparedness and response at all levels;
3.2. Acting in accordance with the national radiation emergency plan;

[5] Concept of operations is a set of scenarios of response to each type of emergency at facilities and practices existing in a State.

3.3. Review, in cooperation with stakeholders, proposals for potential sites for the NPP and other nuclear installations in relation to requirements for emergency preparedness and response;
3.4. Evaluation of feasibility of protective actions at the chosen site for the NPP and other nuclear installations.

To develop this element, the following tasks need to be completed for compliance with the IAEA requirements:

(1) To develop and implement a basic Concept of Operations describing the response to emergencies at facilities of threat category I and II (see Section 4 from EPR-METHOD [6]):

- To establish response organizations and facilities at the national and local levels for a response (see Appendix 14 from EPR-METHOD [6]);
- To determine and assign the roles and responsibilities in emergency preparedness and response for each component of involved parties. Coordinators need to be designated in the radiation emergency plan of each of the involved parties, e.g. facility operator, hospital, police, local government, national government, etc.;
- To allocate responsibilities in consultation with each pertinent party, according to the realistic capabilities and resources of that group. The party to which roles and responsibilities are assigned needs to agree to the assignments and commit to develop the necessary response capability and obtain the required resources.

(2) To establish a framework and support mechanism to facilitate preparing plans at all levels of response (international, national, local and operator) based on the integrated planning concept (see Section 2 from EPR-METHOD [6]):

- To ensure access to, and availability of, on-site information on plant conditions for all involved parties for:
  - emergencies that could result in on-site exposures or off-site releases warranting protective action;
  - information in the facility that can give prior warning of a release or potential exposure;
  - typical source term and timing of a release;
  - radiological and other environmental conditions in and around the facility during an emergency;
  - actions in the facility that need be taken to mitigate the accident, contain or reduce a release;
  - nuclear security events related to potential actions for nuclear security that could impact the emergency response.
- To ensure access to and the availability of information on capabilities and conditions of off-site response for all involved parties:
  - allocation of responsibilities, functions and resources for all potential, or actual, on-site and off-site response;
  - means for coordination of on-site and off-site response;
  - communication available for involved parties;
  - means for communication among involved parties in multiple languages and including other cultural considerations, if appropriate, identifying the radiation emergency, notifying involved parties and activating and terminating the response;

- location of emergency facilities and services in precautionary action zone (PAZ) and urgent protective actions planning zone (UPZ) (e.g. medical, police, fire fighting and sheltering facilities);
- typical transportation available for evacuation within the UPZ;
- communication equipment and facilities need to be available to alert and inform the public on information related to food and milk that is locally produced that may be directly contaminated;
- system of production, collection and distribution of agricultural products;
- drinking water supply systems;
- population distribution: special and transients populations within the UPZ (e.g. hospitals, schools, prisons);
- special facilities that may be affected by a radiation emergency (e.g. factories and essential service facilities that cannot be evacuated);
- transportation systems that may be affected by an accident (e.g. road, rail, air, sea, canals);
- points of import and export of food;
- other areas of special concern that may be seasonal (e.g. beaches and resorts).

- To ensure the availability of information on environmental conditions for all involved parties:
  - the range of weather conditions under which protective actions and monitoring may be conducted;
  - natural disasters that may adversely impact on facility operation, accident recovery operations, and implementation of protective actions.

(3) To determine a site for the NPP, ensuring consistency with the requirements for a response to a radiation emergency, and preparing the relevant part of the site evaluation report, taking into account specific information about the possible site which is related to emergency preparedness and response considerations as described in Appendix II, including:

- demographic characteristics of the potential site or sites;
- prevailing meteorology;
- unique natural resources (e.g. water, soil);
- unique transport, industrial and cultural facilities (e.g. national airports, museums, schools, prisons, churches);
- communication networks;
- site characteristics of the emergency planning zones for facilities of threat category I and II.

(4) To review together with stakeholders [27] proposals for sites for the NPP and other nuclear installations, taking into account the involvement of the following parties in nuclear issues:

- local administration;
- nongovernmental organizations;
- representatives from all type of active population groups which can influence public opinion (e.g. teachers, farmers, fishermen, medical doctors, mass media, politicians and the general public);
- representatives from industry and employment (employers, employees) interested in the development of local infrastructure;
- neighbouring countries;
- international organizations.

(5) To review, together with stakeholders, characteristics of sites to be addressed while considering unique natural characteristics, issues of cultural heritage and natural resources.
(6) To review, together with stakeholders, the ways of communication of characteristics of sites for the NPP and other nuclear installations to neighbouring countries.

(7) To review, together with stakeholders, the potential cost of a radiation emergency which can include the direct cost of response actions (evacuation, sheltering, medical care and follow up, remediation, etc.) and indirect cost of a radiation emergency (loss of heritage, unique environmental characteristics and resources, etc.).

Main element 4. Identifying, notifying and activating

This element concerns the development of capabilities for identifying and assessing a radiation emergency, notifying and activating response at all levels and terminating emergency to meet requirements from GS-R-2 §3.19, §3.20, §4.12–§4.31, §4.49, §4.50, §4.53–§4.55, §4.66–§4.73, §4.82–§4.84 and §4.97–§4.100 [2].

It is intended for the implementation of guidelines and recommendations from:

- GS-G-2.1 §2.1, §2.12–§2.18, §4.1–§4.10, and Appendix VI [4];
- GSG-2 Appendix III, Appendix IV [5];
- EPR-METHOD [6];
- EPR-MEDICAL [16];
- EPR-FIRST RESPONDERS [11];
- EPR-ENATOM [14];
- EPR-D-VALUES [17];
- IAEA-TECDOC-955 [25];
- EPR-RESEARCH REACTOR [12];
- IAEA Safety Reports No. 48 [26].

This element contains, but is not limited to, the following parts which need to be considered while establishing a nuclear power programme:

4.1. Operation of a single national warning point for contact with the IAEA and to other States in compliance with Assistance and Early Notification Conventions [13];
4.2. Awareness of the local authority, operators, the public and potential first responders to an emergency at facility of threat category I and II (response organizations) to the indicators of a potential radiation emergency, notifications and other immediate actions;
4.3. Arrangements and procedures for the notification of involved parties and initiation of response at all levels, in a timely, accurate and appropriate manner;
4.4. Arrangements and procedures for immediate and effective actions of first responders to an emergency at facility of threat category I and II (response organizations);
4.5. Arrangements and procedures for notifying of neighbouring countries and the IAEA in case of a radiation emergency associated with threat categories I and II;
4.6. Arrangements and procedures for assessing the initial phase of the reactor accident at the facilities of threat category I and II by the operator;
4.7. Arrangements and procedures for promptly initiating an on-site and off-site response in the event of a radiation emergency at the facilities of threat category I and II.

To develop this element the following tasks need to be completed for compliance with the IAEA requirements:

(1) To establish a 24/7 contact point to receive notifications of an actual or potential radiation emergency and to initiate a response based on facility and emergency classification;
(2) To inform the IAEA and other States, the State's single warning point of contact responsible for receiving emergency notifications and information from other States and information from the IAEA in compliance with Assistance Convention and Early Notification Convention [13];
(3) To ensure response organizations have sufficient resources, including personnel and funding, to perform their assigned initial response actions;
(4) To make arrangements to ensure that first responders (medical doctors and others) are well trained, qualified and aware of:
    - the symptoms that would indicate a radiation emergency;
    - appropriate notification and other immediate actions warranted if a radiation emergency is suspected.
(5) To establish a system for promptly initiating an off-site response in the event of a radiation emergency. This system is required to include:
    - a system of emergency classification in accordance with international requirements [2];
    - at all times an on-duty person on-site of a facility in threat category I and II with the authority and responsibilities:
        – to promptly classify an emergency without consultation;
        – to initiate an appropriate on-site response;
        – to notify the appropriate off-site notification points;
    - an off-site notification point[6] that is continuously available to receive a notification and to promptly initiate the appropriate preplanned off-site response;
    - reliable, independent and surplus means of alerting the off-site notification point of actions including notifying the public;
    - technical assessment capability to support the emergency classification;
    - arrangements for providing information and issuing instructions and warnings to the public.

Main element 5. Taking mitigatory actions

This element concerns the development of capabilities for the implementation of mitigatory actions to meet requirements from GS-R-2 §4.32–§4.40 [2].

It is intended for the implementation of guidelines and recommendations from:

- GS-G-2.1 §4.1–§4.10 [4];
- EPR-METHOD [6];
- EPR-FIRST RESPONDERS [11];
- EPR-RESEARCH REACTOR [12];
- IAEA-TECDOC-955 [25];
- IAEA Safety Reports Series No. 48 [26];
- INSAG-10 [9].

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[6] An off-site notification point is the location where the responsible decision maker can initiate protective actions within the emergency zones and provide support to the operator or facility. This could be the notification point established to fulfil the requirement in GS-R-2 §4.16 [2].

This element contains, but is not limited to, the following parts which need to be considered while establishing a nuclear power programme:

5.1. Arrangements and procedures for on-call advice to assist first responders to an emergency at a facility of threat category I and II (response organizations) and local authorities;
5.2. Arrangements and procedures for supporting the local authority including the process for obtaining prompt assistance through the IAEA;
5.3. Arrangements and procedures for taking mitigating actions for an emergency at a facility of threat category I and II.

To develop this element the following tasks need to be completed for compliance with IAEA requirements:

(1) To develop capabilities to provide real-time advice to ensure the safety of the first responders to an emergency at the facility of threat category I and II (response organizations);
(2) To make arrangements and procedures to obtain additional assistance, if required, promptly through the IAEA under the terms of the Assistance Convention [13], and directly and through bilateral and multilateral agreements;
(3) To make arrangements and procedures for mitigatory action to prevent the escalation of the hazard to:
   – return the facility to a safe and stable state;
   – reduce the potential for releases of radioactive material or exposures;
   – mitigate the consequences of any actual releases or exposures.
(4) Ensure that teams for mitigating the consequences of a radiation emergency are available, equipped and prepared to perform actions in the facility and off-site responders (including law enforcement) are integrated into the on-site response arrangements by means of the Incident Command System [6, 11].

Main element 6. Taking urgent protective actions

This element concerns the development of capabilities for the implementation of urgent protective actions to meet requirements from:

- GS-R-2 §4.41 – §4.52, §4.61 §4.62 [2];
- CODEOC §8(d), §22(e), §20(o, v), §22(f), §22(o) [21].

It is intended for the implementation of guidelines and recommendations from:
- GS-G-2.1 §4.11–§4.31, §4.54 and Appendix V – Appendix VIII [4];
- GSG-2 §3.1–§3.12, Appendix II – Appendix IV [5];
- EPR-METHOD [6];
- EPR-FIRST RESPONDERS [11];
- EPR-RESEARCH REACTOR [12];
- IAEA-TECDOC-955 [25];
- SSG-16 [3].

This element contains, but is not limited to, the following parts which need to be considered while establishing a nuclear power programme:

6.1. Arrangements for effectively making and implementing decisions on urgent protective actions to be taken off-site;
6.2. Arrangements to ensure the safety of all persons on-site in the event of a radiation emergency;
6.3. Arrangements and procedures for obtaining local, national and international support for an operator of threat category I and II facilities.

To develop this element the following tasks need to be completed for compliance with IAEA requirements:

(1) To make arrangements and procedures to provide expertise and services in radiation protection promptly to local officials and first responders responding to actual or potential emergencies involving facilities in threat category I and II. This includes:
- arrangements for 24/7 on-call advice;
- pre-designating an emergency team of radiation specialists capable of assessing the status of the facility, assessing radiological conditions, providing medical countermeasures, mitigating the radiological consequences and managing the exposure of emergency workers;
- procedures for responding to a range of radiation emergencies, including OILs for protective actions;

(2) To adopt EALs and OILs for taking precautionary, urgent, and early protective actions in accordance with international guidance;

(3) To make arrangements for effectively making and implementing decisions on precautionary and urgent protective actions to be taken off-site. This needs to include:
- arrangements for establishing emergency zones:
  - a precautionary action zone for facilities in threat category I;
  - an urgent protective action planning zone for facilities in threat category I and II;
  - food and water restriction planning radius for facilities in threat category I and II;
- arrangements for implementing the following precautionary and urgent protective actions:
  - thyroid blocking;
  - sheltering;
  - evacuation;
  - decontamination;
  - restriction of food, milk and water consumption;
  - contamination control;
  - public reassurance;
  - relocation;
  - recovery;
- criteria based on event classification and on plant conditions (e.g. EALs) and off-site measurements (e.g. OILs), for the formulation of recommendations for urgent protective actions off-site;
- a single designated authority on-site at all times with the authority and responsibility to recommend protective actions promptly to the appropriate officials off-site, upon the declaration of a radiation emergency;
- provisions to promptly notify the off-site notification points that have the authority and responsibility to take urgent protective actions within the PAZ and UPZ.

(4) To make arrangements for effectively making and implementing decisions on early protective and mitigatory actions to be taken off-site. This needs to include:
- arrangements for establishing food restriction planning radius for facilities in threat category I or II;
- arrangements for implementing the following early protective and mitigatory actions:
  - temporary relocation;
  - decontamination;
  - replacement of contaminated food, milk and water;
  - contamination control;
  - public reassurance;
  - regaining control over the source of emergency exposure recovery;
  - permanent relocation.

(5) To make arrangements using existing capabilities for conventional emergencies for public protection within the emergency zones, in order to implement appropriate urgent actions promptly upon the notification of a radiation emergency;

(6) To make arrangements to ensure the safety of all persons on-site in the event of a radiation emergency.

Main element 7. Providing information and issuing instructions and warnings to the public

This element concerns the development of capabilities for providing information, issuing instructions and warnings to the public to meet requirements from GS-R-2 §4.53–§4.55 [2].

It is intended for the implementation of guidelines and recommendations from:
- GS-G-2.1 §4.32–§4.36, and Appendix VI, Appendix VII [4];
- EPR-FIRST RESPONDERS [11];
- EPR-METHOD [6];
- IAEA-TECDOC-1432 [28];
- EPR-PUBLIC COMMUNICATIONS [33];
- INSAG-20 [27].

This element contains, but is not limited to, the following parts which need to be considered while establishing a nuclear power programme:

7.1. Arrangements and procedures for providing coordinated, useful, timely, accurate, and consistent information to the public in the event of a radiation emergency;
7.2. Arrangements and procedures to provide prompt warning and instruction to the permanent, transient and special population groups within the area potentially affected by a radiation emergency.

To develop this element the following tasks need to be completed for compliance with IAEA requirements:

(1) To provide the public during a potential or actual radiation emergency with a plain language (including multiple languages for the affected population, if appropriate) explanation of the hazards in a radiation emergency, and action they can take to reduce their risk, and of action being taken by officials on their behalf. Provisions need to be made to promptly provide useful and coordinated information to the public directly

through the media and other means. These provisions must be focused on promoting the correct balance of appropriate behaviour by members of the public to help them implement all available means for self-protection [33]. The information is best conveyed from a single location, e.g. from a Public Information Centre, described in Appendix 14 of EPR-METHOD, operating as a part of the response organization executed under an Incident Command System [6, 11];

(2) To develop procedures to issue public warnings in the event of the potential or actual contamination of drinking water and locally produced food;

(3) To make arrangements and procedures for effectively making and implementing decisions on precautionary and urgent protective actions to be taken off-site, including arrangements and procedures to educate members of the public on which self-protection actions are necessary in case of implementation of precautionary and urgent protective actions.

Main element 8. Protecting emergency workers

This element concerns the development of capabilities for protecting emergency workers to meet the requirements from:

- GS-R-2 §4.56 – 4.65 [2];
- SF-1 §3.36 [1].

This also needs to include capabilities for a plain language explanation of results from individual monitoring of emergency workers to workers, decision makers and other stakeholders. It is intended for the implementation of guidelines and recommendations from:

- GSG-2 §4.1–§4.7 [5];
- EPR-FIRST RESPONDERS [11].

This element contains, but is not limited to, the following parts which need to be considered by the State prior to embarking on a nuclear power programme:

8.1 Regulations on the protection of emergency workers;
8.2 Arrangements for the application of a graded approach on the restriction of exposure of emergency workers based on the assignment of tasks;
8.3 Arrangements for the use of personal protective equipment by first responders and emergency workers;
8.4 Arrangements for the efficient dose control of emergency workers.

Main element 9. Assessing the initial phase

This element concerns the development of capabilities for the evaluation of human exposure in an emergency exposure situation in terms of adequate dosimetric quantities and the risks to meet requirements from:

- GS-R-2 §2.1–§2.3, §4.78, §4.79, §4.88–§4.93 [2];
- SF-1 §3.36 [1].

This also needs to include capabilities for plain language explanation of monitoring results to decision makers and stakeholders. It is intended for implementation of guidelines and recommendations from:

- GS-G-2.1 Appendix VI; [4];
- GSG-2 §3.1–§3.12, §3.13–§3.17, §3.18–§3.25, and §3.26–§3.31, and §4.1–§4.7, and §5.1–§5.13, Appendix I – Appendix III [5];
- IAEA-TECDOC-955 [25];
- EPR-RESEARCH REACTOR [12];
- EPR-MEDICAL [16];
- EPR-D-VALUES [17];
- IAEA-TECDOC-1432 [28];
- IAEA Safety Reports Series No. 19 [29];
- IAEA Technical Reports Series No. 472 [30];
- SSG-16 [3].

This element contains, but is not limited to, the following parts which need to be considered by the State prior to embarking on a nuclear power programme:

9.1. Arrangements and procedures for radiation protection of the public, workers and first responders based on plant conditions, off-site radiation measurements and observations at the scene in emergency at facilities in threat category I and II;
9.2. Capabilities for assessing the dose of emergency exposure off-site and on-site in an emergency at facilities in threat category I and II;
9.3. Capabilities for on-line radiation monitoring of PAZ and UPZ of facilities in threat category I and II;
9.4. Capabilities for monitoring contamination in soil, air, foodstuff and water in PAZ and UPZ of facilities in threat category I and II;
9.5. Plant specific EALs based on event classification and on plant conditions at facilities in threat category I and II;
9.6. Site-specific OILs for radiation emergencies at the facilities in threat category I and II.

To develop this element the following tasks need to be completed for compliance with IAEA requirements:

(1) To arrange the evaluation of emergency exposure doses received by persons in actual accidents, off-site and on-site, for the purposes of medical treatment of overexposed persons and the development of medical histories. This includes the assessment of doses of internal and external exposure in terms of dosimetric quantities used in emergency exposure situations and is defined in Appendix I of GSG-2 [5] with the objective to evaluate the risk of development of severe deterministic effects in those overexposed;

(2) To arrange the evaluation of emergency exposure doses received by persons in actual accidents, off-site and on-site, for purposes of medical follow-up of exposed persons with the objective to evaluate the risk of development of stochastic effects in those exposed;

(3) To project the development of emergency exposure situations and predict the transport of radioactive material from a point of release to a distance of food restriction planning radius from threat category I and II facilities;

(4) To arrange the radiological assessor/team to be ready to support mitigatory actions of all involved parties, including first responders at the scene of a radiation emergency. This includes capabilities for providing field and individual radiation monitoring;

(5) To pre-identify and arrange for the effective operation of laboratories for analysis of radioactivity in soil, air, foodstuff and water. This includes capabilities for sampling, measurement, evaluation of measurement results, their reporting and plain language explanation to decision makers and the public;

(6) To make capabilities for dose projection on-site and off-site, and the evaluation of consequences of accidents at facilities of threat category I and II, including the development of site and plant specific scenarios of such accidents and radiation emergencies;

(7) To make capabilities for the recalculation of site-specific OILs for radiation emergencies at the facilities of threat category I and II;

(8) To make capabilities for on-line radiation monitoring of on-site and off-site territory by operator and operating organization of facility of threat category I and II.

Main element 10. Managing the medical response

This element concerns the development of capabilities for medical support of the emergency response to meet requirements from:

- GS-R-2 §4.74–§4.81 and §4.94–§4.95 [2];
- NS-R-2 §2.33(4) [22];
- CODEOC §20(e, v) [21].

It is intended for the implementation of guidelines and recommendations from:

- GS-G-2.1 §2.2–§2.11, §4.37–§4.46 and Appendix V [4];
- GSG-2 §3.1–§3.12, Appendix I, Appendix II [5];
- EPR-MEDICAL [16];
- EPR-FIRST RESPONDERS [11];
- EPR-D-VALUES [17];
- IAEA-TECDOC-1432 [28];
- IAEA Safety Reports Series No. 4 [31];
- EPR-BIODOSIMETRY [44].

This element contains, but is not limited to, the following parts which need to be considered by the State prior to embarking on a nuclear power programme:

10.1. Designation of hospitals and qualified medical professionals to assist during a radiation emergency;
10.2. Arrangements and procedures for the awareness of medical practitioners of the medical symptoms and outcomes of radiation exposure and of the appropriate notification procedures;
10.3. Arrangements and procedures to obtain international assistance in the treatment of overexposed persons if required;
10.4. Capabilities to initially treat exposed and contaminated patients;

10.5. Arrangements for performing measures for the medical protection of the public, workers and responders.

To develop this element, the following tasks need to be completed for compliance with the IAEA requirements:

(1) To make arrangements for training general medical practitioners and emergency staff on the medical symptoms of radiation exposure and of the appropriate notification procedures if a radiation emergency is suspected;

(2) To make arrangements for ambulance teams (medical first responders) to be ready to treat contaminated patients and conduct triage with a priority of life saving;

(3) To make arrangements, at the national level, to provide initial treatment of people who have been exposed or contaminated that include:
- guidelines for treatment;
- designation of medical practitioners trained in the early diagnosis and treatment of radiation injuries and traumas;
- selection of designated institutions (hospitals) to be used for initial and long-term specialized medical treatment of overexposed persons;
- decontamination procedures;
- cytogenetic dosimetry.

(4) To make arrangements through the IAEA or the World Health Organization (WHO) to obtain consultation on treatment from medical practitioners with experience in dealing with such injuries.

Main element 11. Keeping the public informed

This element concerns the development of capabilities for keeping the public informed to meet the requirements from GS-R-2 §4.82–§4.84 [2].

It is intended for the implementation of guidelines and recommendations from:
- GS-G-2.1 §4.32–§4.36 [4];
- EPR-PUBLIC COMMUNICATIONS [33];
- EPR-FIRST RESPONDERS [11];
- EPR-METHOD [6];
- IAEA-TECDOC-1432 [28].

This element contains, but is not limited to, the following parts which need to be considered while establishing a nuclear power programme:

11.1 Arrangements for continuous reliable communications in advance of a radiation emergency;
11.2 Arrangements for responding to requests for information from the public and from mass media.

To develop this element, the following tasks need to be completed for compliance with the IAEA requirements:

(1) To make arrangements for continuous reliable communications in advance of a radiation emergency, including information on risks from radiation emergencies to the public living in PAZ, and actions to be taken by first responders and members of the public for self-protection;

(2) To make arrangements for responding to requests for information from the public and from mass media, including a process for addressing incorrect information and rumours;

(3) Provide regular, periodic and routine updates via available electronic and other means to build confidence in the affected population that they will be provided with the necessary information for maximum protection when they need it, and on a routine, predictable basis.

Main element 12. Taking agricultural countermeasures, countermeasures against ingestion and longer term protective actions

This element concerns the development of capabilities for implementation of agricultural countermeasures to meet the requirements from GS-R-2 §4.85 – §4.93 [2].

It is intended for implementation of guidelines and recommendations from:

- GS-G-2.1 §4.47–§4.51[4];
- GSG-2 Appendix II [5];
- EPR-METHOD [6];
- IAEA-TECDOC-955 [25].

This element contains, but is not limited to, the following parts which need to be considered while establishing a nuclear power programme:

12.1. Capabilities for monitoring contamination in soil, air, foodstuff and water in the emergency zones associated with a facility of threat category I and II;
12.2. Arrangements and procedures to implement actions to protect the public from consumption of contaminated local foods in case of a radiation emergency at a facility of threat category I and II.

To develop this element for compliance with the IAEA requirements, the arrangements and procedures need to be made for taking effective agricultural and drinking water countermeasures, including a restriction of the consumption, distribution and sale of locally produced foods and agricultural products following a release of radioactive material within a food restriction planning radius.

Main element 13. Mitigating the non-radiological consequences of the radiation emergency and the response

This element concerns the development of capabilities for mitigating the non-radiological consequences of the radiation emergency and the response to meet requirements from GS-R-2 §4.94–§4.96 [2].

It is intended for the implementation of guidelines and recommendations from:

- GS-G-2.1 §4.52–§4.53, and Appendix VI, Appendix VII [4];
- EPR-FIRST RESPONDERS [11];
- EPR-METHOD [6];

- IAEA-TECDOC-1432 [28];
- EPR-PUBLIC COMMUNICATIONS [33].

This element contains, but is not limited to, the following parts which need to be considered while establishing a nuclear power programme:

13.1 To provide the public during a potential or actual radiation emergency with a plain language explanation of hazards, potential risks and required protective actions, which would prevent or minimize development of non-radiological consequences of the radiation emergency and the response;
13.2 To make arrangements for responding to public concern during a potential or actual radiation emergency.

Completion of the tasks needed for development of main elements 7 and 11 will ensure the appropriate development of the main element 13. In addition, the following task is to be completed for compliance with the IAEA requirements:

(1) To make arrangements for responding to public concerns during a potential, or actual, radiation emergency. Ensure these preparations include arrangements for:
   - promptly explaining any health risks and what are appropriate and inappropriate personal actions to reduce risk;
   - monitoring and responding to any related health effects;
   - preventing inappropriate actions[7] on the part of workers and the public;
   - designating organization(s) with the responsibility for identifying the reasons for inappropriate actions (such as misinformation from the media or rumours) and for making recommendations on countering them;
   - identification of trusted public communicators (e.g. doctors, health officials, etc.).

Main element 14. Conducting recovery operations

This element concerns development of capabilities for establishing arrangements for the transition from emergency phase operations to routine long term recovery operations, to meet the requirements of GS-R-2 §4.97–§4.100 [2].

It is intended for implementation of recommendations and guidelines from:

- GS-G-2.1 §6.6 [4];
- EPR- METHOD [6].

This element contains, but not limited to, the following parts which have to be considered while establishing a nuclear power programme:

14.1 To plan and implement the transition from the emergency phase to longer term recovery operations and the resumption of normal social and economic activity in an orderly manner and in accordance with international standards and guidance;

[7] Inappropriate actions include, for example, discrimination against potentially exposed persons, spontaneous evacuation, the hoarding of food and unwarranted terminations of pregnancy or rejection of conception.

14.2 To fulfil all requirements for planned exposure situations for workers undertaking recovery operations.

To develop this element the following tasks have to be completed for compliance with the IAEA requirements:

(1) To arrange for the transition from emergency phase operations to routine long term recovery operations. This process includes: the definition of the roles and functions of organizations; methods of transferring information; methods of assessing radiological and non-radiological consequences; and methods of modifying the actions taken to mitigate the radiological and non-radiological consequences of the radiation emergency.

(2) To arrange a formal process in accordance with international guidance to cancel restrictions or other arrangements imposed in response to a radiation emergency.

(3) To ensure that, at the end of the emergency phase, workers undertaking recovery operations, such as repairs to the plant and buildings, recovery of sources, waste disposal or decontamination of the site and surrounding area, are subject to the full system of detailed requirements for planned exposure situations.

Main element 15. Requirements for infrastructure

The process for ensuring emergency response is based on establishing a quality assurance programme which can be verified through the surveying and review of plans, procedures and infrastructure (preparedness). The ability to carry out the required response actions need to be evaluated through surveys and reviews of past performance, and most commonly through training opportunities, drills and exercises[8]. Training staff from all relevant emergency response organizations at each level of response, to include drills and exercises are a key component of a successful emergency preparedness and response programme. They provide an evaluation of the level of compliance with international standards for preparedness in emergency response organizations, tools and procedures. They also provide the basis for the continuous improvement programme for preparedness and response to a radiation emergency.

This element concerns the development of processes to ensure and manage the quality assurance programme. This is done by means of training responders and the demonstration of feasibility and adequacy of emergency plans and procedures to meet the requirements from:

- GS-R-2 §5.3, §5.6–§5.9, §5.10–§5.12, §5.13 –§5.39 [2];
- CODEOC §10, §20(e, v) [21];
- NS-R-2 §2.38 [22].

It is intended for the implementation of guidelines and recommendations from:

- GS-G-2.1 §5.1–§5.6 [4];
- EPR-EXERCISE [18];
- IAEA-TECDOC-1254 [32];
- SSG-16 [3].

[8] Drills are defined as small scale which may be focused on one or more parts of the emergency plan while exercises are all inclusive.

This element contains, but is not limited to, the following parts which need to be considered while establishing a nuclear power programme:

15.1. Emergency plans at all levels for on-site and off-site response at threat category I and II facilities;
15.2. Off-site emergency facilities for managing the response to a radiation emergency at threat category I and II facilities;
15.3. Arrangements and procedures for off-site precautionary and urgent protective actions in a radiation emergency at threat category I and II facilities;
15.4. Arrangements and procedures for on-site response in a radiation emergency at the facilities of threat category I and II;
15.5. Adequate tools, computer codes, instruments, supplies, equipment, communication systems, facilities and documentation for performing response functions on-site and off-site;
15.6. Application of the Systematic Approach to Training (SAT), in order to identify duties for all positions and competences for all parties involved in the response to emergencies at facilities of threat category I and II;
15.7. Designing training courses according to applied SAT for all parties involved in the response to emergencies at facilities of threat category I and II, and establishing and carrying out a continuous programme to train staff of all involved parties in accordance with roles and responsibilities;
15.8. Establishing and running a continuous programme for staffing of all parties involved in the response to emergencies at facilities of threat category I and II in accordance with applied SAT, to ensure duties are maintained regardless of changes in organizations and staff;
15.9. Designing exercises in accordance to exercise scope and objectives and establishing and carrying out a continuous exercising programme;
15.10. Designing scope and objectives for testing equipment and communications, and establishing and carrying out a continuous testing programme in accordance with the scope and objectives for testing equipment and communications;
15.11. Establishing and carrying out the framework of reporting results of exercises, training and testing for feeding information to the national coordinating authority to identify improvements of the framework for preparedness and response to a radiation emergency.

To develop this element the following tasks need to be completed for compliance with IAEA requirements:

(1) To develop and implement parts of a National Radiation Emergency Plan (see Section 2, 4 and Appendix 12 from EPR-METHOD [6]), which correspond to preparedness and response to radiation emergencies at facilities of threat category I and II, and based on the all-hazard approach in planning, which require special attention to the following issues:
- Designating a national coordinating authority for developing, maintaining and regulating arrangements for preparedness and response to a radiation emergency at facilities of threat category I and II;
- Implementing a step-by-step approach for developing emergency response capabilities;
- Designating national institutions with responsibilities for coordinating emergency preparedness and response at all levels (international, national, local, and operator);

- Developing and implementing a concept of operations based on a graded approach to emergency response within the framework of an incident command system, threat categories and emergency classification.

(2) To develop and implement the radiation emergency plans of the operator (operating organization) at facilities of threat category I and II. These plans need to be based on the all-hazard approach and need to combine both on-site and off-site response provisions and include:
- Developing and implementing the operator's emergency preparedness and response programme, plans and procedures related to radiation emergencies at nuclear installations under its jurisdiction;
- Coordinating among the operator's emergency response plans and procedures, the plans and procedures of the relevant national institutions involved in emergency response, emergency plans and procedures of the local authority and other States, as necessary;
- Developing procedures for communications and protocols for prompt decision making between various emergency centres of the responding organizations;
- Arranging for a 24/7 technical advice from vendors of nuclear installations in case of a radiation emergency at facilities of threat categories I and II;
- Arranging for technical advice from the vendor of radiation facilities in case of a radiation emergency at facilities of threat categories I and II;
- Arranging for access to support from technical support organizations both within and outside of the State based on need.

(3) To develop and implement radiation emergency plans of local authorities (off-site response at facilities of threat category I and II) and response organizations (off-site and/or on-site response at facilities of threat category I and II) (See Section 2, 4 and Appendix 12 from EPR-METHOD [6]), based on the all-hazard approach in planning, which require special attention to the following issues:
- Developing arrangements for prompt technical support of qualified experts to response organizations who might be the first responders to a radiation emergency at a facility of threat category I and II;
- Developing arrangements to ensure that the public are informed of the occurrence of a radiation emergency, the actions they need to take as events progress, and being continuously updated;
- Developing plans and procedures to notify and keep informed the public living and working within the immediate vicinity of the facility prior to an accident occurring.

(4) To allocate sufficient financial and other resources to ensure the feasibility of radiation emergency plans at operator, local, national and international levels, including human resource development for all involved parties.

(5) To ensure consistency and compatibility of all emergency plans and procedures. Arrangements for the organization of preparedness and response to radiation emergencies need to be integrated and interlocked with existing procedures and arrangements for responding to conventional emergencies and nuclear security events [34], taking into account objectives of preparedness and response to a radiation emergency and parties involved in an emergency response to radiation emergencies at different levels.

(6) To make procedures for effectively making and implementing decisions on precautionary and urgent protective actions to be taken off-site. This needs to include:

- procedures for establishing emergency zones:
  - a precautionary action zone for facilities in threat category I;
  - an urgent protective action planning zone for facilities in threat category I and II;
  - food and water restriction planning radius for facilities in threat category I and II.
- procedures for implementing the following precautionary and urgent protective actions:
  - thyroid blocking;
  - sheltering;
  - evacuation;
  - decontamination;
  - restriction of food, milk and water consumption;
  - contamination control;
  - public reassurance;
  - relocation;
  - recovery.
- technical tools, such as computer codes, for forecasting development of emergency exposure and meteorology.

(7) To make procedures for effectively making and implementing decisions on early protective and mitigatory actions to be taken off-site. This needs to include:
- procedures for establishing food restriction planning radius for facilities in threat category I or II;
- procedures for implementing the following early protective and mitigatory actions:
  - temporary relocation;
  - decontamination;
  - replacement of contaminated food, milk and water;
  - contamination control;
  - public reassurance;
  - regaining control over the source of emergency exposure recovery;
  - permanent relocation.

(8) To make procedures using existing capabilities for conventional emergencies for public protection within the emergency zones, in order to implement appropriate urgent actions promptly upon the notification of a radiation emergency.

(9) To make procedures to ensure the safety of all persons on-site in the event of a radiation emergency.

(10) To make arrangements, considering the use of existing capabilities, for training on the basis of SAT to ensure that the off-site and on-site personnel have the requisite knowledge, skills, abilities, equipment, procedures and other arrangements to perform their assigned response functions [18, 35, 36], including:
- staff of national authorities within the national radiation emergency plan;
- staff of the regulatory body in issues important for response to a radiation emergency;
- staff of the operating organization for response to a radiation emergency;
- staff of the off-site response organizations (hospitals, ambulances, fire brigades, rescuers, police, civil defence, etc.) for response to a radiation emergency.

(11) To make arrangements for adequate testing, drilling and exercising key elements of the emergency preparedness and response programme [18] at all levels of response. This needs to include as a measure:

- development of key elements of exercise scope and objectives (ESO) at all levels of response, their frequency of exercising and parties concerned;
- development of key elements of testing scope and objectives containing elements which could not be verified by exercises (e.g. communication with the control room as a simulator used during an exercise) and not included in ESO, but needs to be tested at a predetermined frequency;
- development of a programme (or programmes) in accordance with ESO and testing scope and objectives to exercise, drill and test key elements of the emergency preparedness and response programme at all levels of response;
- arrangements for the availability, re-supply, testing and calibration of supplies and equipment and updating associated plans and procedures.

(12) To conduct drills and exercises to ensure that all specific functions required to be performed for emergency response and all organizational interfaces for facilities in threat category I and II are tested at suitable intervals. Any facility from threat category I–II is required to demonstrate the adequacy of their emergency arrangements to the satisfaction of the regulatory authorities. This needs to include as an interim measure:

- table top exercise(s) at the national level to demonstrate national roles and to ensure that responsibilities are clearly understood;
- an exercise on the decision making, assessment and public information response to a radiation emergency at facilities from threat category I and II;
- an integrated exercise involving the off-site authorities and the operator of the facility of threat category I and II.

(13) To provide, considering the use of existing capabilities, for non-radiation emergencies, adequate tools, instruments, supplies, equipment, communication systems, facilities and documentation (such as procedures, checklists, telephone numbers and manuals) for performing response functions. These items need to be operational under emergency conditions (radiological and conventional) and be compatible with the equipment used by other response organizations (e.g. communication frequencies).

(14) To identify and periodically test facilities at which the following will be performed:

- coordination of on-site response actions;
- coordination of local off-site response actions;
- coordination of national response actions;
- coordination of public information;
- coordination of on-site and off-site monitoring and assessment;
- distribution centre activities;
- relocation centre activities.

Several of these activities may be performed at a single centre and the location may change over the different phases of the response;

(15) To make arrangements to ensure the availability and reliability of all supplies, equipment, communication systems and facilities needed during a radiation emergency. This needs to include arrangements for inventories, re-supply, testing and calibration.

(16) To review and update emergency plans, procedures and other arrangements and to incorporate lessons learned from research, operating experience and emergency drills and exercises.

(17) To check consistency of radiation emergency plans at the international, national, off-site and on-site staff levels through the demonstration of the emergency response capabilities by conducting joint exercises to demonstrate the effectiveness of radiation emergency plans at the operator, local, and national level [18].

(18) To make arrangements based on SAT for human resource development and building competence of personnel at all levels in accordance with the responsibilities among the parties, staff positions, roles, and functions [35, 36] including, but not limited to:
- staff of the national coordinating authority and other authorities within the National Radiation Emergency Plan;
- staff of the regulatory body;
- staff of the operating organization;
- staff of all off-site response organizations at the local and national levels (hospitals, ambulances, fire brigades, rescuers, police, civil defence, etc.).

(19) When establishing and implementing a programme for staffing of all involved parties in accordance with applied SAT, special attention needs to be paid to the resilience of response parties in having sufficient personnel to perform over a protracted period.

3.3. ESTABLISHING ARRANGEMENTS AND CAPABILITIES FOR EMERGENCY PREPAREDNESS AND RESPONSE DURING DIFFERENT PHASES OF BUILDING SAFETY INFRASTRUCTURE

Emergency preparedness and response arrangements and capabilities are an important part of the national safety infrastructure. Developing and extending the main elements as described in Section 3.2 will lead to a robust emergency preparedness and response programme needed for a State that decides to move forward with a nuclear power programme.

The general approach to establishing a safety infrastructure for a nuclear power programme [3] in a State embarking on a nuclear power programme is that it consists of three phases, each with an associated milestone. The basic steps for establishing capabilities for response to a radiation emergency at facilities of threat category I and II is described in Refs. [3, 8]. Fig. 1 shows how the establishment of emergency preparedness and response arrangements and capabilities are linked with the establishment of a safety infrastructure for a nuclear power programme [3].

During phase 1, an appreciation of the level of effort required for an effective emergency preparedness and response programme must be conveyed to national decision makers, taking into account existing preparedness and response capabilities and arrangements (e.g. for response to a radiological emergency).

During phase 2, after a decision to proceed has been taken, the legal basis and safety requirements needed for combating I and II category of threats need to be issued.

During phase 3, before the plant is commissioned, capabilities need to be developed to respond to a radiation emergency at a facility of threat category I and II, in compliance with the international requirements [2].

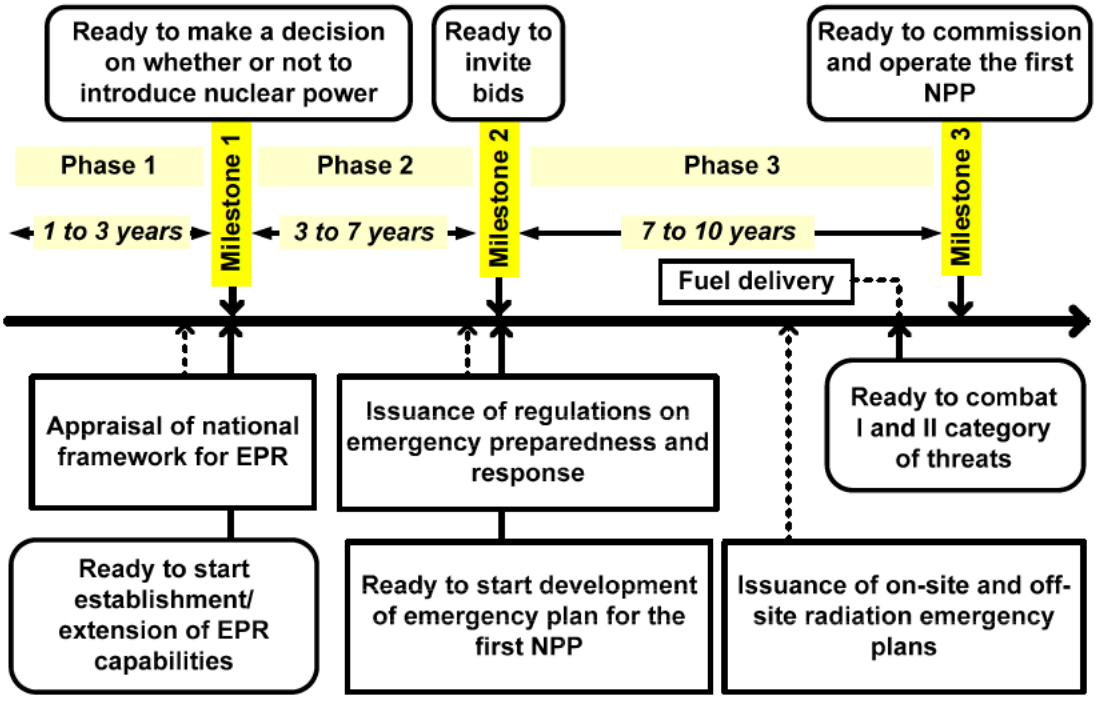

FIG. 1. Establishing and/or extension of emergency preparedness and response capabilities and arrangements during different phases of building safety infrastructure for a nuclear power plant.

The main stages of the establishment of emergency preparedness and response capabilities and arrangements during different phases of building safety infrastructure for a nuclear power programme are:

(1) An appreciation of the level of effort required for an effective emergency preparedness and response programme;
(2) Ready to start establishment and/or extension of capabilities for emergency preparedness and response;
(3) Issuance of safety requirements needed for combating I and II category of threats;
(4) Ready to start development of emergency plan for the first NPP;
(5) Issuance of on-site and off-site radiation emergency plans for facilities of threat categories I and II;
(6) Ready to combat I and II category of threats.

The framework of preparedness and response to a radiation emergency at facilities of threat category I and II needs to be in place before the first fuel delivery to the NPP and commissioning begins, and must be in full compliance with the international requirements [2] for States which have operating nuclear installations.

3.3.1. Phase 1. Safety infrastructure before deciding to launch a nuclear power programme

During phase 1, it will be necessary to examine existing emergency preparedness and response capabilities, and to advise national decision makers on what will be required to augment the current system to support a nuclear power programme. The Milestones publication [8] provides the basis for phase 1 which is: 'Considerations before a decision to launch a nuclear power programme is taken.' It culminates in milestone 1: 'ready to make a knowledgeable commitment to a nuclear programme.' At this stage, the State has to be ready to start the establishment and/or extension of its capabilities for emergency preparedness and response.

During phase 1 of development of the nuclear power programme, protection of the public from risks of an emergency exposure situation associated with an accident at nuclear installations must be recognised as the subject of highest priority. In addition, an appreciation must be conveyed by the emergency preparedness representative to the NEPIO [19] to State decision makers of the effort required to build a robust emergency preparedness and response programme to support a nuclear power programme. The IAEA Fundamental Safety Principles [1] and INSAG-22 report [10] both stress this point.

Government decision makers need to consider that a strong emergency preparedness and response programme needs a joint and well-coordinated effort of many governmental bodies, authorities and jurisdictions. To assure such coordination, the comprehensive National Radiation Emergency Plan has to be revised to include preparedness and response to radiation emergencies associated with the facilities of threat category I and II. This upgraded plan is required to be developed and implemented before commissioning the first nuclear installation [2]. The infrastructure for emergency preparedness and response to radiation emergencies needs to be part of the capability for responding to other types of events, but its central objective needs to be to mitigate adverse radiological consequences to the general public. The need for an early establishment of emergency plans, mutually coordinated at all levels (international, national, local, and operator) has to be recognized before a decision to launch a nuclear power programme is taken. At this phase, the following actions need to be taken [3]:

Action 133. The government should develop awareness of the need for early establishment of emergency plans.

Action 134. The government should identify institutions and new arrangements for supporting emergency preparedness and response.

Before reaching milestone 1, in support of making a policy decision on NPP development, an overall survey of existing capabilities for emergency response needs to be completed. The following questions need to be addressed:

(1) How the existing framework of protecting the area and the population from emergency situations of natural and person-made origin be expanded to cover the needs of protecting the public, environment and property from radiation emergencies at facilities of threat category I and II?
(2) How the existing framework of preparedness and response to radiological emergencies needs to be expanded to cover the needs for protecting the public, environment and property from radiation emergencies at facilities of threat category I and II?

(3) How the existing national practice for threat assessment needs to be upgraded to cover the necessities for radiological and nuclear threat assessment at facilities of threat category I and II?
(4) How the existing national emergency plan needs to be upgraded to cover the necessities for protecting the public, environment and property from radiation emergencies at facilities of threat category I and II?
(5) How responsibility needs to be clearly assigned and provisions need to be put in place to allow prompt decision making and the implementation and maintenance of an adequate response capability?
(6) Do social issues (e.g. languages, culture, level of domestic education) exist that could prevent the development and maintenance of an adequate response capability?
(7) Will funding be available for on-going support of an adequate response capability?
(8) Are potential sites of the NPP and other nuclear installations in compliance with emergency preparedness and response considerations?

An overall survey of existing capabilities for the preparedness and response to a radiation emergency needs to be performed against the international requirements [2] and guidance [4, 6] as described in Appendix IV. The focus of the review needs to be on actions required to upgrade or develop appropriate institutions, plans and procedures to support a nuclear power programme.

One of the objectives of the overall survey is a development in NEPIO, for the appreciation of the need in establishing a capability in response to a nuclear emergency as part of an 'all hazards' response. International requirements [2] require that plans and procedures for response to all hazards be structured into a coherent and interlocking system. At the top level, a national emergency plan for an integrated response to any combination of hazards is required, and the national radiation emergency plan (NREP) will be a part of this 'all hazards' plan. This overall survey has to include a review of all the main elements of preparedness and response to a radiation emergency:

- Survey of the basic responsibilities and governmental infrastructure for emergency preparedness and response;
- Survey of the capabilities for the assessment of threats;
- Survey of the emergency management and operations;
- Survey of the capabilities for initiating and terminating emergency response;
- Survey of the capabilities for taking mitigatory actions;
- Survey of the capabilities for taking urgent protective actions;
- Survey of the capabilities for providing information and issuing instructions and warnings to the public;
- Survey of the capabilities for protecting emergency workers;
- Survey of the capabilities for assessing the initial phase;
- Survey of the capabilities for medical response to a radiation emergency;
- Survey of the capabilities for keeping the public informed;
- Survey of the capabilities for taking agricultural countermeasures, countermeasures against ingestion and longer term protective actions;
- Survey of the capabilities for communications and the availability of information during a radiation emergency;
- Survey of the infrastructure and capabilities for conducting recovery operations;
- Survey of the infrastructure and capabilities for establishing the process for ensuring emergency response.

The survey of basic responsibilities and governmental infrastructure for emergency preparedness and response includes an evaluation of the needs for new arrangements in preparedness for response to a radiation emergency at an international level. It includes the participation in international legal instruments [37], including conventions and cooperation with neighbouring countries, IAEA, and other international organizations. The survey also needs to include an analysis of the regulatory infrastructure, and needs for its upgrade to be in compliance with the international requirements [2]. The State has to evaluate (see for more details Appendix IV):

- National policy and capabilities for the protection of workers, the public, the environment and property in case of a natural or man-made accident (including a radiation emergency), identification of national institutions and arrangements to support emergency preparedness and response at the international, national, local, and operator levels;
- International legal instruments, requirements, guidance and practices on emergency preparedness and response developed under the auspices of the IAEA to protect workers, the public, the environment and property in case of a radiation emergency. It has to also include an analysis of the legal and regulatory bases for the protection of the public and environment in case of natural or man-made non-radiation accidents, and requirements for the harmonization of future regulations on radiation protection that already exist.

The survey of capabilities for the assessment of threats includes the evaluation of needs for the upgrade of arrangements for the assessment of radiological threats. It also includes the categorization of existing sources of radiation in terms of the radiological threat, as a basis for establishing emergency management and operations at the national, local and facility levels.

The survey of emergency management and operations includes:

- Evaluation of needs for the development and assignment of functions, allocation of responsibilities, establishing coordination and providing resources for emergency preparedness and response at all levels;
- Evaluation of the need for the development of capabilities for site selection and site evaluation regarding emergency response in cooperation with stakeholders. An analysis of existing capabilities for site evaluation and selection in regard to the response to a radiation emergency at candidate site(s) and the involvement of stakeholders in a decision making process has to be performed. During phase 1, the State also has to evaluate the feasibility of radiation emergency plans at potential sites for the NPP and other nuclear installations (see Appendix III). This evaluation has to be conducted in coordination with the local authorities and other stakeholders to involve them at the earliest stage of the siting process.

The survey of capabilities for initiating and terminating emergency response includes the evaluation of needs for the development of capabilities for identifying, notifying and activating in the case of a radiation emergency at all levels. It has to include an evaluation of how the local authority, operators, medical doctors and public are made aware of the indicators of a potential radiation emergency, the appropriate notifications and other immediate actions. The need for establishing a 24/7 off-site notification points at local and national levels need to be evaluated. This evaluation has to be conducted in coordination with the local authorities.

The survey of capabilities for taking mitigatory actions includes the evaluation of needs for the development of capabilities for the implementation of mitigating actions in the case of a radiation emergency at all levels. It has to include an analysis of the capabilities of existing teams of first responders, and requirements for their equipment and further training. The

properties of emergency facilities existing in the vicinity of potential sites for NPP, and other nuclear installations, need to be evaluated. The existence of adequate tools, computer codes, instruments, supplies, equipment, communication systems, facilities and documentation for performing response functions need to be reviewed. This evaluation has to be conducted in coordination with the local authorities and other stakeholders to involve them at the earliest stage of embarking on a nuclear power programme.

The survey of capabilities for taking urgent protective actions includes the evaluation of needs for the development of capabilities for taking urgent protective actions in the case of a radiation emergency at all levels, including the capabilities for sheltering, evacuation and special medical aid in the vicinity of potential sites for the NPP, or other nuclear installations. It has to include an analysis of the capabilities for the replacement of contaminated foodstuff and water in case of a radiation emergency and associated release of radioactive material. This evaluation has to be conducted in coordination with local authorities and other stakeholders to involve them at the earliest stage of embarking on a nuclear power programme.

The survey of capabilities for providing information and issuing instructions and warnings to the public includes an evaluation of the needs for the development of capabilities for providing prompt warning and instruction to the permanent, transient and special population groups, or those responsible for them, and to special facilities in the emergency zones upon the declaration of an emergency class.

The survey of capabilities for protecting emergency workers includes an evaluation of the needs for upgrading the capabilities in protecting emergency workers. This survey has to include an evaluation of the existing legislative basis for the use of different categories of citizens as emergency workers, and the capabilities for taking all practicable measures to provide protection for first responders and emergency workers during an emergency at a facility of threat category I and II.

The survey of capabilities for assessing the initial phase includes an evaluation of the needs for the development of capabilities for a radiological response to emergencies associated with facilities in threat category I or II. This survey has to include an evaluation of the existing capabilities for establishing default operational intervention levels (OILs) for radiological emergencies and monitoring contamination in soil, air, foodstuff and water at territory associated with facilities of threat category I and II. The survey needs to include an analysis of the existing arrangements for the involvement of qualified radiation protection experts in preparedness and response to a radiation emergency at the national and local level.

The survey of capabilities for the medical response to a radiation emergency includes an evaluation of the needs for the development of capabilities for the medical response to a radiation emergency at all levels, including the level of competence of medical personnel in specialized medical care at the scene of the radiation emergency. It has to include an analysis of the capabilities for medical treatment of overexposed and contaminated patients. An analysis of the existing capabilities of public health facilities to treat mass casualties, in the case of a natural or man-made non radiation accident, has to be performed.

The survey of capabilities for keeping the public informed includes an evaluation of the needs for the development of arrangements for providing useful, timely, truthful, and consistent information to the public, responding to incorrect information and rumours, and responding to requests for information from the public, and from news and information media.

The survey of capabilities for taking agricultural countermeasures, countermeasures against ingestion and longer term protective actions includes an evaluation of the needs for the development of operational intervention levels for agricultural countermeasures and the

conduct of an evaluation of the existing capabilities for taking effective agricultural countermeasures.

The survey of capabilities for communications and the availability of information during a radiation emergency includes an evaluation of the needs for the development of additional capabilities for communications during a radiation emergency at all levels, including the existing competence levels of medical doctors, school teachers, etc. in communicating the risks of radiation exposure in the case of a radiation emergency to the public. An analysis of the existing capabilities of the local authorities, civil defence, emergency medical personnel and police for response in the case of natural or man-made non-radiation accident, has to be performed.

The survey of capabilities for conducting recovery operations includes evaluation of arrangements for the transition from emergency phase operations to routine long term recovery operations and assessment of the roles and functions of organizations in transition process.
The survey of infrastructure and capabilities for establishing the process for ensuring emergency response includes an evaluation of the needs for maintaining adequate capabilities for a response to radiation emergencies at all levels including:

- Needs for new arrangements in preparedness for response to a radiation emergency at the local and operator level, including considerations for the development of emergency facilities defined in Appendix II, and considerations for the involvement of the vendor of the nuclear installation to provide prompt consultations to the operating organization in the case of a radiation emergency. It also needs to include considerations for the allocation of financial resources for the development and maintenance of on-site and off-site infrastructure and facilities involved in emergency response;
- Needs for the development of capabilities for the coordination of emergency preparedness and response at an international, national, local and operator level using the all-hazard approach in planning. It needs to include an analysis of the legal and regulatory basis for preparedness and response to a natural or man-made non-radiation accident, and needs to allow for harmonization with future regulations for managing radiation emergencies;
- Needs for ensuring an adequate level of emergency preparedness and response at all above-mentioned levels, utilizing a graded approach for funding and staffing.

To support milestone 1, a policy decision on establishing capabilities for response to radiation emergencies at the national, local and operator levels must be considered. This decision needs to be realized in the form of a national programme for establishing the framework for preparedness and response to radiation emergency, to be implemented in the early stages of phase 2.

At phase 1 the emergency preparedness representative of the NEPIO [19] needs to advise decision makers on the plan of government and regulatory policies, after a review of the national policy, legal and regulation basis for the protection of workers, the public, the environment and property in case of a radiation emergency with the objectives of :

- determining if the arrangements for preparedness and response to radiation emergencies within the State were in conformity with international requirements;
- identifying methods and means of meeting the international requirements [2] and guidance of references [4, 5], and other good practices provided in Refs. [6, 16, 18];
- identifying tasks for implementation, which need to, and can be addressed, in a national emergency preparedness and response programme at phase 2;

- preparing an interim sub-programme to the national programme for establishing a framework of preparedness and response to a radiation emergency for implementation during the next phase of the embarking process.

Practical recommendations from Ref. [38] can be useful to enable the State to self-assess the existing level of capabilities for preparedness and response to a radiation emergency.

At the end of phase 1 the State has to be ready to start establishment and extension of capabilities for emergency preparedness and response adequate to nuclear facility in threat category I or II.

3.3.2. Phase 2. Safety infrastructure: preparatory work for construction of an NPP after a policy decision has been taken

During phase 2, it will be necessary to begin establishing new programmes or augmenting the current ones to support a nuclear power programme. The Milestones publication [8] provides that the basis for phase 2 which is: 'preparatory work for the construction of a NPP after a policy decision has been taken', culminates in milestone 2: 'Ready to invite bids for the first NPP'.

Whilst activities performed during phase 1 are intended to inform a decision to launch a nuclear power programme, phase 2 activities are related to the beginning of implementation of the national programme for establishing a framework of preparedness and response to a radiation emergency. During this phase the following actions need to be taken [3]:

Action 135. The government should specify the national institutions with responsibilities for emergency preparedness and response.

Action 136. The government should specify the general approach for emergency preparedness and response on the basis of the probability and severity of the emergency.

Action 137. The government should start implementing new arrangements as identified in phase 1 for strengthening the infrastructure for emergency preparedness and response.

Action 138. The regulatory body should develop basic regulations on emergency preparedness and response, as necessary for development of infrastructure.

Action 139. The operating organization should start developing a general emergency preparedness programme for nuclear power plants.

The objective for this phase related to establishing the emergency capabilities is to establish the legal, regulatory framework and emergency response infrastructure at a national, local and operator level to meet international requirements on preparedness and response to a radiation emergency at a threat category I–II facility. To reach milestone 2, actions 135–139 need to be implemented. They are presented in Table 1. The corresponding tasks need to be fully completed during phase 2.

At the end of phase 2 the State has to be ready to start development of emergency plan for the first NPP.

3.3.3. Phase 3. Safety infrastructure during implementation of the first NPP

During phase 3, it will be necessary to continue emergency preparedness and response activities started in phase 2. The Milestones publication [8] provides that basis for phase 3 which is: 'activities to implement the first NPP', culminates in milestone 3: 'ready to commission and operate the first NPP.'

The main objective of this phase related to emergency preparedness and response is to assure preparedness for the protection of workers, public and environment in case of an accident at nuclear installations, and to demonstrate it at exercises at the international, national, local and operator levels. To achieve this objective, the following actions need to be taken at this phase [3]:

Action 140. The regulatory body should establish detailed regulations on emergency preparedness and response.

Action 141. The operating organization should develop and implement an emergency preparedness programme, plans and procedures for nuclear power plants, and should prepare the corresponding chapter of the safety analysis report.

Action 142. The government and the regulatory body should develop and implement emergency preparedness programmes at the local, national, and international level.

Action 143. The government and the regulatory body should establish arrangements for coordination between the emergency response plan of nuclear power plant and the plans of the relevant national institutions that would be involved in emergency response.

Action 144. The regulatory body should review and assess the emergency programme, plans and procedures for nuclear power plants, and should verify compliance with the regulatory requirements.

Action 145. The government, the regulatory body and the operating organization should demonstrate emergency response capabilities by conducting appropriate exercises that include local authorities and local communities.

To reach milestone 3, a number of issues need to be implemented through actions 140–145. They are presented in Table 1. The corresponding tasks need to be fully completed during phase 3.

It is assumed that all States ready to combat I and II category of threats meet international requirements [2] for all threat categories. Table 1 defines expectations for this milestone. Emergency preparedness and response is to assure preparedness for the protection of workers, public and environment in case of an accident at nuclear installations, and to demonstrate it at exercises at the international, national, local and operator levels at this phase. This level of preparedness needs to be reviewed by means of requesting an Emergency Preparedness Review (EPREV) service from the IAEA, and conducting full-scale emergency exercises corresponding to each category of threat. Details of the EPREV service are discussed in Appendix IV.

The regulatory body and national coordinating authority will be responsible for ensuring that the emergency management system is fully functional, the corresponding activities are

conducted properly, a well-coordinated concept of operations is in place at the national, local and operator levels, emergency response capabilities progress in accordance with the international requirements [2] and international best practices, and any deviations are corrected through periodic training, drills and exercises.

At the end of phase 3 the State has to be ready combat I and II category of threats.

3.4. OVERALL PROGRAMME FOR ESTABLISHING CAPABILITIES AND ARRANGEMENTS FOR EMERGENCY PREPAREDNESS AND RESPONSE DURING DIFFERENT PHASES

Establishing capabilities and arrangements for an appropriate level of emergency preparedness and response is mandatory, as illustrated in Table 1 and is intended to guide the State embarking on a nuclear power programme in implementing the main elements previously identified.

Table 1 presents an integrated guidance for establishing capabilities and arrangements for preparedness and response to a radiation emergency. The actions are derived from the description of the main elements in Section 3.2. The principal points in the development of capabilities and arrangements for emergency preparedness and response to a radiation emergency were defined in Section 3.3 and given in Fig. 1.

The box below with the sign ■ in the table, reflects the period of conducting planned actions aimed to complete the objectives (expected results) of establishing the particular main elements of the framework. The box with the sign □ reflects the need to further develop additional capabilities and arrangements for the emergency response. This process lasts throughout the lifetime of operation of the NPP and other nuclear installations, to ensure the level of response that meets the requirements of the IAEA for emergency preparedness and response to radiation emergencies. Table 1 addresses all parties (defined in Table 1) involved in establishing the capabilities for emergency response at the different levels of responsibility and defined in Section 2. Each phase is shaded slightly different for ease of use.

TABLE 1. OVERALL PROGRAMME FOR ESTABLISHING CAPABILITIES AND ARRANGEMENTS FOR PREPAREDNESS AND RESPONSE TO A RADIATION EMERGENCY DURING DIFFERENT PHASES

Main elements of a framework of preparedness and response to a radiation emergency	Party[9]	Status at particular phase			
		1	2	3	4[10]
Main element 1. Basic responsibilities		□	□	■	■
Survey of the basic responsibilities and governmental infrastructure for emergency preparedness and response	**G (B)**	■			
1.1. Allocation of functions among governmental agencies and jurisdictions involved in preparedness and response to emergencies at facilities of threat category I and II at all levels	**G (C, B)**		□	■	■

[9] **G** – Government, **B** – Regulatory body, **C** – Coordinating authority, **L** – Local authority, **O** – Operating organization, **R** – Response and technical support organizations.

[10] Phase 4 is NPP operation stage.

Main elements of a framework of preparedness and response to a radiation emergency	Party[9]	Status at particular phase			
		1	2	3	4[10]
1.2. Operation of a national coordinating authority for developing, maintaining and coordinating arrangements for preparedness and response to emergencies at facilities of threat category I and II	**G (B)**		☐	■	■
1.3. Participation in international conventions relevant to emergency preparedness and response area	**G (C, B)**		☐	■	■
1.4. Development of relevant regulations on emergency preparedness and response to emergencies at facilities of threat category I and II	**G (C, B)**		☐	■	■
Main element 2. Assessment of threats		☐	☐	■	■
Survey of the capabilities for the assessment of threats	**G (B)**	■			
2.1 Regulations about the assessment of radiological threats in a State	**G (B, C)**		☐	■	■
2.2 Threat assessment in a State performed in accordance with the IAEA Safety Standards GS-R-2 and GS-G-2.1	**C (B, G)**		☐	■	■
2.3 Periodic reassessment of threats	**C (B, G)**		☐	■	■
Main element 3. Establishing emergency management and operations		☐	☐	☐	■
Survey of the emergency management and operations	**G (B)**	■			
3.1. Assignment of functions, allocation of responsibilities, establishing coordination and providing resources for emergency preparedness and response at all levels	**C (L, O, B, R, G)**		☐	■	■
3.2. Acting in accordance with the national radiation emergency plan	**C (L, O, R, G)**		☐	☐	■
3.3. Review, in cooperation with stakeholders, proposals for potential sites for the NPP and other nuclear installations in relation to requirements for emergency preparedness and response	**G (L, O, B, C)**		☐	■	
3.4. Evaluation of feasibility of protective actions at the chosen site for the NPP and other nuclear installations	**B (L, O, C)**		☐	■	■
Main element 4. Identifying, notifying and activating		☐	☐	☐	■
Survey of the capabilities for initiating and terminating emergency response	**G (B)**	■			
4.1. Operation of a single national warning point for contact with the IAEA and to other States in compliance with Assistance and Early Notification Conventions [13]	**G (C)**		☐	■	■
4.2. Awareness of the local authority, operators, the public and potential first responders to an emergency at facility of threat category I and II (response organizations) to the indicators of a potential radiation emergency, notifications and other immediate actions	**C (O, L, R, G)**		☐	■	■

Main elements of a framework of preparedness and response to a radiation emergency	Party[9]	Status at particular phase			
		1	2	3	4[10]
4.3. Arrangements and procedures for the notification of involved parties and initiation of response at all levels, in a timely, accurate and appropriate manner	**G (C, O, L, B, R)**		☐	■	■
4.4. Arrangements and procedures for immediate and effective actions of first responders to an emergency at facility of threat category I and II (response organizations)	**L (R, C)**		☐	■	■
4.5. Arrangements and procedures for notifying of neighbouring countries and the IAEA in case of a radiation emergency associated with threat categories I and II	**G (O, C)**			☐	■
4.6. Arrangements and procedures for assessing the initial phase of the reactor accident at the facilities of threat category I and II by the operator	**O (C, B)**			☐	■
4.7. Arrangements and procedures for promptly initiating an on-site and off-site response in the event of a radiation emergency at the facilities of threat category I and II	**C (O, L, R)**			☐	■
Main element 5. Taking mitigatory actions		☐	☐	☐	■
Survey of the capabilities for taking mitigatory actions	**G (B)**	■			
5.1. Arrangements and procedures for on-call advice to assist first responders to an emergency at facility of threat category I and II (response organizations) and local authorities	**C (G, B, L, R)**		☐	☐	■
5.2. Arrangements and procedures for supporting the local authority including the process for obtaining prompt assistance through the IAEA	**G (C, B)**		☐	■	■
5.3. Arrangements and procedures for taking mitigating actions for an emergency at facility of threat category I and II	**C (L, G)**		☐	☐	■
Main element 6. Taking urgent protective actions		☐	☐	☐	■
Survey of the capabilities for taking urgent protective actions	**G (B)**	■			
6.1. Arrangements for effectively making and implementing decisions on urgent protective actions to be taken off-site	**C (G, L, O, R)**		☐	☐	■
6.2. Arrangements to ensure the safety of all persons on-site in the event of a radiation emergency	**C (G, L, O, R)**		☐	☐	■
6.3. Arrangements and procedures for obtaining local, national and international support for operator of threat category I and II facilities	**C (G, L, O)**		☐	☐	■
Main element 7. Providing information and issuing instructions and warnings to the public		☐	☐	■	■
Survey of the capabilities for providing information and issuing instructions and warnings to the public	**G (B)**	■			

Main elements of a framework of preparedness and response to a radiation emergency	Party[9]	Status at particular phase			
		1	2	3	4[10]
7.1. Arrangements and procedures for providing coordinated, useful, timely, accurate, and consistent information to the public in the event of a radiation emergency	**G (B, C, O, L)**		☐	■	■
7.2. Arrangements and procedures to provide prompt warning and instruction to the permanent, transient and special population groups within the area potentially affected by a radiation emergency	**L (C, O, G)**		☐	■	■
Main element 8. Protecting emergency workers		☐	☐	■	■
Survey of the capabilities for protecting emergency workers	**G (B)**	■			
8.1 Regulations on the protection of emergency workers	**B (G, C)**		☐	■	■
8.2 Arrangements for the application of a graded approach on the restriction of exposure of emergency workers based on the assignment of tasks	**G (B, C, O, R)**		☐	■	■
8.3 Arrangements for the use of personal protective equipment by first responders and emergency workers	**C (O, R)**		☐	■	■
8.4 Arrangements for the efficient dose control of emergency workers	**C (O, R)**		☐	■	■
Main element 9. Assessing the initial phase		☐	☐	☐	■
Survey of the capabilities for assessing the initial phase	**G (B)**	■			
9.1. Arrangements and procedures for radiation protection of the public, workers and first responders based on plant conditions, off-site radiation measurements and observations at the scene in an emergency at facilities in threat category I and II	**G (B, C)**		☐	☐	■
9.2. Capabilities for assessing the dose of emergency exposure off-site and on-site in emergency at facilities in threat category I and II	**G (B, C)**		☐	☐	■
9.3. Capabilities for on-line radiation monitoring of PAZ and UPZ of facilities in threat category I and II	**G (L, C, B)**			☐	■
9.4. Capabilities for monitoring contamination in soil, air, foodstuff and water in PAZ and UPZ of facilities in threat category I and II	**G (B, O, C)**			☐	■
9.5. Plant specific EALs based on event classification and on plant conditions at facilities in threat category I and II	**G (B, O, C)**			☐	■
9.6. Site-specific OILs for radiation emergencies at the facilities in threat category I and II	**G (B, O, C)**			☐	■
Main element 10. Managing the medical response		☐	☐	■	■
Survey of the capabilities for medical response to a radiation emergency	**G (B)**	■			
10.1. Designation of hospitals and qualified medical professionals to assist during a radiation emergency	**L (C, G)**		☐	■	■

Main elements of a framework of preparedness and response to a radiation emergency	Party[9]	Status at particular phase			
		1	2	3	4[10]
10.2. Arrangements and procedures for the awareness of medical practitioners of the medical symptoms and outcomes of radiation exposure and of the appropriate notification procedures	**G (B, C, L)**		☐	■	■
10.3. Arrangements and procedures to obtain international assistance in the treatment of overexposed persons if required	**G**		☐	■	■
10.4. Capabilities to initially treat exposed and contaminated patients	**G (L)**		☐	■	■
10.5. Arrangements for performing measures for the medical protection of the public, workers and responders	**G (B, C, L)**		☐	■	■
Main element 11. Keeping the public informed		☐	☐	■	■
Survey of the capabilities for keeping the public informed	**G (B)**	■			
11.1 Arrangements for reliable communications in advance of a radiation emergency	**G (B, C, O, L)**		☐	■	■
11.2 Arrangements for responding to requests for information from the public and mass media	**G (B, C, O, L)**		☐	■	■
Main element 12. Taking agricultural countermeasures, countermeasures against ingestion and longer term protective actions		☐	☐	■	■
Survey of the capabilities for taking agricultural countermeasures, countermeasures against ingestion and longer term protective actions	**G (B)**	■			
12.1. Capabilities for monitoring contamination in soil, air, foodstuff and water in the emergency zones associated with a facility of threat category I and II	**L (C, G, B)**		☐	■	■
12.2. Arrangements and procedures to implement actions to protect the public from consumption of contaminated local foods in case of a radiation emergency at a facility of threat category I and II	**G (B, L)**		☐	■	■
Main element 13. Mitigating the non-radiological consequences of the radiation emergency and the response		☐	☐	■	■
Survey of the capabilities for communication and availability of information during a radiation emergency	**G (B)**	■			
13.1 To provide the public during a potential or actual radiation emergency with a plain language explanation	**G (B, C, O, L)**		☐	■	■
13.2 To make arrangements for responding to public concern during a potential or actual radiation emergency	**G (B, C, O, L)**		☐	■	■
Main element 14. Conducting recovery operations		☐	☐	☐	■
Survey of the capabilities for conducting recovery operations	**G (B)**	■			

Main elements of a framework of preparedness and response to a radiation emergency	Party[9]	Status at particular phase			
		1	2	3	4[10]
14.1 To plan and implement the transition from the emergency phase to longer term recovery operations and the resumption of normal social and economic activity in an orderly manner and in accordance with international standards and guidance	**G (B, C, O, L)**		☐	☐	■
14.2 To fulfil all requirements for planned exposure situations for workers undertaking recovery operations	**G (B, C, O, L)**			☐	■
Main element 15. Requirements for infrastructure		☐	☐	☐	■
Survey of the infrastructure and capabilities for establishing the process for ensuring emergency response	**G (B)**	■			
15.1. Emergency plans at all levels for on-site and off-site response at threat category I and II facilities	**C (O, R)**		☐	☐	■
15.2. Off-site emergency facilities for managing the response to a radiation emergency at threat category I and II facilities	**G (C, L)**		☐	☐	■
15.3. Arrangements and procedures for off-site precautionary and urgent protective actions in a radiation emergency at threat category I and II facilities	**G (B, C, O, L, R)**			☐	■
15.4. Arrangements and procedures for on-site response in a radiation emergency at the facilities of threat category I and II	**O (B, C, G, L, R)**			☐	■
15.5. Adequate tools, computer codes, instruments, supplies, equipment, communication systems, facilities and documentation for performing response functions on-site and off-site	**C (B, L, R)**	☐	☐	■	
15.6. Application of the Systematic Approach to Training (SAT), in order to identify duties for all positions and competences for all parties involved in the response to emergencies at facilities of threat category I and II	**G (C, B, O, L, R)**			☐	■
15.7. Designing training courses according to applied SAT for all parties involved in the response to emergencies at facilities of threat category I and II, and establishing and carrying out a continuous programme to train staff of all involved parties in accordance with roles and responsibilities	**G (B, C, O, L, R)**		☐	☐	■
15.8. Establishing and running a continuous programme for staffing of all parties involved in the response to emergencies at facilities of threat category I and II in accordance with applied SAT, to ensure duties are maintained regardless of changes in organizations and staff	**G (C, B, O, L, R)**		☐	☐	■
15.9. Designing exercises in accordance to exercise scope and objectives, and establishing and carrying out a continuous exercise programme	**C (B, O, L, R)**		☐	☐	■

Main elements of a framework of preparedness and response to a radiation emergency	Party[9]	Status at particular phase			
		1	2	3	4[10]
15.10. Designing scope and objectives for testing equipment and communications, and establishing and carrying out a continuous testing programme in accordance with the scope and objectives for testing equipment and communications	**C (B, O, L, R)**		☐	☐	■
15.11. Establishing and carrying out the framework of reporting results of exercises, training and testing for feeding information to the national coordinating authority to identify improvements of the framework for preparedness and response to a radiation emergency	**C (B, O, L, R)**		☐	■	■

APPENDIX I
BACKGROUND FOR THE MAIN ELEMENTS OF EMERGENCY PREPAREDNESS AND RESPONSE

Experience from response to emergencies that have occurred in the past 30 years has clearly demonstrated the importance of an efficient response system that includes, among other components, emergency plans, procedures, and internally consistent operational criteria. An analysis of lessons identified from recent responses has shown that a lack of crucial components in the emergency response system could result in major radiological and non-radiological consequences at the national level.

Lessons learned from emergencies at NPPs show that the primary means of preventing and mitigating the consequences of these emergencies is 'defence in depth' [9]. Protection of the public and the environment is maintained by the first levels of defence in depth, established and maintained during design, construction and operation of the plant. These levels of defence in depth attempt to ensure protection from design basis accidents at a nuclear installation. Arrangements and capabilities for a response to severe nuclear emergency are the last level of defence in depth. These arrangements and capabilities provide a basis for protecting the public, environment and property in case of failure at other levels of defence in depth, which are mainly for the purpose of protection against design basis accidents. To establish arrangements and capabilities for emergency preparedness and response to severe accident conditions (thematic area 14 [3]) is the principal task in the development of a national safety infrastructure in States embarking on a nuclear power programme. These States, when developing a national safety infrastructure, need to take into consideration the lessons learned from major emergencies at NPPs which have occurred to date [43].

The background information for the main elements of emergency preparedness and response for an emergency at an NPP are presented below.

I.1. CATEGORIZATION OF THREATS

Requirements and guidance for emergency preparedness and response are specified in the IAEA Safety Standards [2, 4] for five threat categories (I–V). Threat categories I, II and III represent the incremental level of threat and strength of requirements for emergency preparedness and response. This classification of threats has to be established in a State embarking on a nuclear power programme by means of special regulations based on the definition of threat categories and numerical criteria for threat categorization of nuclear installations given in Refs. [6, 4]. Threat categories and their description are summarized in Table 2 [2, 4, 6]. A preliminary threat assessment at phase 1 in the introduction of a framework of preparedness and response to a radiation emergency needs to be accomplished by identifying:

(a) the threat category of facilities within the State, based on Table 2 and Table 3;
(b) any national area that is within the emergency zones, or food restriction planning radius (see Table 5) of the threat category I and II facilities within or outside the State;
(c) the operators of dangerous mobile sources (threat category IV in Table 2) that can result in emergencies anywhere in the State.

TABLE 2. FIVE CATEGORIES OF NUCLEAR AND RADIATION RELATED THREATS FOR THE PURPOSE OF THE REQUIREMENTS FOR EMERGENCY PREPAREDNESS AND RESPONSE [2]

Threat category	Description
I	Facilities, such as nuclear power plants, for which on-site events[1] (including very low probability events) are postulated that could give rise to severe deterministic health effects[2] off-site, or for which such events have occurred in similar facilities.
II	Facilities, such as some types of research reactors, for which on-site events are postulated that could give rise to doses to people off-site that warrant urgent protective action in accordance with international standards[3], or for which such events have occurred in similar facilities. Threat category II (as opposed to threat category I) does not include facilities for which on-site events (including very low probability events) are postulated that could give rise to severe deterministic health effects off-site, or for which such events have occurred in similar facilities.
III	Facilities, such as industrial irradiation facilities, for which on-site events are postulated that could give rise to doses that warrant or contamination that warrants urgent protective action on-site, or for which such events have occurred in similar facilities. Threat category III (as opposed to threat category II) does not include facilities for which events are postulated that could warrant urgent protective action off-site, or for which such events have occurred in similar facilities.
IV	Activities that could give rise to a radiation emergency that could warrant urgent protective action in an unforeseeable location. These include non-authorized activities such as activities relating to dangerous sources obtained illicitly.
V	Activities not normally involving sources of ionizing radiation, but which yield products with a significant likelihood[4] of becoming contaminated, as a result of events at facilities in threat category I or II, including such facilities in other States, to levels necessitating prompt restrictions on products in accordance with international standards.

IAEA Safety Standards [4] provides suggested criteria for determining emergency threat categories for facilities which are described in Table 3.

Requirements and guidance for emergency preparedness and response are specified in the IAEA Safety Standards [2, 4] for two generic areas: on-site (on-site) and off-site (off-site).

The on-site area is the area under the control of the operator. For facilities in threat category I, II or III, the on-site area is the area surrounding the facility within the security perimeter that is under the immediate control of the facility operator. For radiological

[1] Such on-site events would be events involving an atmospheric or aquatic release of radioactive material or external exposure (e.g. due to a loss of shielding or a criticality event) that originates from a location on-site.
[2] For dose criteria see Table 2 of Ref. [5].
[3] For dose criteria see Table 3 of Ref. [5].
[4] Contingent on the occurrence of a significant release of radioactive material from a facility in threat category I or II.

emergencies involving the transport of radioactive material, the first responders need to establish a security perimeter containing the inner and outer cordoned areas to define the on-site area [11, 39].

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

TABLE 3. SUGGESTED CRITERIA FOR DETERMINING EMERGENCY THREAT CATEGORIES FOR FACILITIES AND PRACTICES [4][5]

Threat category	Criteria[6]
I	Facilities for which emergencies have been postulated that could result in severe deterministic health effects off-site, including: – Reactors with power levels greater than 100 MW(thermal) (power, nuclear ship and research reactors); – Facilities and/or locations with spent fuel pools that may contain some recently discharged irradiated reactor fuel with a total of more than about 0.1 EBq of Cs-137 (equivalent to the inventory in a 3000 MW(thermal) reactor core); – Facilities with inventories of dispersible radioactive material with IDM[7] exceeding 10 000.
II	Facilities for which emergencies have been postulated that could result in doses warranting urgent protective action being taken off-site, including: – Reactors with power levels greater than 2 MW (thermal) and less than or equal to 100 MW (thermal) (power reactors, nuclear ship and research reactors); – Facilities and/or locations containing recently discharged irradiated reactor fuel requiring active cooling; – Facilities with inventories of dispersible radioactive material with IDM in the range of 10 000 – 100 that is sufficient to result in doses warranting urgent protective action being taken off-site.
III	Facilities for which emergencies have been postulated that could result in doses warranting urgent protective action being taken on-site, including: – Reactors with power levels of less than or equal to 2 MW (thermal); – Facilities with inventories of radioactive material with IDM in the range of 100–0.01 that is sufficient to result in doses warranting urgent protective action being taken on-site.

Facilities in threat categories I and II warrant extensive on-site and off-site arrangements for emergency preparedness and response. For facilities in threat category III, the radiation related threat is limited to the site or to areas on-site (e.g. treatment rooms or laboratories), but arrangements to inform and reassure the public in the event of a radiation emergency are still warranted. In accordance with this approach:

[5] Table 3 is a combination of Table III and Table A5-II from [4].

[6] Site specific analysis can be performed to determine the appropriate threat category.

[7] IDM is an index of dispersible radioactive material inventory equal to sum of ratios of activity of all stored radionuclides to corresponding D_2 value characterizing its radiotoxicity in dispersed form, as defined in Ref. [17].

(1) During construction work

- Stationary facilities containing dangerous sources (e.g. radiation gages) have threat category III or none depending on the IDM value as given in Table 3;
- Use of mobile facilities containing dangerous sources (e.g. mobile industrial radiographer) has threat category IV.

(2) During the NPP operation

- NPP has threat category I or II depending on its construction;
- Fuel cycle services, such as spent fuel or radioactive waste storage facilities have threat category II or III depending on its inventory;
- Transportation of fresh low enriched nuclear fuel has no threat category[8];
- Transportation of spent nuclear fuel has threat category IV;
- Foodstuff production in the surrounding areas of facilities of threat categories I and II has threat category V.

Therefore, a State embarking on a nuclear power programme will face the full range of categories of threats and will need capabilities for response to any of them.

I.2. CLASSIFICATION OF EMERGENCIES

Requirements and guidance for emergency response are specified in the IAEA Safety Standards [2, 4] for five classes of emergency which are described in Table 4:

(1) General emergencies at facilities in threat category I or II;
(2) Site area emergencies at facilities in threat category I or II;
(3) Facility emergencies at facilities in threat category I, II or III;
(4) Alerts at facilities in threat category I, II or III;
(5) Other emergencies at unpredictable locations associated with activities in threat category IV.

Appendix 6 of EPR-METHOD [6] provides a detailed description of the immediate response actions to be taken depending on the emergency classification, which is itself based upon the events which have occurred at the facility.

The operator of a facility or practice in threat category I, II, III or IV is required to make arrangements for the prompt identification of an actual or potential radiation emergency and determination of the appropriate level of response. A related requirement for NPP and other nuclear installations was established in §2.32 of the IAEA Safety Requirements NS-R-2 [22]. A State embarking on a nuclear power programme is required to establish a regulatory base for classifying all potential radiation emergencies that warrant implementation of protective actions to protect workers and the public, in accordance with a graded approach.

[8] No special emergency preparations required for the radiological hazard beyond those warranted to address perceived concerns and normal industrial and workplace safety measures needed because of chemical toxicity and other non-radiological hazards associated with the practice. A radiation emergency that involves fresh low enriched nuclear fuel does not warrant urgent protective actions.

TABLE 4. DESCRIPTIONS OF EMERGENCY CLASSES [2][9]

Accident conditions	Threat category	Emergency class	Response
Actual or substantial risk of a release of radioactive material, or radiation exposure that warrants taking urgent protective actions off-site	I or II	General emergencies at facilities	Actions are required to be promptly taken to mitigate the consequences and to protect people on-site and within the precautionary action zone and urgent protective action planning zone. Restriction of consumption of local food inside food restriction planning radius.
Major decrease in the level of protection for those on-site and near the facility	I or II	Site area emergencies at facilities	Actions are required to be promptly taken to mitigate the consequences, to protect people on-site and to make preparations to take protective actions off-site if this becomes necessary.
Major decrease in the level of protection for people on-site	I, II, or III	Facility emergencies at facilities	Actions are required to be promptly taken to mitigate the consequences and to protect people on-site. Emergencies in this class can never give rise to an off-site threat.
Uncertain or significant decrease in the level of protection for the public or people on-site	I, II, or III	Alerts at facilities	Actions are required to be promptly taken to assess and mitigate the consequences and to increase the readiness of the on-site and off-site response organizations, as appropriate.
Uncontrolled source emergency at unpredictable location involving the loss, theft or lack of control of a dangerous source, including the re-entry of a satellite containing such a source	IV	Source (other) emergencies at unpredictable locations	Actions are required to be promptly taken to protect people on the scene of an event at an unpredictable location.

I.3. CLASSIFICATION OF EMERGENCY ZONES FOR PLANNING RESPONSE TO A RADIATION EMERGENCY

The international requirements [2] are that, off-site of facilities in threat category I or II, arrangements are required to be made for effectively making and implementing decisions on urgent protective actions within:

(i) A precautionary action zone (PAZ), for facilities in threat category I, for which arrangements are required to be made with the goal of taking precautionary urgent

[9] Table 4 presents material from Paragraph 4.19 Reference [2] in the form of a table.

protective action, before a release of radioactive material occurs or shortly after a release of radioactive material begins, on the basis of conditions at the facility (such as the emergency classification), in order to reduce substantially the risk of severe deterministic health effects.

(ii) An urgent protective action planning zone (UPZ), for facilities in threat category I or II, for which arrangements are required to be made for urgent protective action to be taken promptly, in order to avert dose off-site in accordance with international standards.

(iii) A food restriction planning (FRP) radius, for facilities in threat category I or II, for which arrangements are required to be made for prompt restrictions on products and agricultural protective planning in accordance with international standards.

Suggested dimensions of these zones are defined in Ref. [4] and presented in Table 5. The emergency zones for a proposed site of the nuclear installation are required to be established with account being taken of the potential for radiological consequences for people and the feasibility of implementing emergency plans, and of any external events or phenomena that may hinder its implementation. Before construction of the NPP, together with other nuclear installations is started, it is required to be confirmed that there will be no insurmountable difficulties in establishing an emergency plan for the emergency zones. The siting process for a nuclear installation generally consists of an investigation of a large region to select one or more candidate sites (site survey), followed by a detailed evaluation of those candidate sites.

TABLE 5. SUGGESTED EMERGENCY ZONES AND AREA SIZES [4, 6]

Facilities	Threat category	Precautionary action zone (PAZ) radius[10]	Urgent protective action planning zone (UPZ) radius[19]	Food restriction planning (FRP) radius[19]
Nuclear power plants				
Reactors >1000 MW (thermal)	I	3–5 km	5–30 km	300 km
Reactors 100–1000 MW(thermal)	I	0.5–3 km	5–30 km	50–300 km
Reactors 10–100 MW (thermal)	II	None	0.5–5 km	5 – 50 km
Reactors 2–10 MW (thermal)	II	None	0.5 km	2 – 5 km
Reactors < 2 MW (thermal)	III	None	None	None
Storage facilities				
IDM[11] is ≥ 100 000	I	3–5 km	5–30 km	300 km
IDM in range of 10 000 – 100 000	I	0.5–3 km	5–30 km	50–300 km
IDM in range of 1000 – 10 000	II	None	05–5 km	5–50 km
IDM in range of 100 – 1000	II	None	0.5 km	2–5 km
IDM is <100	III	None	None	None

[10] Guidelines and recommendations from Safety Guide No. GS-G-2.1 [4] and EPR-METHOD [6].

[11] IDM is an index of dispersible radioactive material inventory equal to sum of ratios of activity of all storied radionuclides to corresponding D2 value characterizing its radiotoxicity in dispersed form and is defined in Ref. [17].

The site evaluation and examination of the design for the nuclear installation are required to be conducted in conjunction with one another. For each proposed site, the potential radiological impact during the operational state and in accident conditions on the public, environment and property in the region, including impact that could lead to emergency measures, are required to be evaluated with due consideration of the relevant factors, including population distribution, dietary habits, use of land and water, and the radiological impacts of any other releases of radioactive material in the region.

Appendix III provides a site evaluation data requirement list. In relation to the characteristics and distribution of the population, the combined effects of the site and the installation are required to be such that the radiological risk to the population associated with accident conditions, including those that could lead to emergency measures being taken, is acceptably low. If, after thorough evaluation, it is shown that no appropriate measures can be developed to meet the above mentioned requirement, the site is required to be deemed unsuitable for the location of a nuclear installation of the type proposed.

Responsibilities of government jurisdictions in response to emergencies associated with the realization of the threat category within the State, are based on Table 6.

TABLE 6. EMERGENCY PLANNING FOR GOVERNMENT JURISDICTIONS [6]

Threat category[12]	Local planning is warranted	National planning is warranted
I	• for jurisdictions responsible for urgent protective actions within the PAZ and UPZ of a threat category I facility	• for States with areas within the PAZ, UPZ or food restriction planning radius of threat category I facilities
II	• for jurisdictions responsible for urgent protective actions within the UPZ of a threat category II facility	• for States with areas within the UPZ or food restriction planning radius of a threat category II facility
III	• for jurisdictions responsible for providing emergency services to a threat category III facility, including fire fighting, police and medical	• for States containing a threat category III facility
IV	• for all jurisdictions	• for all States
V	• for jurisdictions with farming or food processing facilities and/or responsible for taking local actions for agricultural and ingestion control within food restriction planning radius for a threat category I or II facility	• for States with any areas within a food restriction planning radius for a threat category I or II facility, including those located in other States

I.4. EMERGENCY RELATED FACILITIES OR LOCATIONS

There are two different types of emergency related facilities or locations: those established in advance and those established at the time of a radiation emergency. In both cases the functions of, and operational conditions and requirements for, the facilities or locations need

[12] Taken from Table IV of EPR-METHOD [6].

to be carefully considered and necessary advance preparations need to be made. Facilities or locations established in advance (e.g. the technical support centre for a NPP) 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 a radiation emergency, advance preparation needs to be made to find a suitable location and to establish the emergency centre rapidly under field conditions. These preparations would include: developing site selection criteria, assigning the responsibility for acquiring a site during a radiation emergency, having procured and prepared in advance equipment (e.g. generators), supplies and other main elements needed to establish the centre in the field, and establishing a team for setting up the centre. Establishing such a centre under field conditions needs to be exercised.

Each emergency facility or location needs to be:

- Designed to support the functions that take place within it;
- Usable under emergency conditions;
- Integrated into the incident command system.

The facilities and locations recommended for each threat category are described in Appendix 14 of EPR-METHOD [6].

APPENDIX II
DATA REQUIREMENT LIST FOR SITE EVALUATION FOR PURPOSES OF EMERGENCY PREPAREDNESS AND RESPONSE

This site survey guideline is based on the general guidelines from Ref. [40] and Site Evaluation for Nuclear Installations [24] which are designed to assist survey groups investigating locations for a new NPP site in obtaining the emergency response sensitive data needed to select the site. The subject information is intended to address all sites including a remote site location, where the effective implementation of countermeasures may be questionable and the availability of emergency services is limited. In locations where these services are easily available, the survey group may disregard certain questions that appear obvious. The site review has to contain a description of the typical transportation available for evacuation within the UPZ, medical, police and fire fighting support available, typical sheltering available in the UPZ, communication available for decision makers, communication available to alert and inform the public, food and milk that is locally produced that may be directly contaminated, information on agricultural product collection and distribution systems, drinking water supply systems, population distribution, special populations (e.g. hospitals) and transients within the UPZ, special facilities (e.g. factories that cannot be evacuated) that may be affected by an emergency, transportation systems that may be affected by an accident (e.g. road, rail, air, sea, canals), points of import and export of food.

II.1. GENERAL INFORMATION

1.1. Maps and surveys

To expedite the initial layout and design, certain information needs to be obtained with as little delay as possible. This includes property survey data obtained either from existing civil engineering drawings, or from property deeds obtained from the local authority. Special attention has to be focused on the probable interference from off-site areas during the conduct of emergency response operations (e.g. evacuation of the public), and on localization of sensitive public and natural objects in the expected emergency planning zones of new NPP and other nuclear installations. Maps and surveys need to cover all emergency planning zones of new nuclear installations with default radiuses.

1.1.1. Features regarding the location of the new NPP and other nuclear installations site through a general inspection of the property:
- Nature of the terrain (hilly, wooded, marshy, rocky) including natural drainage conditions and slopes in relation to the adjoining property;
- Highways, roads, railways, waterways, swamps, or lakes that may affect the site layout;
- Industrial and military sites, farms, reservoirs, sewers, water mains, electric cables, etc. adjacent to the site that may affect layout considerations.

1.1.2. General map of the area showing boundaries of the new NPP and other nuclear installations site and emergency zones, elevations, contours, location and elevation of benchmarks.

1.1.3. Topographical map of the off-site area showing the location and giving proximity of the following:
- Internal national administrative borders and borders with neighbouring countries;
- Residential areas;
- Surrounding communities;

- Town centres, malls and shopping centres, housing areas;
- Special facilities, sensitive population centres such as schools, hospitals, day care centres, prisons, transient and special population groups or those responsible for them;
- Public parks and areas (e.g. stadiums);
- Future population encroachment;
- Resorts and environmentally sensitive areas (e.g. wetlands);
- National treasures or landmarks;
- Land use for agricultural purposes, farms and agricultural centres;
- Streams, sewers, water mains and storm drainage;
- Transport features (e.g. highways, railroads and sidings, airports, harbours);
- Business areas;
- Nearby industrial sites and transportation centres, including special facilities in emergency planning zones of the new NPP and other nuclear installations;
- Existing facilities (civil or military) that may present an external threat to NPP and other nuclear installation site (e.g. natural gas and other pipelines, arsenals, production of flammable or explosive materials);
- Future facilities (civil or military) that are in the planning stage, particularly if they present an external threat to NPP or other nuclear installations sites;
- Services that may be subject to interference from a NPP or other nuclear installation site, or may interfere with the response operations at NPP site (these may include radio, television, or microwave communication equipment).

1.2. SITE SPECIFIC METEOROLOGICAL AND GEOLOGICAL DATA

Whenever possible, meteorological data collected needs to be based on records covering a period of ten years. The specific main elements listed below are needed for the various emergency planning purposes. It is also useful to collect specific records for certain climatic conditions to provide a clearer picture on the extremes of the area. For example, develop a plot of daily maximum and minimum temperatures for a calendar year. For air temperature and humidity, what might be termed ‘average extremes’ is more significant than absolute extremes. In all cases, name the source of the data and specify where the data was recorded relative to the site for the following:

1.2.1. Elevation above mean sea level for the site measured in feet or meters. This is used for calculating atmospheric pressure at the site;

1.2.2. Temperature conditions for the site. These are available from local weather stations. Temperatures of interest include:

- Annual average temperature;
- Coldest month average temperature;
- Lowest one-day mean temperature;
- Extreme low temperature;
- Extreme high temperature;
- Dates for earliest and latest frost recorded.

1.2.3. Wind conditions from local weather stations which include the following data points:

- Mean wind velocity;

- Prevailing wind direction — generally in the form of a wind rose indicating the per cent of time the wind blows in 16 radial directions (N, NNE, NE, ENE, E, etc.). An analysis by season is most useful;

1.2.4. Precipitation categories including:

- Rainfall usually given as a 10 year average and maximums for one month, 24 hours, one hour and 30 minutes;
- Snowfall usually given as a 10 year average and maximums for one month, 24 hours. Maximum snow;
- Dates for earliest and latest ice load on road recorded;
- Dates for earliest and latest stable blanket of snow recorded.

1.2.5. Severe weather conditions by season that may cause the interruption of emergency response operations including the following information:

- Is area subject to fog? If so, what are the frequency and intensity of fog alerts?
- Tornadoes—frequency and worse case recorded severity;
- Hurricanes or typhoons—frequency and historic worse case scenarios (maximum winds and rain fall);
- Floods—including dates, total rainfall, and flood depth at the site. If there is a flood control organization for the area, determine who is responsible for maintenance and operation of the flood control equipment (locks, pumps, and levee)? Has there been a flood model developed for the area and has it been validated?
- Drought—recorded history needs to be collected to determine the water availability during a drought and impact on the area from the plant in a drought situation;
- Dust storm—activity, frequency, and records of previous storms;
- Snow storm—activity, frequency, and records of previous storms;
- Lightning strike frequency.

1.2.6. Severe geological hazards that may cause interruption of the emergency response operations including the following information:

- Volcanic hazards for transportation routes during an emergency at a NPP;
- Earthquake hazards for transportation routes and emergency facilities (fire stations, hospitals, etc.) during an emergency at a NPP;
- Tsunami hazards for transportation routes and emergency facilities during an emergency at a NPP.

II.2. TRANSPORTATION ISSUES

Whenever possible, transportation data collected needs to be based on existing examinations. The specific main elements listed below are needed for various emergency planning purposes. Special attention has to be paid to possible routes for evacuation of the public from UPZ without crossing the PAZ.

2.1. Roads

2.1.1. Describe the highways and roads in the locality. Can the existing highway handle the increased traffic loads during on-site and off-site radiation emergency?

2.1.2. Will a new road need to be built to connect the NPP site with the local highway system?

2.1.3. Determine the maximum allowable loading on roads and bridges;

2.1.4. Estimate the distance to the nearest express and freight yard;

2.1.5. Can local roads accommodate the width required for trucks, including for making right turns?

2.1.6. What public transport is available to and from the site in normal conditions and during a radiation emergency at an NPP?

2.2. Railroads

2.2.1. Determine the names and types of railroads (electric, diesel, steam) servicing the potential site area;

2.2.2. Discuss arrangements that can be made with the railroad company for transportation inside PAZ and UPZ.

2.3. Marine facilities

2.3.1. Furnish pertinent information (published data, if available[13]) on:

- Current measurements;
- Soundings;
- Tides and/or flood conditions;
- Traffic conditions;
- Silting conditions and type of harbour bottom;
- Dredging;
- Bulkheads.

2.3.2. Supply map of harbour showing harbour boundaries, pier headlines, channels, soundings, and river velocity.

2.3.3. Marine accommodations.

2.4. Special transportation requirements

2.4.1. Where is the nearest military, cargo and passenger airport? What is the distance to the site?

2.4.2. What is the availability and prospect for using helicopters as a form of transport to the site?

2.4.3. Describe in detail the manner in which rescue teams can reach the site via a highway, or from railroad to the site;

2.4.4. Describe in detail the manner in which members of the public can leave PAZ and could be evacuated from UPZ.

II.3. ENVIRONMENTAL CONDITIONS

Whenever possible, environmental data collected needs to be based on existing examinations. The specific elements listed below are needed for establishing site-specific OILs.

3.1. Water quality

[13] Tidal information needs to include yearly average high and low and extreme high and low tides on record, with discussion of meteorological conditions causing the extremes. If available, a copy of tide tables for the area can be included.

3.1.1. What natural water body will receive the wastewater effluent from the new NPP site in case of a radiation emergency?

3.1.2. Are the natural receiving water bodies contaminated at present? What are the existing levels of pollutants such as I-131, Cs-137, H-3, Pu-239, and others that can be discharged to the water mains?

3.2. Air quality

3.2.1. What is the nature of industrial emissions to the atmosphere near the site?

3.2.2. Obtain data on existing levels of atmospheric pollutants such as I-131, Cs-137, H-3, Pu-239, and others that can be discharged to the atmosphere during a radiation emergency;

3.2.3. Are there any special topographical features such as nearby hills or valleys that can affect dispersal of air pollutants?

3.3. Soil quality

3.3.1. What is the nature of industrial soil contamination near the site?

3.3.2. Obtain data on existing levels of soil pollutants such as I-131, Cs-137, H-3, Pu-239, and others that can be discharged to the atmosphere during a radiation emergency.

II.4. LOCAL FOOD PRODUCTION

Whenever possible, food production data collected needs to be based on existing examinations. The specific elements listed below are needed for establishing site-specific OILs.

4.1. Food and milk that is locally produced that may be directly contaminated;

4.2. Agricultural product collection and distribution systems;

4.3. Drinking water supply systems;

4.4. Options for food and water replacement.

II.5. INFRASTRUCTURE FOR SUPPORTING THE RESPONSE

Whenever possible, infrastructure data collected needs to be based on existing examinations. The specific elements listed below are needed for various emergency planning purposes. Special attention has to be paid to independent power supplies and communication routes.

5.1. Electrical systems

5.1.1. Reliability of power supply based on past performance (unplanned outages per year, planned outages per year, length of outages, and per cent voltage variation);

5.1.2. Present and future public power availability and reliability including amount available during a radiation emergency at a NPP (kW) and its characteristics (phase, system frequency and system voltage);

5.1.3. Will the public utility provide power during a radiation emergency at a NPP or other nuclear installations?

5.1.4. Have the emergency facilities got independent emergency power supplies? For what period of autonomic operation could it be used during a radiation emergency at a NPP or other nuclear installations?

5.2. Communication systems

5.2.1. Telephone systems: describe local system type (manual or automatic) and adequacy to handle increased traffic during a radiation emergency;

5.2.2. Internet systems: determine what internet communication support is available: phone lines, broadband, cable, ISDN;

5.2.3. Microwave communications: are microwave systems required due to the lack of telephone and internet support?

5.2.4. Radio communications: what laws govern its use? Are there available frequencies? What other users could provide interference? How secure are the channels?

5.3. Safety and security

5.3.1. What local police protection is available in the surrounding area?

5.3.2. To what extent can the local police and military forces be used during a radiation emergency?

5.4. Emergency facilities

5.4.1. Describe local fire fighting facilities. Obtain drawings of the nearest municipal fire mains showing size, capacity, and pressure. Indicate the location of fire fighting facilities relative to the site;

5.4.2. Describe local medical service:

- Hospital and ambulance;
- Radiotherapy and nuclear medicine clinic;
- Burn centre;
- Facilities for decontamination;
- Air lift to major medical centres.

5.5. Support of response

5.4.1. What is the quality of the emergency services?

5.4.2. Are shared services available from complex or adjacent sites?

5.4.3. Does the road structure permit good emergency access to the site and good routes for evacuation of the public from around NPP and other nuclear installations?

5.4.4. Are other features available such as schools, shops, and recreational facilities?

5.4.5. To what extent can personnel speak and write the language used in a radiation emergency for site labelling and documentation?

5.6. Systems of units

5.6.1. What system of units will be used for calibrating instruments? (Is it SI[14]?)

5.6.2. What system of measurement for weight and dimension is used in the area? (Is it SI?)

5.6.3. What system of measurement for radiation is used in the area? (Is it SI?)

5.6.4. What system of measurement is likely to be preferred locally for site instrumentation, drawing and procedure development?

5.7. Systems of communication with public

5.7.1. What languages are used?

5.7.2. What languages could be used for communication?

[14] International System of Units (SI is taken from the French *Système international d'unités*)

APPENDIX III
INTERNATIONAL ASSISTANCE FOR A RADIATION EMERGENCY

The Convention on Early Notification of a Nuclear Accident (the 'Early Notification Convention') and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (the 'Assistance Convention') [13] are the prime legal instruments that establish an international framework to facilitate the exchange of information and the prompt provision of assistance in the event of a radiation emergency, with the aim of minimizing the consequences.

The Convention on Early Notification of a Nuclear Accident [13] was adopted in 1986 following the Chernobyl nuclear plant accident. This Convention establishes a notification system for nuclear accidents which have the potential for significant transboundary release that could be of radiological safety significance for another State. It requires States to report the accident's time, location, radiation releases, and other data essential for assessing the situation. Notification is to be made to affected States directly or through the IAEA, and to the IAEA itself. Reporting is mandatory for any nuclear accident involving facilities and activities listed in Article 1. Pursuant to Article 3, States may notify other accidents as well.

The Convention on Assistance in the Case of Nuclear Accident or Radiological Emergency [13] was adopted in 1986 following the Chernobyl nuclear plant accident, this Convention sets out an international framework of cooperation among State Parties and the IAEA to facilitate prompt assistance and support in the event of nuclear accidents or radiological emergencies. It requires States to notify the IAEA of their available experts, equipment, and other materials for providing assistance. In case of a request, each State Party decides whether it can render the requested assistance as well as its scope and terms. Assistance may be offered without costs taking into account *inter alia* the needs of developing countries and the particular needs of countries without nuclear installations. The IAEA serves as the focal point for such cooperation by channelling information, supporting efforts, and providing its available services.

The IAEA has specific functions assigned to it under these Conventions, to which, in addition to a number of States, the EURATOM[15], WHO[16], WMO[17] and FAO[18] are full Parties.

III.1. JOINT RADIATION EMERGENCY MANAGEMENT PLAN OF THE INTERNATIONAL ORGANIZATIONS

The Joint Emergency Management Plan of the International Organizations (Joint Plan) [15] describes the inter-agency framework of preparedness for and response to an actual, potential or perceived radiation emergency irrespective of its cause. The application of the Joint Plan is limited to the participating international organizations, namely the EC[19], EUROPOL[20], FAO[27], IAEA, ICAO[21], INTERPOL[22], IMO[23], OECD/NEA[24], PAHO[25], UNEP[26], OCHA[27],

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15 European Atomic Energy Community.
16 World Health Organization.
17 World Meteorological Organization.
18 Food and Agriculture Organization of the United Nations.
19 European Commission.
20 European Police Office.
21 International Civil Aviation Organization.
22 International Criminal Police Organization.
23 International Maritime Organization.

OOSA[28], UNSCEAR[29], WHO[25] and WMO[26]. The IAEA is the main coordinating body for maintenance of the Joint Plan, which is re-issued every two years.

III.2. RESPONSE ASSISTANCE NETWORK

The IAEA has a central role in coordinating international assistance in a radiation emergency. Parties to the Assistance Convention [13] have agreed to cooperate with each other and with the IAEA to facilitate the prompt provision of assistance in case of a radiation emergency, in order to mitigate its consequences. As part of the IAEA's strategy for supporting practical implementation of the Assistance Convention and in order to coordinate a global response, the IAEA's Incident and Emergency Centre manages the Response Assistance Network (RANET) of national response capabilities able to respond rapidly to radiation emergencies [23], if so requested by the Accident State.

RANET is a network of Competent Authorities capable and willing to provide, upon request, specialized assistance by appropriately trained, equipped and qualified personnel with the ability to respond quickly and effectively to radiation incidents and emergencies. RANET may be activated under the Assistance Convention in case of a radiation emergency, for example:

- Nuclear installation incidents;
- Lost, stolen or damaged radioactive sources;
- Malicious acts involving radioactive materials.

RANET aims to facilitate assistance in case of a radiation emergency in a timely and effective manner and, in principle, on a regional basis. It also facilitates the harmonization of emergency assistance capabilities, exchange of relevant information and feedback of experience, and complements the IAEA initiatives to promote emergency preparedness and response in its States.

Assistance may be provided in the form of field teams, or delivered remotely from supporting State's offices and laboratories. The type and form of assistance is specified and agreed in an Assistance Action Plan that is prepared for the requested assistance. Each Competent Authority is responsible for ensuring that responding personnel are qualified to perform functions and duties to which they are assigned. Responders are expected to be equipped with all work elements necessary for the efficient performance of emergency tasks in compliance with the international technical and administrative guidelines.

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[24] Nuclear Energy Agency of the Organisation for Economic Cooperation and Development.
[25] Pan American Health Organization.
[26] United Nations Environment Programme.
[27] United Nations Office for the Coordination of Humanitarian Affairs.
[28] United Nations Office for Outer Space Affairs.
[29] United Nations Scientific Committee on the Effects of Atomic Radiation.

Appendix IV
EMERGENCY PREPAREDNESS REVIEW

An Emergency Preparedness Review (EPREV) is a service provided by the IAEA to independently appraise preparedness for a radiation emergency in States. The focus of EPREV is on preparedness for response to a radiation emergency. The main focus is on assessing the capability to respond to such situations rather than on the safety of facilities or practices. EPREV missions, if aligned with the milestones in the development of a national infrastructure for nuclear power, would be a powerful instrument for the development of capabilities for emergency response in States embarking on a nuclear power programme.

The EPREV service, offered since 1999, is an appraisal by international experts selected for their experience in such reviews, for their knowledge of international requirements and best practices, and for their ability to recognize and understand the strengths of different national systems and arrangements. The EPREV is based on international guidelines [2, 4, 5] and best practices of States in the development of capabilities for emergency preparedness and response. It is not prescriptive, nor is it rigid: it takes into account the practical context in the State and emphasizes the positive features of 'how things are done' in that State. An important outcome from the EPREV is qualified advice on what needs to be done by the State in the near future, and over the longer term in order to be prepared for the protection of the public and environment in case of a radiation emergency at an NPP or other nuclear installation.

An EPREV covers a wide area: from the appraisal of the arrangements at a specific installation, to a full appraisal of all the arrangements in a requesting State, including on-site, off-site and national arrangements. In all cases, the facility categorization laid down in the GS-R-2 [2] is the starting point for determining the scope and content of the appraisal.

States developing their nuclear power programmes may benefit from EPREV service due to the following EPREV objectives:

- To compare the embarking State's arrangements with current international standards and best practices;
- To initiate a fundamental reassessment of well-established arrangements that have evolved over time, but that are now thought to contain some inefficiency;
- To benefit from the EPREV team members' experience by considering how other States have successfully implemented innovative and effective solutions;
- To ensure that the embarking State has effectively implemented arrangements, consistent with the milestones at which the EPREV mission is performed, and that are practical within the constraints of the local conditions, and that can be implemented effectively;
- To determine if the legal framework has ensured an appropriate set of arrangements for all types of facility, reflecting the full range of risks to which they apply;
- To highlight the positive and negative aspects of the arrangements;
- To prioritize the aspects requiring improvement, recognizing that resources are limited;
- To highlight the need for additional training;
- To identify possible objectives for future emergency exercises;
- To appraise aspects of the arrangements thought to be inadequate or that require an independent review;
- To raise the profile of emergency planning within the embarking State;
- To demonstrate the commitment of the government of the embarking State to safety and particularly to emergency preparedness and response.

The major benefits of regular EPREV missions are:

- Maintain or enhance the credibility of the embarking State's emergency preparedness and response programme;
- Identify in an objective and unbiased manner the areas where improvements may be required;
- Information on best practices from the embarking State to be made available to other States;
- To provide independent assurance that the emergency preparedness and response programme is on track to establish appropriate arrangements for responding to a nuclear or radiological emergency prior to fuel delivery to the facility.

The EPREV can only be conducted with the total cooperation of the State. For the embarking State to get the most out of the appraisal, it will need to be prepared to organize meetings, describe arrangements in detail and provide documentation, tours of facilities, and access to equipment used in emergency response.

The stages of EPREV are the following:

- Receipt of a request from the government of the embarking State, leading to a memorandum of understanding between the State and the IAEA;
- Preparation of a self-assessment in line with general EPREV check lists providing the basis for the preparatory visit;
- Agreement on the scope, content and schedule of the EPREV;
- Appointment of the EPREV team;
- Gathering of information about the arrangements through meetings, interviews and survey of facilities and equipment;
- Evaluation of the information gathered by the EPREV team against predetermined criteria and the standards;
- Exit briefing by the EPREV team based on the preliminary findings;
- Presentation of the final report to the embarking State;
- A follow-up mission is to be performed subsequent to the main EPREV mission.

All team members will sign a confidentiality agreement prior to visiting the embarking State. The EPREV report will only be issued in confidence to the embarking State, unless the embarking State approves a wider distribution.

The IAEA is committed to ensuring the quality of the EPREV service. States will be encouraged to cooperate with the IAEA by requesting the EPREV and by providing experts for their conduct in other countries.

Assessment check lists given in Table 7 provide a means for States to assess their level of compliance with the international requirements [2] and guidance [4] for preparedness and response to a radiation emergency.

TABLE 7. CHECKLIST TO ASSESS LEVEL OF COMPLIANCE WITH THE IAEA REQUIREMENTS ON RADIATION EMERGENCY PREPAREDNESS AND RESPONSE CAPABILITIES

Main element	Appraisal criteria
1. Basic responsibilities	1.1. Establish a governmental body or organization (or identify an existing one) to act as a national coordinating authority (NCA)
	1.2. Clearly assign the functions and responsibilities of operators and response organizations and ensure they are understood by all response organizations
	1.3. Establish a regulatory and inspection system that provides reasonable assurance that emergency preparedness and response arrangements are in place for all facilities/practices
2. Assessment of threats	2.1. Perform threat assessments of the facilities and activities in the State, categorizing them in accordance with the five threat categories in Table I of GS-R-2 [2]
3. Establishing emergency management and operations	3.1. Make arrangements to coordinate the emergency response of all the off-site response organizations with the on-site response to include a command and control system for the local and national response to any radiation emergency
4. Identifying, notifying and activating	4.1. Establish a contact point operating 24 hours/day and 7 days/ week
	4.2. Ensure that on-site managers of scrap metal processing facilities and responsible officials at national borders are aware of the indicators of a radiation emergency and are able to take immediate actions
	4.3. Ensure that first responders are aware of the indicators of a radiation emergency and familiar with the appropriate notification procedures and other immediate actions warranted if a radiation emergency is suspected
	4.4. Establish a system for promptly initiating an offsite response in the event of a radiation emergency
	4.5. Ensure response organizations have sufficient personnel
	4.6. Make known to the IAEA and other States the country's single warning point of contact responsible for receiving emergency notifications and information from other States and information from the IAEA
5. Taking mitigatory actions	5.1. Make arrangements to provide expertise and services in radiation protection promptly to local officials and first responders responding to actual or potential emergencies involving practices in threat category IV
	5.2. Ensure that the operator of a practice in threat category IV is given basic instructions to be able to mitigate the consequences of the emergency situation
	5.3. Make arrangements to initiate a prompt search and to issue a warning to the public in the event of the loss of a dangerous source
	5.4. Make arrangements for mitigatory actions to prevent the escalation of the threat, to return the facility to a safe and stable state, to reduce the potential for release of radioactive material or exposure, and to mitigate the consequences of any actual release or exposure

Main element	Appraisal criteria
6. Taking urgent protective actions	6.1. Adopt national criteria for taking urgent protective actions in accordance with the relevant international standards
	6.2. Make arrangements for effectively making and implementing decisions on urgent protective actions to be taken off-site
	6.3. Make arrangements to ensure the safety of all persons on-site in the event of a radiation emergency
7. Providing information and issuing instructions and warnings to the public	7.1. Make arrangements to provide prompt warning and instruction to the permanent, transient and special population groups or those responsible for them, and to special facilities in the emergency zones upon declaration of an emergency class
8. Protecting emergency workers	8.1. Make arrangements for taking all practicable measures to provide protection for: 1) emergency workers in threat category I, II or III or within the precautionary action zone or the urgent protective action planning zone; 2) radiation specialists, radiation protection officers, emergency team of radiological assessors and medical personnel who may respond to radiation emergencies
9. Assessing the initial phase	9.1. Establish default operational intervention levels (OILs) for radiological emergencies
10. Managing the medical response	10.1. Make arrangements for general practitioners and emergency staff to be made aware of the medical symptoms of radiation exposure and of the appropriate notification procedures if a radiation emergency is suspected
	10.2. Make arrangements, at the national level, to provide initial treatment of people who have been exposed or contaminated
11. Keeping the public informed	11.1. Make arrangements for providing useful, timely, truthful, and consistent information to the public, responding to incorrect information and rumours, and responding to requests for information from the public and from news and information media
12. Taking agricultural countermeasures, countermeasures against ingestion and longer term protective actions	12.1. Adopt national criteria for agricultural countermeasures
	12.2. Make arrangements, concentrating on the use of existing capabilities, for taking effective agricultural countermeasures
13. Mitigating the non-radiological consequences of the radiation emergency and the response	13.1. Make arrangements for responding to public concern in an actual or potential radiation emergency
14. Conducting recovery operations	14.1 Make arrangements for transition from the emergency phase to longer term recovery operations
15.Requirements for infrastructure	15.1. Develop emergency plans that are consistent with the threat and coordinated with all response organizations
	15.2. Ensure that operating and response organizations develop the procedures needed to perform their response functions
	15.3. Provide, concentrating on the use of existing capabilities, adequate tools, instruments, supplies, equipment, communication systems, facilities and documentation

Main element	Appraisal criteria
	15.4. Identify facilities at which the following will be performed: coordination of on-site response actions, coordination of local off-site response actions (radiological and conventional), coordination of national response actions, coordination of public information, and coordination of off-site monitoring and assessment
	15.5. Make arrangements, concentrating on the use of existing capabilities, for the selection of personnel and training
	15.6. Conduct exercises and drills to ensure that all specified functions required to be performed for emergency response and all organizational interfaces for facilities in threat category I, II or III and the national level programmes for threat category IV or V are tested at suitable intervals
	15.7. Make arrangements to ensure the availability and reliability of all supplies, equipment, communication systems and facilities needed during a radiation emergency

Appendix V
IAEA PUBLICATIONS ON PREPAREDNESS AND RESPONSE FOR A RADIATION EMERGENCY

One of the statutory functions of the IAEA is to establish or adopt standards of safety for the protection of health, life, property and the environment in the development and application of nuclear energy for peaceful purposes, and to assist States to apply these standards. In addition, the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency [13] place specific obligations on the involved parties and on the IAEA. In fulfilment of its obligations, the IAEA develops Safety Standards and emergency-related publications that include:

- Safety Requirements that must be met to ensure the protection of people and the environment [2];
- Safety Guides that provide recommendations and guidance on how to comply with the safety requirements [4, 5];
- Series of emergency preparedness and response (EPR) publications that provide practical guidelines for emergency preparedness and response and discussed below.

V.1 EPR-METHOD: METHOD FOR DEVELOPING ARRANGEMENTS FOR RESPONSE TO A NUCLEAR OR RADIOLOGICAL EMERGENCY

The aim of this publication is to provide a practical resource for emergency planning, and to fulfil, in part, functions assigned to the IAEA in the Assistance Convention [13]. If used effectively, it will help users to develop a capability to adequately respond to a radiation emergency.

The EPR-METHOD [6] provides tools and information needed to develop a response capability which complies with international requirements [2]. It contains extensive guidance drawn from the lessons learned from past emergencies. The publication provides tools for conducting threat assessment, assignment of tasks (determining responsibilities) and how to meet the functional and infrastructure requirements in GS-R-2. In addition, the publication contains a description of the response to the full range of possible emergencies (concepts of operations) and action guides that detail the response actions to a range of radiological emergencies (e.g. radiological dispersal devices, improvised nuclear devices). It also provides information concerning methodologies, techniques and available results of research relating to a response to radiation emergencies. It also provides a practical, step-by-step method for developing integrated operator, local and national capabilities for emergency response.

The EPR-METHOD consists of 4 sections and 17 appendices. Section 2 reviews basic concepts and describes the overall steps to follow in order to establish an adequate emergency response capability. It also explains how to select the appropriate threat category applicable to practices in any given State. Section 3 contains a worksheet for the identification and assignment of critical tasks i.e. a list of tasks that are critical for a successful response. Section 4 contains descriptions of severe emergencies, descriptions of the ideal response to these emergencies, and detailed checklists of main elements that need to be considered by emergency planners in developing and maintaining the capability to respond to radiation emergencies. Appendices provide further elaboration or clarification:

Appendix 1: Generic Intervention and Action Levels (upgraded in Ref. [5]);
Appendix 2: Action Levels for Intervention Under any Circumstances (upgraded in Ref. [5]);
Appendix 3 Emergency Worker Guidance Levels (upgraded in Ref. [5]);
Appendix 4 Typical Threat Categories of Practices;
Appendix 5: Area and Zone Sizes (upgraded in Ref. [4]);
Appendix 6: Classification and Initial Response Actions for Emergencies at Facility;
Appendix 7: Action Guides for Radiological Emergencies (upgraded in Ref. [11]);
Appendix 8: Dangerous Quantities of Radioactive Material (upgraded in Ref. [17]);
Appendix 9: Information Needs for the Planning Process
Appendix 10: Response Time Objectives (upgraded in Ref. [4]);
Appendix 11: Urgent Protective Actions for Threat Category I and II Facilities;
Appendix 12: Outlines of Emergency Plans and Procedures;
Appendix 13: Emergency Response Organization (upgraded in Ref. [11]);
Appendix 14: Emergency Facilities and Location;
Appendix 15: Emergency Radiation Response Teams (upgraded in Ref. [11]);
Appendix 16: Radiation Protection Equipment for On-Site Emergency Workers;
Appendix 17: Categorization of Terrorist Acts and Threats Thereof.

This publication is consistent with the international requirements [2] and complements guidance in Safety Guide No. GS-G-2.1 [4], Safety Guide No. GSG-2 [5], EPR-D-VALUES [16] and EPR-FIRST RESPONDERS [11].

V.2. EPR-MEDICAL: GENERIC PROCEDURES FOR MEDICAL RESPONSE DURING A RADIATION EMERGENCY

The EPR-MEDICAL [16] is jointly sponsored by the IAEA and WHO[20] and is consistent with international requirements [2]. It builds on the Safety Report on Planning the Medical Response to Radiological Accidents [28]. The procedures of this manual are to be used at the preparedness stage to train medical personnel participating in a response to radiation emergencies.

The aim of this manual is to provide the medical community with practical guidance for medical emergency preparedness and response, describing the tasks and actions of different members of the national, regional or local medical infrastructure in accordance with international standards. The manual provides the tools, generic procedures, and data needed for dose assessment and initial medical response to radiation emergencies. It explains the roles and responsibilities of the members of the emergency medical response organization within the general response organization. This manual provides generic response procedures for medical personnel responding to different types of radiation emergencies and at the different stages of the emergency response (at the scene of the emergency, pre-hospital, hospital), and during the early post-emergency stage (about 1–2 months afterwards).

This manual is organized in sections based on an assumed medical response structure. Each section contains generic implementing procedures. Each procedure is organized in the order in which response actions will most likely be performed. Section A provides generic procedures for response initiation, Section B deals with medical management procedures, Section C contains procedures describing the first steps of emergency medical personnel on scene at the emergency (at pre-hospital level), Section D deals with the steps at the hospital level, and Section E contains procedures for dealing with psychological consequences of the emergencies. Finally, Section F provides procedures necessary for dose assessment, and

Section G describes the steps of public health response. Necessary support information is provided in the following 12 appendices:

Appendix I: Health Authority Responsibilities;
Appendix II: Immediate Public Health Response;
Appendix III: Ministry of Health Plan for Medical Response to Radiation Emergencies (Outline);
Appendix IV: Hospital Plan for Medical Response to Radiation Emergencies (Outline);
Appendix V: Medical Response Structure within Emergency Response Organization;
Appendix VI: Equipment and Supplies;
Appendix VII: Psychological Effects: Management and Prevention Considerations;
Appendix VIII: Procedure for Undressing Contaminated Victim;
Appendix IX: Plans of Reception Area in Hospital for Handling Contaminated Casualties;
Appendix X: Considerations for Response to Malicious Acts Involving Radioactive Material;
Appendix XI: International System for Medical Assistance in Radiation Emergency;
Appendix XII: Data for Internal Dose Assessment in Case of Inhalation and Ingestion of Radionuclides.

This publication is consistent with the international requirements [2] and complements guidance in Safety Guide No. GSG-2 [5], EPR-METHOD [6], EPR-D-VALUES [17], and EPR-FIRST RESPONDERS [11].

V.3. EPR-EXERCISE: PREPARATION, CONDUCT AND EVALUATION OF EXERCISES TO TEST PREPAREDNESS FOR A NUCLEAR OR RADIOLOGICAL EMERGENCY

The EPR-EXERCISE [18] builds on the practical recommendations for training drills and exercises provided in the EPR-METHOD [6].

The purpose of EPR-EXERCISE is to provide practical guidance for planners to efficiently and effectively prepare, conduct and evaluate emergency response exercises. This publication covers response exercises for emergencies involving all types of radiation practices, given in threat categories I to V. It also includes a section on special considerations for exercises for response to emergencies arising from malicious acts.

The EPR-EXERCISE focuses primarily on the process involved in preparing and controlling a large-scale exercise, i.e. a partial or full-scale exercise combined with a field exercise. In smaller scale exercises, the process is conceptually the same, but the level of effort and the time required to prepare the exercise are reduced and some parts of the process may not be required. For such exercises, the guidance provided in this publication may be used, but organizers will need to employ their judgment in deciding which steps may be downscaled or omitted.

The EPR-EXERCISE begins by introducing general concepts in the area of emergency preparedness and response and the process involved in organising an emergency exercise. It also describes the various sections of an exercise manual, which is the main tool for preparing and conducting an exercise. Examples spanning all types of radiation practices are included. The 21 appendices contain detailed examples and guides to illustrate some of the key concepts described in the main text.

This publication is consistent with the international requirements [2] and complements guidance in Safety Guide No. GS-G-2.1 [4], EPR-METHOD [6] and EPR-FIRST RESPONDERS [11].

V.4. EPR-D-VALUES: DANGEROUS QUANTITIES OF RADIOACTIVE MATERIAL

The aim of EPR-D-VALUES [17] is to provide practical guidance on the quantity of radioactive material that may be considered dangerous. A dangerous quantity (D-value) is that, which if uncontrolled, could be involved in a reasonable scenario resulting in the death of an exposed individual or a permanent injury, which decreases that person's quality of life. D-values are used as normalizing factors in generating the numerical relative ranking of sources and practices for purposes of threat assessment. Thus, the D-values are used as the basis for the IAEA's system for categorization of radioactive sources [21, 41].

The EPR-D-VALUES consists of6 sections and 8 appendices. Section 2 contains the list of the recommended D-values. Sections 3, 4 and 5 contain a summary of their basis to include the health effects, scenarios and characteristics of the radioactive material that were considered. Section 6 describes the approaches used to calculate the D-values. The 8 appendices provide dosimetric basis for assessing the onset of severe deterministic effects due to external exposure or intake of radionuclides, and deriving the D-values:

Appendix I: Reference and Threshold Levels for the Onset of Deterministic Effects
Appendix II: Scenarios for Determining D-values
Appendix III: Calculation of D-values
Appendix IV: External Dose Rate Conversion Factors
Appendix V: Inhalation, Immersion and Skin Dose Conversion Factors Used in the Expert Approach
Appendix VI: Inhalation, Ingestion, Immersion and Skin Dose Conversion Factors Used in the Risk Approach
Appendix VII: Evaluation of D-values
Appendix VIII: Characteristics of Radioactive Sources

This publication is consistent with the international requirements [2], Safety Guide No. GS-G-2.1 [4] and Safety Guide No. GSG-2 [5], and complements IAEA-TECDOC-1432 [28], EPR-METHOD [6] and EPR-FIRST RESPONDERS [11].

V.5. EPR-FIRST RESPONDERS: MANUAL FOR FIRST RESPONDERS TO A RADIOLOGICAL EMERGENCY

The EPR-FIRST RESPONDERS [11] is jointly sponsored by CTIF[30], IAEA, PAHO[34] and WHO[25] and is consistent with the international requirements [2] and the concepts contained in EPR-METHOD [6]. It builds on and replaces guidance in IAEA-TECDOC-1162 [42] in the areas of early response and first responders' actions.

The objective of this publication is to provide practical guidance for those responding within the first few hours of a radiological emergency. This includes the emergency service personnel who would initially respond at the local level and the national officials who would support this early response.

[30] Comité Technique International de Prévention et d'Extinction du Feu

This publication provides guidance to the emergency services responding to radiological emergencies. It does not address the response to emergencies involving facilities or operations for which specific emergency arrangements are required to have been developed and be in place, as required by the international requirements [2]. Guidance on response to radiological emergencies not covered in this publication can be found in Appendix 7 of EPR-METHOD [6]. This publication also does not apply to other types of hazardous materials such as chemicals or biohazards.

The EPR-FIRST RESPONDERS contains 3 chapters, 4 sections, 4 appendices and an annex. Chapter 2 of the publication covers the basic concepts and terms that must be understood to effectively use this publication and Chapter 3 describes how to apply the guidance. The remainder of the publication, Sections A, B and C, is in a form that can be easily converted into guidance for use by first responders. Appendix I contains a registry form for persons involved in a radiological emergency. Appendix II contains sample media and public media statements for different radiological emergencies. Appendix III describes those emergency preparedness and response arrangements that need to be in place to use this guidance effectively. Appendix IV contains answers to some of the frequently asked questions in case of a radiological emergency. The annex provides a brief description of the basis for the radiological criteria used in this publication.

This publication is consistent with the international requirements [2] and complements guidance in Safety Guide No. GS-G-2.1 [4], Safety Guide No. GSG-2 [5], EPR-D-VALUES [16] and EPR-METHOD [6]. The relevant parts of the EPR-FIRST RESPONDERS [11] supersede corresponding parts of the IAEA-TECDOC-1162 [42].

V.6. IAEA-TECDOC-955: GENERIC ASSESSMENT PROCEDURES FOR DETERMINING PROTECTIVE ACTIONS DURING A REACTOR ACCIDENT

The aim of this publication is to provide practical guidance and tools for accident assessment that, if implemented now, will provide a basic assessment capability needed in the event of a serious reactor accident. The IAEA-TECDOC-955 [25] provides technical procedures for determining protective actions for the public and controlling dose to emergency workers for accidents at a nuclear reactor. These include: procedures for classifying an accident, projecting consequences, coordinating environmental monitoring, and interpreting environmental data, determining public protective actions and controlling emergency worker doses. This manual describes an emergency assessment organizational structure recommended for the optimum implementation of the accident assessment procedures.

This publication is consistent with the international requirements [2] and complements guidance in Safety Guide No. GS-G-2.1 [4] and EPR-METHOD [6].

V.7. EPR-RESEARCH REACTOR: GENERIC PROCEDURES FOR RESPONSE TO A NUCLEAR OR RADIOLOGICAL EMERGENCY AT RESEARCH REACTORS

The EPR-RESEARCH REACTOR [12] provides guidance for development of emergency response procedures and implementation of an emergency plan at research reactors in threat categories II and III. A research reactor in threat category III is not expected to create a situation where members of the public beyond the site boundary are threatened by any reactor emergency. Research reactors with power levels up to about 2 MW are usually in this category. Research reactors with higher power levels are in threat category II and may threaten the public beyond the site boundary during severe emergencies [2, 4]. The difference

in affected populations creates a difference in the response organization as well as a difference in the scope of the response actions that may be required.

The publication consists of four parts. Section 1 is an Introduction to the background, objective, scope and structure of the publication. Section 2, Overview, explains how the emergency response procedures are organized, the response team structure on which the guidelines are based, responsibilities of each response team member and information to assist developing site-specific procedures from the generic procedures provided here.

The remaining two parts are labelled Part 1 and Part 2. Each part contains a complete set of generic emergency response procedures for threat category II research reactors and threat category III research reactors, respectively. Research reactors up to several tens of megawatts are covered by these generic emergency response procedures. Appendices with each Part provide supplementary information.

The emergency response procedures in each part consist of action guides that are the generic emergency response procedures for the site emergency response team positions and worksheets that may be used to assist information organization and recording during the response.

This publication is consistent with the international requirements [2] and complements guidance in Safety Guide No. GS-G-2.1 [4], No. GSG-2 [5] and EPR-METHOD [6].

V.8. EPR-PUBLIC COMMUNICATIONS: COMMUNICATION WITH THE PUBLIC IN A NUCLEAR OR RADIOLOGICAL EMERGENCY

The aim of EPR-PUBLIC COMMUNICATIONS [33] is to provide practical guidance for public information officers on the preparation for and response to a nuclear or radiological emergency, and to fulfil in part functions assigned to the IAEA in the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency [13], as well as meeting requirements stated in IAEA Safety Standards Series No. SF-1, [1], and the international requirements, [2].

This publication has two sections. Section 1 includes the background, objective, scope, structure of the contents and guidance on how this publication should be used. Section 2 covers the basic information on the Incident Command System, the public information/communication organization, public communications roles and coordination during an emergency, budget requirements for public communications, and public communications planning and preparation for an emergency. The remainder of the publication is in the form of Action Guides, Information Sheets and Appendices that give guidance and advice to Public Information Officers. A list of definitions is also included.

This publication is consistent with the international requirements [2] and complements IAEA-TECDOC-1432 [28], EPR-METHOD [6] and EPR-FIRST RESPONDERS [11].

V.9. EPR-BIODOSIMETRY: CYTOGENETIC DOSIMETRY: APPLICATIONS IN PREPAREDNESS FOR AND RESPONSE TO RADIATION EMERGENCIES

The primary objective of EPR-BIODOSIMETRY [44] is to provide the user with technical information for selecting and implementing, in a standardized manner, the appropriate

cytogenetic technique to ensure comparable dose assessment following accidental exposure to ionizing radiation. The publication describes the four possible cytogenetic methods

- dicentric chromosome assay (DCA);
- fluorescence *in situ* hybridization (FISH);
- premature chromosome condensation (PCC);
- cytokinesis-block micronucleus assay (CBMN) assays.

currently available for biological dosimetry. It is appropriate to have all these techniques readily available in main geographical regions, but, given a degree of international cooperation and networking, it is not necessary to have all of them available in each national biological dosimetry laboratory.

This publication is consistent with the Safety Guide No. GSG-2 [5], and complements EPR-MEDICAL [16].

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GLOSSARY

Definitions are taken from Ref. [7]. Definitions marked with an asterisk, however, apply for the purposes of the present publication only.

Accident
Any unintended event, including operating errors, equipment failures and other mishaps, the consequences or potential consequences of which are not negligible from the point of view of protection or safety.

Action level
The level of dose rate or activity concentration above which remedial actions or protective actions should be carried out in chronic exposure or emergency exposure situations. An action level can also be expressed in terms of any other measurable quantity as a level above which intervention should be undertaken.

Arrangements (for emergency response)
The integrated set of infrastructural elements necessary to provide the capability for performing a specified function or task required in response to a nuclear or radiological emergency. These elements may include authorities and responsibilities, organization, coordination, personnel, plans, procedures, facilities, equipment or training.

Dangerous source
A source that could, if not under control, give rise to exposure sufficient to cause severe deterministic effects**.** This categorization is used for determining the need for emergency response arrangements and is not to be confused with categorizations of sources for other purposes.

Deterministic effect
A health effect of radiation for which generally a threshold level of dose exists above which the severity of the effect is greater for a higher dose. Such an effect is described as a severe deterministic effect if it is fatal or life threatening or results in a permanent injury that reduces quality of life.

Emergency
A non-routine situation or event that necessitates prompt action, primarily to mitigate a hazard or adverse consequences for human health and safety, quality of life, property or the environment. This includes nuclear and radiological emergencies and conventional emergencies such as fires, release of hazardous chemicals, storms or earthquakes. It includes situations for which prompt action is warranted to mitigate the effects of a perceived hazard.

Emergency class
A set of conditions that warrant a similar immediate emergency response. This is the term used for communicating to the response organizations and the public the level of response needed. The events that belong to a given emergency class are defined by criteria specific to the installation, source or practice, which if exceeded indicate classification at the prescribed level. For each emergency class, the initial actions of the response organizations are predefined. The IAEA defines three emergency classes, namely (in order of increasing severity) alert, site area emergency and general emergency.

Emergency classification
The process whereby an authorized official classifies an emergency in order to declare the applicable emergency class. Upon declaration of the emergency class, the response organizations initiate the predefined response actions for that emergency class.

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

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

Emergency response
The performance of actions to mitigate the consequences of an emergency for human health and safety, quality of life, property and the environment. It may also provide a basis for the resumption of normal social and economic activity.

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

Emergency worker
A worker who may be exposed in excess of occupational dose limits while performing actions to mitigate the consequences of an emergency for human health and safety, quality of life, property and the environment.

Emergency zones
The precautionary action zone and/or the urgent protective action planning zone.

First responders
The first members of an emergency service to respond at the scene of an emergency.

Food restriction planning radius*
The distance that could be affected by emergencies at a threat category I or II facility resulting in levels of ground deposition necessitating food restrictions consistent with international standards [6].

Generic criteria*
Criteria (expressed numerically in terms of radiation dose) that form a basis for developing the operational levels needed for decision making concerning protective actions and other response actions necessary to meet the emergency response objectives. Generic criteria are based on current knowledge of deterministic and stochastic health effects (see Ref. [27] for the basis for the numerical values of the criteria addressing deterministic and stochastic health effects) [5].

Incident
Any unintended event, including operation errors, equipment failures, initiating events, accident precursors, near misses or other mishaps, or unauthorized act, malicious or non-malicious, the consequences or potential consequences of which are not negligible from the point of view of protection or safety.

Initial phase
The period of time from the detection of conditions that warrant the performance of response actions that must be taken promptly in order to be effective until those actions have been completed. These actions include mitigatory actions by the operator and urgent protective actions on and off-site.

Longer term protective action
A protective action that is not an urgent protective action. Such protective actions are likely to be prolonged over weeks, months or years. These include measures such as relocation, agricultural countermeasures and remedial actions.

Mitigatory action
Immediate action by the operator or other party: to reduce the potential for conditions to develop that would result in exposure or a release of radioactive material requiring emergency actions on or off-site; or to mitigate source conditions that may result in exposure or a release of radioactive material requiring emergency actions on or off-site.

National coordinating authority*
A governmental body or organization whose function, among others, is to co-ordinate the assessment of the threats within the State and to co-ordinate the resolution of differences and incompatible EPR arrangements between the various response organizations. This authority shall ensure that the functions and responsibilities of operators and response organizations as specified in these requirements are clearly assigned and are understood by all response organizations, and that arrangements are in place for achieving and enforcing compliance with the requirements. (from §3.4 [2]).

Notification
A set of actions taken upon detection of emergency conditions with the purpose of alerting all organizations with responsibility for emergency response in the event of such conditions.

Notification point
A designated organization with which arrangements have been made to receive notification and to initiate promptly the predetermined actions to activate a part of the emergency response.

Nuclear installation
A nuclear fuel fabrication plant, research reactor (including subcritical and critical assemblies), nuclear power plant, spent fuel storage facility, enrichment plant or reprocessing facility. This is essentially any authorized facilities that are part of the nuclear fuel cycle except facilities for the mining or processing of uranium or thorium ores and radioactive waste management facilities.

Nuclear or radiological emergency
An emergency in which there is, or is perceived to be, a hazard due to: the energy resulting from a nuclear chain reaction or from the decay of the products of a chain reaction, or radiation exposure.

Off-site
Outside the site area.

On-site
Within the site area.

Operating organization
See ‘operator’.

Operational intervention level (OIL)
A calculated level measured by instruments or determined by laboratory analysis that corresponds to an intervention level or action level. OILs are typically expressed in terms of dose rates or of activity of radioactive material released, time integrated air concentrations, ground or surface concentrations, or activity concentrations of radionuclides in environmental, food or water samples. An OIL is a type of action level that is used immediately and directly (without further assessment) to determine the appropriate protective actions on the basis of an environmental measurement.

Operator
Any organization or person applying for authorization or authorized and/or responsible for nuclear, radiation, radioactive waste or transport safety when undertaking activities or in relation to any nuclear installations or sources of ionizing radiation. This includes private individuals, governmental bodies, consignors or carriers, licensees, hospitals, self-employed persons, etc. Operator includes either those who are directly in control of a facility, or an activity during use of a source (such as radiographers or carriers) or, in the case of a source not under control (such as a lost or illicitly removed source or a re-entering satellite), those who were responsible for the source before control over it was lost.

Precautionary action zone
An area around a facility for which arrangements have been made to take urgent protective actions in the event of a nuclear or radiological emergency to reduce the risk of severe deterministic health effects off-site. Protective actions within this area are to be taken before or shortly after a release of radioactive material or an exposure on the basis of the prevailing conditions at the facility.

Protective action
An intervention intended to avoid or reduce doses to members of the public in emergencies or situations of chronic exposure.

Radiation specialist
A person trained in radiation protection and other areas of specialization necessary in order to be able to assess radiological conditions, to mitigate radiological consequences or to control doses to responders.

Radiological assessor
A person who in the event of a nuclear or radiological emergency assists the operator of a dangerous source by performing radiation surveys, performing dose assessments, controlling contamination, ensuring the radiation protection of emergency workers and formulating recommendations on protective actions. The radiological assessor would generally be the radiation protection officer.

Radiological emergency
See 'Nuclear or radiological emergency'.

Regulations
All legal provisions such as acts, legal codes or statutes and other binding rules.

Regulatory body
An authority, or a system of authorities, designated by the government of a State as having legal authority for conducting the regulatory process, including issuing authorizations, and thereby regulating nuclear, radiation, radioactive waste and transport safety.

Response organization
An organization designated or otherwise recognized by a State as being responsible for managing or implementing any aspect of an emergency response.

Severe accident
Accident conditions more severe than a design basis accident and involving significant core degradation.

Significant transboundary release
A release of radioactive material to the environment that may result in doses or levels of contamination beyond national borders from the release which exceed international intervention levels or action levels for protective actions, including food restrictions and restrictions on commerce.

Site area
A geographical area that contains an authorized facility, authorized activity or source and within which the management of the authorized facility or authorized activity may directly initiate emergency actions. This is typically the area within the security perimeter fence or other designated property marker. It may also be the controlled area around a radiography source or a cordoned off area established by first responders around a suspected hazard.

Special facility
A facility for which predetermined facility specific actions need to be taken if urgent protective actions are ordered in its locality in the event of a nuclear or radiological emergency. Examples include chemical plants that cannot be evacuated until certain actions have been taken to prevent fire or explosions and telecommunications centres that must be staffed in order to maintain telephone services.

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

Stochastic effect
A radiation induced health effect, the probability of occurrence of which is greater for a higher radiation dose and the severity of which (if it occurs) is independent of dose.

Threat **assessment**
The process of analysing systematically the hazards associated with facilities, activities or sources within or beyond the borders of a State in order to identify: those events and the associated areas for which protective actions may be required within the State, and the actions that would be effective in mitigating the consequences of such events.

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

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

Urgent protective action
A protective action in the event of an emergency which must be taken promptly (normally within hours) in order to be effective, and the effectiveness of which will be markedly reduced if it is delayed. The most commonly considered urgent protective actions in a nuclear or radiological emergency are evacuation, decontamination of individuals, sheltering, respiratory protection, iodine prophylaxis and restriction of the consumption of potentially contaminated foodstuffs.

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

ABBREVIATIONS

EAL	emergency action level
EPR	emergency preparedness and response
EPREV	emergency preparedness review
ESO	exercise scope and objectives
FRP	food restriction planning (radius)
IDM	index of dispersible radioactive material inventory
INSAG	International Nuclear Safety Group (after 2006); International Nuclear Safety Advisory Group (in 1986–2006)
NEPIO	Nuclear Energy Programme Implementing Organization
NREP	National Radiation Emergency Plan
OIL	operational intervention level
PAZ	precautionary action zone
RANET	Response and Assistance Network
SAT	systematic approach to training
UPZ	urgent protective action planning zone

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