Version 5.15

Dated: 2018-07-04

Preparedness and Response for an Emergency during the Transport of Radioactive Material

Jointly sponsored by the

XXX

Specific Safety Guide

No. SSG-x

Draft DS469

DRAFT

Status: SPESS STEP 8 – Soliciting comments by Member States

Action: --

IAEA
International Atomic Energy Agency

CONTENTS

1. INTRODUCTION 1

BACKGROUND 1

OBJECTIVE 2

SCOPE 2

STRUCTURE 3

2. NATIONAL ARRANGEMENTS AND FRAMEWORK 4

EMERGENCY MANAGEMENT SYSTEM 4

ROLES AND RESPONSIBILITIES 5

Government 5

Consignors and carriers 6

Radiological assessor 7

HAZARD ASSESSMENT 9

PLANS AND PROCEDURES 11

National plans 12

Local plans 12

Consignor and carrier plans 13

TRANSNATIONAL RESPONSES 15

3. PREPAREDNESS AND RESPONSE ELEMENTS 16

PREPAREDNESS STAGE 16

CONCEPT OF OPERATIONS 16

EMERGENCY RESPONSE PHASE 17

Urgent Response Phase 17

Early Response Phase 21

TRANSITION PHASE 22

TRAINING, DRILLS AND EXERCISES 24

4. CONSIDERATIONS FOR MODES OF TRANSPORT 26

ROAD TRANSPORT 26

RAIL TRANSPORT 27

MARITIME TRANSPORT 28

INLAND WATERWAY TRANSPORT 30

AIR TRANSPORT 31

5. INTERFACE WITH NUCLEAR SECURITY 33

CONSIDERATIONS FOR THE EMERGENCY RESPONSE WHEN A NUCLEAR SECURITY EVENT IS CONFIRMED TO BE THE INITIATING EVENT 34

APPENDIX I: FEATURES OF THE TRANSPORT REGULATIONS RELEVANT TO EMERGENCY ARRANGEMENTS 36

MATERIALS, PACKAGES AND SHIPMENTS 36

TYPES OF PACKAGES 37

Excepted packages 37

Industrial packages 38

Type A packages 39

Type B(U) and B(M) packages 39

Type C packages 40

Packages containing uranium hexafluoride (UF_6) 40

Packages containing fissile material 40

DOSE RATES AND CATEGORIES 41

MARKING OF PACKAGES 42

LABELLING OF PACKAGES 44

PLACARDING 46

TRANSPORT DOCUMENTS 46

APPENDIX II: CONSIDERATIONS FOR DEVELOPING A NATIONAL CAPABILITY 47

APPENDIX III: TYPES OF EMERGENCIES DURING TRANSPORT 51

APPENDIX IV: POSTULATED EVENTS AND POTENTIAL CONSEQUENCES FOR THE HAZARD ASSESSMENT 55

REFERENCES 64

ANNEX I: EXAMPLE EVENT NOTIFICATION FORM 67

ANNEX II: SAMPLE EMERGENCY INSTRUCTIONS 72

ANNEX III: TEMPLATE FOR THE ‘CARRIER AND CONSIGNOR EMERGENCY RESPONSE PLAN’ 77

CONTRIBUTORS TO DRAFTING AND REVIEW 81

DRAFT

1. INTRODUCTION

BACKGROUND

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

1.2. In March 2015, the IAEA's Board of Governors approved a Safety Requirements publication, Preparedness and Response for a Nuclear or Radiological Emergency, issued in the IAEA Safety Standards Series as Part 7 of the General Safety Requirements (hereinafter referred to as GSR Part 7) [2], which was jointly sponsored by thirteen international organizations. GSR Part 7 establishes requirements for an adequate level of preparedness and response for a nuclear or radiological emergency[1], irrespective of the initiator of the emergency.

1.3. IAEA Safety Standards No. SSR-6, Regulations for the Safe Transport of Radioactive Material, 2018 Edition (hereinafter referred to as the Transport Regulations) [3], establishes requirements to be complied with by the package designer, consignor, carrier and consignee. These requirements ensure a high level of safety for the transport of radioactive material. However, events during transport may occur and lead to a nuclear or radiological emergency. Advance planning and preparation are required to provide an efficient and effective response to such emergencies. Therefore, relevant national organizations should establish emergency plans to be followed in the event of an emergency during transport of radioactive material, as specified in GSR Part 7 [2].

1.4. This publication updates and supersedes the IAEA Safety Guide, Planning and Preparing for Emergency Response to Transport Accident Involving Radioactive Material (2002) [4].

1.5. Packages used for transport of radioactive material are designed in the Transport Regulations [3] with a graded approach to meet stringent requirements that include considerations of the effects on the package of prescribed accident conditions of transport. In addition, the Transport Regulations [3] stipulate control measures to be implemented during transport. Further, the Transport Regulations [3] specify requirements for design approval and shipment approval. Finally, the Transport Regulations [3] require arrangements for preparedness and response for an emergency during the transport of radioactive material.

1.6. Preparedness and response for an emergency during transport should consider all hazards that may be present. The hazards may include radiological hazards, other hazards from the shipment,

[1] Nuclear or radiological emergency: An emergency in which there is, or is perceived to be, a hazard due to (1) the energy resulting from a nuclear chain reaction or from the decay of the products of a chain reaction; or (2) radiation exposure. [2]

operational hazards at the emergency site and environmental factors. Non-radiological hazards are outside the scope of this publication.

1.7. Most emergencies during transport have limited radiological consequences and can be resolved in a relatively short period. The emergency response may last only hours or days. This publication describes emergency arrangements that may be necessary, including those relating to events of very low probability with significant radiological consequences.

OBJECTIVE

1.8. The objective of this Safety Guide is to provide guidance and recommendations to States on preparedness and response for a nuclear or radiological emergency during the transport of radioactive material.

1.9. This Safety Guide should be used in conjunction with the requirements established in GSR Part 7 [2] and the Transport Regulations [3], in order to prepare for and respond to emergencies during the transport of radioactive material[2], with due account to be taken of the recommendations provided in IAEA Safety Standards Series No. GS-G-2.1, Arrangements for Preparedness for a Nuclear or Radiological Emergency [6] (hereinafter referred to as GS-G-2.1), IAEA Safety Standards Series No. GSG-2, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency [7] (hereinafter referred to as GSG-2) and IAEA Safety Standards Series No. GSG-11, Arrangements for the Termination of a Nuclear or Radiological Emergency [8] (hereinafter referred to as GSG-11).

1.10. The guidance and recommendations provided in this Safety Guide form the basis of achieving the goals of emergency response described in GSR Part 7 [2].

SCOPE

1.11. This publication covers preparedness and response for a nuclear or radiological emergency during transport, irrespective of the initiator of the emergency. The term emergency refers to a nuclear or radiological emergency, unless otherwise specified.

1.12. The publication is limited to transport activities under emergency preparedness category IV[3], as defined in GSR Part 7 [2]. It includes guidance and recommendations for States, regulatory bodies,

[2] GSR Part 7 [2] and the Transport Regulations [3] use different definitions of radioactive material. For the purposes of this publication, the first definition of radioactive material from the IAEA Safety Glossary [5] is used, which includes all radioactive material under the definition in the Transport Regulations [3]. The term ‘radioactive material’ also includes nuclear material as defined in the Nuclear Security Series.

[3] Emergency preparedness category IV is defined as, “Activities and acts that could give rise to a nuclear or radiological emergency that could warrant protective actions and other response actions to achieve the goals of emergency response in accordance with international standards in an unforeseen location. These activities and acts include: (a) transport of nuclear or radioactive material and other authorized activities involving mobile

emergency response organizations, including consignors, carriers and consignees, for the implementation of the requirements for transport activities in emergency preparedness category IV, established in GSR Part 7 [2].

1.13. The publication does not apply to events during the transport of radioactive material that do not initiate an emergency (e.g. a vehicle involved in a minor traffic accident).

1.14. The publication does not apply to emergencies during the movement of radioactive material fully within the site boundaries of authorized facilities. Such emergencies should be addressed as part of the on-site emergency arrangements for the facility, in line with GSR Part 7 [2].

1.15. The publication does not provide guidance concerning measures specific to nuclear security, which can be found in the publications of the IAEA Nuclear Security Series.

STRUCTURE

1.16. Section 2 describes the overall national emergency arrangements and framework for preparedness and response for emergencies during transport. It defines the roles and responsibilities of States, regulatory bodies, consignors, carriers and radiological assessors. Section 3 describes preparedness and response elements, including the preparedness stage, the concept of operations, and training, drills and exercises. Section 4 describes specific considerations for each mode of transport, which can be considered in the overall context of the concept of operations described in Section 3. Section 5 describes the interface with nuclear security and provides linkages to the IAEA Nuclear Security Series.

1.17. Appendix 1 provides a synopsis of aspects of the Transport Regulations [3] that are relevant to emergency response and does not replace the Transport Regulations. Appendix 2 provides considerations for States that are developing a national capability. Appendix 3 and Appendix 4 describe the types of initiating events that could lead to an emergency as well as the possible radiological consequences. The Annexes provide samples and templates of documents described in the body of the publication, including example notification forms, sample emergency instructions and a template carrier and consignor emergency response plans.

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dangerous sources such as industrial radiography sources, nuclear powered satellites or radioisotope thermoelectric generators; and (b) theft of a dangerous source and use of a radiological dispersal device or radiological exposure device. This category also includes: (i) detection of elevated radiation levels of unknown origin or of commodities with contamination; (ii) identification of clinical symptoms due to exposure to radiation, and (iii) a transnational emergency that is not in category V arising from a nuclear or radiological emergency in another State. Category IV represents a level of hazard that applies for all States and jurisdictions."

2. NATIONAL ARRANGEMENTS AND FRAMEWORK

2.1. This section provides guidance and recommendations for establishing and maintaining arrangements for an emergency during the transport of radioactive material.

2.2. The arrangements below are meant to help Member States achieve the goals of emergency preparedness and response, as defined in GSR Part 7 [2] and are intended to support an effective governmental, legal and regulatory framework in relation to preparedness and response for emergencies during transport.

EMERGENCY MANAGEMENT SYSTEM

2.3. Consistent with the requirements in the IAEA Safety Standards series, an emergency management system should integrate all relevant elements (e.g. organizational structure, resources, policies and processes) into one coherent system, to enable the organization to set clear goals and strategies in emergency preparedness and response for any emergency during transport in an effective manner, commensurate with the results of the hazard assessment.

2.4. Since emergencies during transport may occur in any territory, this level of hazard applies to all States and jurisdictions, as defined in emergency preparedness category IV in GSR Part 7 [2].

2.5. The emergency management system should include a national coordinating mechanism designed to ensure that the roles and responsibilities of the governmental bodies and the different operating and response organizations are clearly specified, and that emergency arrangements are established in line with the graded approach.

2.6. The national coordinating mechanism should identify all the response organizations and agencies involved in emergency preparedness and response regarding transport of radioactive material, at the national and local level, including the consignors, carriers and consignees that may be foreign or international entities. The national coordinating mechanism should consider all response organizations and ensure that their roles and responsibilities are clear.

2.7. The national coordinating mechanism should include the relevant competent authorities for emergency preparedness and response and for transport safety and transport security, which may or may not be the same organization, depending on the structure of the government.

2.8. Within the national coordinating mechanism, various organizations may have distinct responsibilities concerning emergencies during transport. Where practicable, one organization should be assigned responsibility for each aspect of emergency preparedness.

2.9. Emergency arrangements should be in place for emergencies during transport involving foreign consignors and/or carriers. The arrangements of those foreign consignors and/or carriers should be compliant with national regulations and compatible with the actions of national response organizations, including issues concerning coordination and communication.

2.10. During the preparedness stage, a unified command and control system should be identified and established with clear authority and responsibility[4] to direct the response at the site during an emergency, including that of public and private response organizations that may be present for an emergency during transport.

ROLES AND RESPONSIBILITIES

2.11. During the preparedness stage, the roles and responsibilities of all organizations for emergencies during transport — including the government, the emergency response organizations (national and local), first responders, carriers and consignors — should be identified. In some cases, consignees may also have responsibilities in the event of a transport emergency.

2.12. Example roles and responsibilities are listed in this section. Since the preparedness and response actions for a transport emergency involving any class of dangerous goods have much in common, the aspects that are specific to radiological emergencies should be developed and incorporated into the overall emergency management system under the all-hazards approach.

Government

2.13. The government is required in GSR Part 7 [2] to "make adequate preparations to anticipate, prepare for, respond to and recover from a nuclear or radiological emergency at the operating organization, local, regional and national levels, and also, as appropriate, at the international level".

2.14. For an emergency during transport, the relevant governmental bodies should ensure that:

(a) Specific provisions regarding emergency preparedness and response during the transport of radioactive material are taken into account by the national coordinating mechanism, as defined in GSR Part 7 [2], which should include representatives of the transport safety competent authorities and are kept up to date.

(b) The emergency preparedness and response requirements for consignors and carriers, including foreign consignors and carriers operating within or through the State, are defined and included in the governmental, legal and regulatory framework, as appropriate.

(c) Arrangements are in place to respond to the loss or theft of radioactive material during transport. Once material has been lost during transport, it should be treated as material out of regulatory control, and appropriate guidance from publications in the IAEA Safety Standards Series and the IAEA Nuclear Security Series should be considered.

[4] This authority and responsibility typically would be assigned to the individual in the organization which has the primary role during each phase of the response. The authority may be transferred between organizations as the emergency response progresses.

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2.15. In developing emergency arrangements, the relevant government bodies, including the competent authorities for transport safety, transport security and emergency preparedness and response, should:

(a) Consider ensuring that legislation defines the areas of responsibility and the functions of the various national authorities that have expertise in transport safety and emergency preparedness and response;

(b) Ensure that the national coordinating mechanism includes relevant transport safety competent authorities;

(c) Define the responsibilities of national and local governments for emergencies during transport, which may occur anywhere in the territory;

(d) Identify carriers, consignors and consignments regularly transiting the State so that the State will be able to conduct an accurate hazard assessment;

(e) Ensure that radiation protection services and any required technical expertise (e.g., package experts, radiological assessors) are available in case of an emergency during transport;

(f) Identify the authorities and organizations to be notified when an emergency occurs during the transport of radioactive material and establish notification procedures;

(g) Require periodic review, testing and updating of response organization plans, which may include private organizations under the overall responsibility of the consignor;

(h) Establish proper training, drill and exercise programmes;

(i) Consider establishing arrangements with the governments in relevant States, including neighbouring States, for emergencies that may extend beyond national boundaries;

(j) Specify the responsibility for the provision and coordination of public information in the event of a transport emergency, including the role of the consignor and carrier.

2.16. Local governments should develop emergency arrangements based on the national requirements and the national hazard assessment. These arrangements should address: the ability to recognize a consignment of radioactive material; being familiar with basic safety precautions; knowing whom to notify. They should include the deployment and operation of the local government's own resources. The elaboration of these arrangements should be coordinated between the local and national governments.

Consignors and carriers

2.17. The consignor has the primary responsibility for ensuring that adequate emergency arrangements are in place for a given shipment of radioactive material, in accordance with the national

emergency arrangements of all the States relevant to the shipment. In some cases, such as air transport, when the consignor may not know the exact route, some aspects of this responsibility may be assigned to the carrier. The States relevant to the shipment can include:

(a) the flag State of the conveyance;

(b) the State of the consignor and that of the consignee;

(c) States with land, air or territorial waters through which the shipment transits.

2.18. The consignor should ensure that, before undertaking the transport of radioactive material, carriers are provided with the instructions to be followed in case of a transport emergency. An example of guidance that can be given to a carrier prior to undertaking the transport of radioactive material is provided in Annex II.

2.19. The consignor should, when appropriate, provide instructions for any specific environmental considerations relevant to the shipment and its route.

2.20. The consignor should make arrangements with relevant organizations, which could include private companies, to ensure that emergency arrangements are in place throughout the duration of the transport, through all territories, taking account of the possibility of multiple modes of transport for one shipment. These arrangements should be applied in a graded approach, considering the consignment and based on distances, languages, applicable jurisdictional requirements or other factors of the shipment. The overall responsibility remains with the consignor.

2.21. The carrier should ensure that written emergency instructions applicable to the material being transported are carried on board the conveyance. In addition, efforts should be made by the carrier to ensure that this emergency information will be available to the first responders, even if the carrier personnel are incapacitated.

2.22. During an emergency, the consignor and/or the carrier may need to communicate with the media and the public. When required, the information should be shared between the different authorities and response organizations involved, before being published, to help provide correct and consistent information [9].

Radiological assessor

2.23. In some events, emergency services for conventional emergencies may be sufficient to respond to the emergency. When it is suspected that the integrity of the package may have been compromised, a radiological assessor with specialized expertise may be needed to respond to the emergency. The role of the radiological assessor[5], either a person or a team, is to perform radiological

[5] Depending on the situation and the national arrangements, the radiological assessor may come from government, technical support organizations or consignors and carriers.

surveys, perform dose assessments, control contamination, ensure the radiation protection of emergency workers and the public and formulate recommendations on protective actions and other response actions. This role may be fulfilled remotely or at the emergency site, depending on the emergency situation.

2.24. As part of the emergency arrangements, a trained and equipped radiological assessor should be available to assess the radiological consequences of an emergency. Radiological assessors should be trained and qualified in their necessary functions, including radiation safety, assessing containment, radiation and contamination measurements and emergency response. Depending on the results of the hazard assessment, the radiological assessor may also need to be trained in the prevention of criticality.

2.25. Capabilities to communicate with the radiological assessors should be continuously available so that they can be notified of an emergency requiring their expertise.

2.26. If required under the emergency arrangements, the radiological assessor should be able to reach the site of the emergency within an appropriate response time, based on the hazard assessment and defined in the emergency arrangements. This could be achieved by identifying teams and equipment across the territory, or by having a pre-identified means of transport for a centralized team and its equipment, to ensure the timely movement from their location to the site of the emergency.

2.27. The radiological assessor should be authorized, prepared and equipped to:

(a) Travel to the site, if required, with the appropriate equipment, within the time specified in the emergency arrangements;

(b) Integrate into the existing emergency response and coordinate with other response organizations;

(c) Operate in emergency conditions, if required, while being protected from radiological and non-radiological hazards;

(d) Evaluate the radiological hazard resulting from the radioactive material through measurements, observations, sampling and other methods, as required;

(e) Advise on the appropriate steps to minimize the exposure of persons to radiation and/or radioactive material;

(f) Minimize the spread of radioactive contamination;

(g) Assess the current status of the package safety functions and the prognosis of their condition;

(h) Provide technical information and advice to the appropriate authorities and response organizations that would help in the emergency response.

HAZARD ASSESSMENT

2.28. GSR Part 7 [2] requires that the government "shall ensure that a hazard assessment is performed" and that the potential hazards associated with an emergency during the transport of radioactive material should be identified. The potential consequences of an emergency should be assessed to provide a basis for establishing arrangements for preparedness and response to an emergency. The hazard assessment should include identifying potential initiating events that need to be considered and their potential consequences on individuals, property and the environment. The hazard assessment provides the basis for a graded approach and allows the development of emergency arrangements commensurate with the potential consequences.

2.29. The hazard assessment should be based on information from the consignor, the carriers (for all modes of the transport), the operators of in-transit storage facilities, the first responders, local governments and competent authorities.

2.30. The potential consequences of the identified hazards should be assessed, including radiation hazards and hazards not related to radiation that may impair the emergency response. This should include, but should not be limited to, an evaluation of external dose rates and the potential intake of radioactive material, and the individual doses that could be received.

2.31. There are multiple values of sources used for the transport of radioactive material and emergency preparedness and response. The A1 and A2 values defined in the Transport Regulations are used "to determine the activity limits for the requirements of these Regulations" [3]. Similarly, in emergency preparedness and response, D values have been developed to specify the radionuclide specific activity of a source which, if not under control, could cause severe deterministic effects for a range of scenarios that include both external exposure from an unshielded source and internal exposure following dispersal of the source material [10]. The A1 and A2 values should be used to determine required package types, with the goal of applying the graded approach of the Transport Regulations [3] to shipments and withstanding accident conditions of transport, as appropriate. D values should be used for determining the extent of the necessary emergency arrangements according to the graded approach for emergency preparedness and response in line with GS-G-2.1 [6].[6]

2.32. The different types of packages and their radioactive contents transported within or through the State should be considered when completing or revising the hazard assessment. The events leading

[6] The graded approach to the requirements for package design and classification, as described in the Transport Regulations [3], has been developed in part to limit the exposure of emergency workers in an effort to prevent relevant dose limits from being exceeded.

to single or combined failures of the package safety functions (e.g. containment, protection against external radiation, prevention of damage caused by heat, prevention of criticality), risks arising from the transport infrastructure and the risk of human error should be considered in the hazard assessment.

2.33. For the assessment of identified hazards, other external conditions that could hinder or impair the response capability should be taken into account when their combination with an emergency during transport is foreseeable. These include:

(a) a conventional emergency (e.g. earthquake, hurricane, flood, severe weather at sea);

(b) another simultaneous emergency affecting a nearby facility;

(c) non-radiological hazards arising during the transport emergency.

2.34. Foreseeable events, even with low probabilities, where the package can be compromised beyond the design requirements should be considered in the hazard assessment. Events of this type include:

(a) Operational errors arising from human and organizational factors in package preparation, resulting in excessive dose rates. Examples include errors in primary conditioning, forgetting to engage a closure bolt and missing complementary shielding;

(b) Exceptional environment loadings, such as: tunnel fires; burying in soft soil and covering with debris; high energy crushing (exceeding the energy of the 9 metre drop test); sharp punching (e.g. impact from a forklift truck), an airplane crash (except Type C packages);

(c) Malicious acts that may impact the integrity of the package.

2.35. Modalities of transport should also be considered when identifying initiating events and potential consequences. These include the route, nearby infrastructure, terrain, distance, timing, seasonal weather and sensitive environments (e.g. local food and water supplies). Additional factors, including the frequency of transport (e.g., shipments that occur once every 20 years), may be used to apply the graded approach to identifying the planning basis for emergency preparedness and response.

2.36. A periodic review of the hazard assessment should be undertaken to ensure that any major change in transport activities is adequately considered, and that existing arrangements remain appropriate, taking into account any information obtained from the use or the testing of the emergency arrangements.

PROTECTION STRATEGY

2.37. GSR Part 7 states that the “government shall ensure that, on the basis of the hazards identified and the potential consequences of a nuclear or radiological emergency, protection strategies are developed, justified and optimized at the preparedness stage for taking protective actions and other response actions effectively in a nuclear or radiological emergency” [2].

2.38. The government is required to ensure that "interested parties are involved and consulted, as appropriate, in the development of the protection strategy" [2], including regulatory bodies, consignors and carriers.

2.39. Protective actions for emergencies during transport should be consistent with those for other nuclear or radiological emergencies and should be based on the identified reference level, described in terms of residual dose, and generic criteria, expressed in terms of projected dose or received dose [2, 7, 11].

2.40. Operational Intervention Levels (OILs) for radiological emergencies are provided in GSG-2 [7]. As described in Section 3, OILs can only be used in conjunction with other observables and indicators to initiate an emergency response. Exceeding an OIL value should not be used as the sole basis for initiating an emergency response. In some rare cases, such as the active monitoring of the temperature of shipments, Emergency Action Levels (EALs) may also be used to initiate an emergency response.

2.41. In accidents during transport, dose rate measurements in excess of the OILs should not be used as a justification to declare an emergency class and trigger emergency response actions. When dose rate measurements show that OILs are exceeded, they should be compared with the measurements recorded at the beginning of the shipment process (e.g. transport index) and other observables and indicators to help identify abnormal conditions and trigger emergency response actions, if appropriate.

2.42. As part of the protection strategy, cordoned off areas should be established based on the guidance in GSG-2 [7]. States may establish specific cordon area distances to be implemented in an emergency for radioactive material regularly transported in their territory.

2.43. In case of recurring international shipments, governments should harmonize protective strategies for similar postulated emergencies when practicable.

PLANS AND PROCEDURES

2.44. The national arrangements for emergency preparedness and response relating to transport should incorporate the responsibilities of both domestic and regular foreign consignors and carriers, as applicable. The emergency arrangements of the consignor and the carrier should be consistent with the national arrangements of all the States relevant to their shipments.

2.45. At the national level, emergencies during the transport of radioactive material should be addressed in the national radiation emergency plan (NREP) [6]. The NREP should include the results of the hazard assessment and either include or make reference to the protection strategy.

2.46. Consignors and carriers are required by the Transport Regulations [3] to have emergency plans and procedures for their shipments in place. These plans and procedures should be commensurate with the hazard assessment.

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2.47. Additional plans and procedures should be developed for specific shipments. This will depend primarily on the material being transported. These plans and procedures should be consistent with the existing plans and procedures.

2.48. Emergency arrangements for all organizations should be coordinated and integrated with the arrangements for the response to a nuclear security event during the transport of nuclear or radioactive material [12, 13].

2.49. All response organizations should ensure that their plans are consistent and compatible with other response organizations. A process to ensure that any changes to existing plans are communicated to affected organizations should be developed.

National plans

2.50. There does not need to be a separate national plan for emergencies during transport. In some countries, the NREP may be part of the all-hazards emergency plan [14].

2.51. The emergency arrangements relating to transport should address all the required topics for a national radiation emergency plan as required in GSR Part 7 [2]. These are:

(a) The planning basis and the hazard assessment;

(b) Responsibilities, capabilities and duties of the organizations involved;

(c) Procedures for alerting and notifying key organizations and persons;

(d) Methods of providing public information, including warning and informing;

(e) Generic criteria, EALs, OILs and observables and indicators;

(f) Protective actions and other response actions for human life and health, property and the environment;

(g) Protection of emergency workers and helpers;

(h) Resources for medical support;

(i) Training, drills and exercise programme;

(j) Procedures for reviewing and updating plans and procedure;

(k) Procedures for response actions involving recovering a package.

Local plans

2.52. The local authorities with a role in responding to emergencies during transport should develop a plan to enable emergency response functions to be performed. The emergency arrangements relating to transport should address all the required topics, including:

(a) A list of emergency response facilities in the local area, consistent with the national

hazard assessment and planning basis;

(b) The responsibilities, capabilities and duties of the organizations involved, including the allocation of tasks and responsibilities during the response, and the responsibility for management of local operations; the procedures for requesting information and support from the consignor and the carrier in order to bring the packages under control;

(c) The procedures for alerting and notifying key organizations and persons, including the fire brigade, emergency medical service, radiological assessors, police and any other experts;

(d) Arrangements for the provision of public information, including warning and informing the public and links with the media;

(e) The procedures for response actions, including the means of communicating with organizations involved in the response, and the conditions for terminating an emergency [8];

(f) The resources for medical support and managing the medical response;

(g) The procedures for training, drills and exercises;

(h) Arrangements for analysing the emergency response;

(i) Maintenance of the emergency plan.

Consignor and carrier plans

2.53. At the operating organization level, emergency plans for responding to nuclear or radiological emergencies during transport of radioactive material should conform as closely as possible to the plans and procedures for the transport of other dangerous goods and for conventional emergencies. The plans should be integrated with the plans for other nuclear or radiological emergencies and conventional emergencies, as appropriate. These plans should be reviewed and approved by the regulatory bodies.

2.54. Consignors and carriers conducting international shipments should ensure that their emergency arrangements are compliant with the requirements of each State through which they conduct shipments.

2.55. Consignor and carrier emergency plans should be reviewed and updated regularly within a defined frequency to include any experience gained. The plan should be modified as appropriate based on any updates to the NREP, regional emergency plan or local emergency plan and also to take account of the results of drills, exercises and actual emergencies, or when the nature of transport activities changes. In addition, the contact information of personnel and organizations should be kept up to date. To simplify the frequency of updating, names and communication details should be included as an annex to the plan.

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2.56. As required by the Transport Regulations [3], consignors and carriers should develop plans and procedures, as appropriate, for emergencies during transport of radioactive material, commensurate with the hazard assessment. The arrangements should be documented in a formal plan that is available to competent authorities. Consistent with GSR Part 7 [2], the plans and procedures should include, but are not limited to:

(a) A description of the shipments covered under the plan;

(b) The initiating events that can be envisaged;

(c) The responsibilities of response organizations involved in the transport, such as consignors, carriers, in-transit facilities, package designer, package owner and other subcontractor(s) employed during the preparedness stage or during an emergency response;

(d) The procedures for identifying an emergency and notifying, in particular, the public safety authorities when the carrier is incapacitated or unavailable;

(e) The coordination with public safety authorities;

(f) Any technical support that can be provided, including equipment that can be deployed to the site area of the event for:

(i) Assessment, e.g. leak tightness, dose rates, contamination, meteorological data;

(ii) Mitigation, e.g. complementary shields, tarpaulins, replacement of damaged components, overpack, recovery of contaminated items;

(iii) Package recovery, including specific means, e.g. means of lifting, trailers, tie-down system, escort; and a strategy for locations or facilities that can receive damaged packages;

(g) The likely response actions (including instructions from the consignor to the carrier and emergency response organizations);

(h) The response procedures and time frames;

(i) The means of communication, documentation and recording;

(j) Templates and checklists for the activities of the assigned transport operator during emergency response;

(k) Quality management programme for emergency preparedness and response;

(l) Training, drill and exercise programme.

2.57. The plan should cover all phases of the response to an emergency, from:

(a) the emergency response phase, including initial response actions, up to

(b) the transition phase, which includes preparation for timely resumption of normal social and economic activity [8].

TRANSNATIONAL RESPONSES

2.58. Appropriate communication and coordination systems should be used by all response organizations when establishing emergency arrangements and when responding to transport emergencies, taking into account the possibility of different nationalities of the response organizations. The systems should include the designation of emergency contact points and mechanisms for communication.

2.59. All response organizations involved in an emergency that may occur during international transport should be aware of the notification process required by the relevant national and local authorities of the State where the emergency may occur, e.g. the means of communication, the language to be used and the persons to be contacted. In particular, the consignor should be able to contact the authorities concerned quickly, to provide information, advice and assessments as necessary.

2.60. Consignors and carriers operating internationally need to take into account the national legislation, regulations and requirements of all States in which they operate. The consignor should ensure that the transport documents are written in languages readily understandable by all the response organizations involved in emergency response, e.g. carriers, national and local authorities, operators of in-transit facilities and the consignee.

2.61. Consignors should make arrangements with organizations in other countries, as appropriate, to ensure the efficiency and effectiveness of arrangements and to comply with national requirements, such as language requirements.

2.62. The development of emergency arrangements should take into account that the consequences of an emergency may cross national borders, even if the shipment did not, consistent with the hazard assessment as described in this section. Protective actions and other response actions should be harmonized, to the extent practicable, across national borders.

2.63. If frequent or recurring international shipments are planned, States may consider establishing bilateral or multilateral agreements specifying emergency arrangements. These agreements may include arrangements for cross border deployment of personnel and resources to ensure that appropriately qualified personnel are permitted to respond across borders. They may also include provisions for advance exchange of information, results, findings and instructions intended for the public.

DRAFT

3. PREPAREDNESS AND RESPONSE ELEMENTS

3.1. This section provides guidance on how an emergency response could be planned for and implemented. It covers areas that should be considered when developing emergency arrangements. Preparedness for transport emergencies should cover a broad range of scenarios. The range of postulated emergencies should therefore be identified at the national level and be based on a hazard assessment, as discussed in Section 2, for the types of shipments in its national territory.

PREPAREDNESS STAGE

3.2. The development of emergency arrangements should be completed prior to transport, in accordance with the graded approach stipulated in GSR Part 7 [2]. These emergency arrangements should take into consideration the actions that need be performed in the event of an emergency, and the resources that may be needed for the emergency response.

3.3. Unique shipments that go beyond those addressed in the national hazard assessment require specific emergency arrangements.

CONCEPT OF OPERATIONS

3.4. The concept of operations[7] is a brief description of an ideal response to a postulated emergency, used to ensure that all the personnel and organizations involved in the development of emergency response capabilities share a common understanding.

3.5. The concept of operations can be used by emergency planners to develop or revise their national concept of operations, covering the topics below and incorporating their national planning basis and response organizations.

3.6. In order to achieve the goals of emergency response described in GSR Part 7 [2], and in addition to other objectives not specific to transport, the following objectives should be considered when responding to nuclear or radiological emergencies during transport:

(a) Establish and control the site area[8];

(b) Identify the hazards of the radioactive material involved;

(c) Mitigate the consequences (e.g. fight the fire, contain the spill);

(d) Restore the package(s) to a safe and stable state;

[7] In addition to the description of the ideal response, some steps of the described response include additional clarifications to better understand those steps.

[8] The site area is defined as, “A geographical area that contains an authorized facility, authorized activity or source, and within which the management of the authorized facility or authorized activity or first responders may directly initiate emergency response actions.” (GSR Part 7 [2])

(e) Recover the radioactive material, package and conveyance;

(f) Prepare to re-open the transport route to normal activity, including any required decontamination.

3.7. The concept of operations set out below describes a series of actions; however, the sequence of these actions would depend on the emergency conditions. It should also be considered that there may be little or no time from the initiating event to accident progression, and that the situation may have deteriorated when the responders arrive at the site.

3.8. This publication focuses on hazards from radioactive material. In some cases, other hazards may be present at the site area and may be the primary factor in determining response actions. The concept of operations should be applied in the context of plans and procedures for other hazardous materials and dangerous goods.

3.9. In some cases, such as uranium hexafluoride (UF_6), the radioactive material may also present chemical hazards which outweigh the radiological hazards.

EMERGENCY RESPONSE PHASE

Urgent Response Phase

3.10. Once the initiating event has occurred and the emergency class has been declared, pre-planned procedures based on the concept of operations should be implemented to make the appropriate notifications and initiate the emergency response.

3.11. The initial response to an emergency during transport should be based on observable criteria and other indicators.

3.12. Carriers who are at a transport accident and first responders arriving at the site area should identify observable conditions that could indicate an emergency situation. Any observable indication that a radiological emergency may be present should be acted upon, and response procedures should be activated. An emergency class should be declared if there is a visible loss of containment or shielding integrity, or if a radiation reading taken by a qualified individual with an appropriate radiation instrument confirms that radiation levels are higher than should be expected.

3.13. Emergency workers should consider the possibility that external damage to a container or package of radioactive material does not necessarily mean that the interior packaging component containing the radioactive material or providing shielding has been damaged or breached. Nevertheless, external damage is an indication that an emergency response should be activated, and the package should be examined by qualified personnel. Leaking liquids, gases or powders may indicate that package integrity has been compromised.

DRAFT

3.14. An emergency response should also be activated, even without any visible indication of external damage, when the accident conditions are still developing and might lead to serious damage to package functions (e.g. in case of a fire that could not be extinguished in a timely manner).

3.15. In addition to the notification points for the emergency services, the consignor's notification point should be listed on the transport documents or identified through other means, such as national programmes. In the event that a carrier is unable to make the initial notification, for example because of injury or death, first responders may do so.

3.16. Initial responding organization(s), which could be first responders or the carrier, should, without delaying notifications, carry out an initial assessment by considering the following observable criteria (Annex I provides additional information):

(a) The location of the emergency;

(b) Available information regarding the affected area, including its geography (e.g. hilly terrain, plains), population, infrastructure or special environmental concerns;

(c) Site accessibility;

(d) The nature of the initiating event (e.g. collision, fire, submersion);

(e) Injuries to people;

(f) Meteorological conditions;

(g) Labels, markings, placards, UN numbers or transport documents;

(h) Other dangerous goods or other hazards present in the immediate vicinity of the accident site, such as:

(i) Large quantities of flammable liquids or gases;

(ii) Explosive material;

(iii) Toxic or corrosive materials;

(i) Any indications that the containment of any of the packages has been breached;

(j) Any indications that the emergency was initiated by a malicious act.

3.17. The emergency response should be coordinated between response organizations based on the required level of emergency response and pre-planned emergency arrangements. The initial notification will likely be general in nature; however, further assessment may be needed to determine the resources and technical expertise that may be required (e.g. criticality safety).

3.18. After the initial notification, notification points should activate the appropriate response organizations, including any experts that may be needed to assess the situation, such as radiological assessors, either at the site area or remotely.

3.19. If the emergency has, or is likely to have, transnational radiological consequences of safety significance, the competent authority of the Accident State identified under the Convention on Early Notification of a Nuclear Accident [1] is obligated to notify the IAEA and potentially affected States.

3.20. Emergency workers should access and review the transport documents, which provide information on the radioactive material and the package(s) being transported and, if available, they should be used to determine the number of packages, activities and radionuclides that could be present. The documents provide information that may be used to help determine the extent of the emergency and the expertise needed to respond to the emergency. Consignors/consignees and carriers should make arrangements so that transport documents can be promptly available to emergency response organizations, on request.

3.21. Consistent with the guidance provided in GS-G-2.1 [6], first responders and other emergency response organizations should:

(a) Ensure that saving lives and administering first aid is the highest priority. First responders should be trained and given information on the precautions to take while performing first response duties in a radiological and/or contaminated environment.

(b) Ensure that mitigatory actions, such as firefighting, are not delayed by the presence of radiological hazards. Response actions such as suppressing fires and dealing with flammable, explosive and toxic materials may take priority before any assessment of package integrity can or should be made.

(c) Establish a unified command and control system for emergency response under the all-hazards approach as part of the emergency management system. For transport emergencies, this may include the consignor or carrier.

(d) Check that all relevant response organizations have been effectively activated and have established appropriate communication channels.

3.22. Emergency workers should organize the site area consistent with the guidance provided in GS-G-2.1 [6]. Additional considerations may determine the exact definition and location of specific areas:

(a) Checkpoints and command posts should be set up, upwind of the damaged package(s) and out of potential spill areas.

(b) Inner cordoned off areas should be established immediately, for protection of the public and responders. These areas should encompass all packages or containers of radioactive material that may have been ejected from a vehicle as a result of an accident. The location of the ejected packages and operational factors may necessitate creating multiple inner cordoned off areas or one larger inner cordoned off area.

DRAFT

(c) Cordoned off areas and security perimeters should be re-established and periodically verified.

3.23. Emergency workers should consider all material released from the package to be hazardous unless and until otherwise determined by a radiological assessor.

3.24. Package integrity may have failed, even if there are no visible indications of this; it can only be determined by a radiological assessor using appropriate instruments. All packages involved in an accident should therefore initially be treated with caution.

3.25. The radiological assessor should assess the status of the package(s), including all of its safety functions: containment, shielding, heat dissipation and criticality safety, if applicable. The package design approval, which defines the design of the package, may be used, when available, to help the radiological assessor to assess the integrity of the package functions. Note that, if firefighting agents containing water have been used in proximity to fissile material, radiological assessors should include this information in their criticality safety assessment.

3.26. Instruments, equipment and other supplies needed for mitigatory actions should be identified and made available so that they can be used expeditiously in an emergency, as required in the Transport Regulations [3]. Mitigatory actions for damaged packages include:

(a) Using plugs, tarpaulins and leak-tight overpacks for plugging and containing leaks and preventing the spread of contamination;

(b) Using additional shielding, as required;

(c) Allowing packages to cool if they have been involved in a fire or if the heat dissipation system is damaged;

(d) Recovering dispersed fissile material in special containers that have a safe geometry and are watertight. Ensure that there is appropriate spacing between groups of packages containing fissile material.

3.27. Depending on the location of the emergency and operational considerations, damaged package(s) may be transferred to an acceptable interim location, following an assessment by qualified personnel and with due precautions. However, the package(s) should not be forwarded to any other location until they have been repaired, reconditioned and decontaminated, as appropriate, by qualified personnel [3].

3.28. Radiological monitoring should be conducted as soon as possible during the emergency response to confirm the presence or absence of radiological consequences caused by the initiating event. The type of instrumentation selected for monitoring a specific site area should be based on the radionuclides likely to be present.

3.29. Dose rate measurements can be compared to the transport index to determine whether the package shielding has been damaged. For example, if a reading greater than 100 μSv/h (0.1 mSv/h) is observed at a distance of more than one metre from a single package containing radioactive material, it is likely that the package shielding has been compromised. Note that this may not apply to shipments under exclusive use or to shipments where multiple packages are present.

3.30. During the urgent response phase, a thorough assessment of the radiological conditions at an emergency site may not be possible. A proper assessment of the situation may be an extended process, especially in cases involving the contamination of persons, objects and the environment.

3.31. Information concerning radiation levels, loss of shielding and any release of radioactive material from a container or package will typically only be obtained once radiation monitoring equipment is available. Any emergency workers in possession of suitable radiation monitoring equipment — whether first responders or other emergency workers — should be trained on dose rate and contamination limits for the safety of personnel.

3.32. Additional protective actions may be considered as a result of the loss of containment or shielding of the package(s), including:

(a) Control of access to and egress from the site area;

(b) Protective actions within the cordoned off area (e.g. sheltering or evacuation);

(c) Personal protective actions;

(d) Decontamination of persons;

(e) Controlling potentially contaminated food and water supplies;

(f) Protection of the local drainage system and/or area.

3.33. During an emergency, the public should be informed of the potential hazards and about what is being done to ensure public safety and to protect the environment. There should be no delays in providing this information, which could jeopardize the effectiveness of protective actions [9].

3.34. To minimize the risk of conflicting statements being issued to the news media, the responsibility of communicating with news media representatives should be coordinated by a designated individual or organization [9].

Early Response Phase

3.35. Prompt and continuous assessment of radiological hazards and related hazards should be carried out by the radiological assessor:

(a) To prevent the escalation of the emergency;

(b) To return the site area to a safe and stable state;

DRAFT

(c) To reduce the potential for, and to mitigate the consequences of, radioactive release or exposures;

(d) To identify and obtain any additional expert support needed (e.g. chemical toxicity, medical).

3.36. Emergency plans and procedures should address how the news media and the public will be provided with information. For any accident involving radioactive material, concerted efforts should be made to keep the news media and the public well informed of the situation at all times. The public should be made aware of any protective actions that are recommended and the efforts that are being made to transition the site area back to its original condition [9].

3.37. Depending on the type of consignment, the mode of transport and the severity of the accident, response organizations should consider that early protective actions may be necessary. These can include restrictions on the consumption of food, milk and drinking water, and from using commodities other than food that may be contaminated, where OILs may be exceeded.

3.38. If the drinking water supply is suspected of being contaminated by dispersed radioactive material, it should be tested for contaminants. Similarly, in an emergency in or near a waterway where there is suspicion that radioactive material may have been released the water should be tested for possible contamination.

3.39. Radiation monitoring should be based on the hazards from the emergency, as well as radiation and/or contamination levels that are present. Monitoring should be routinely performed during the emergency to ensure:

(a) that any protective actions and other response actions are still valid or are adjusted according to changing circumstances, and that the most vulnerable members of the public are protected, based on pre-established OILs;

(b) that consideration is given to locating people, vehicles and goods that may have left the affected area.

TRANSITION PHASE

3.40. An emergency during transport can require transition to either a planned exposure situation or an existing exposure situation, following the emergency exposure situation, depending on the circumstances [2, 8, 11].

3.41. The transition phase “commences as early as possible once the source has been brought under control and the situation is stable; the transition phase ends when all the necessary prerequisites for terminating the emergency have been met” [8].

3.42. GSG-11 states, “To a great extent, the transition from the emergency exposure situation in areas off the site will be subject to confirmation by the operating organization that the respective

prerequisites have been fulfilled on the site" [8]. For an emergency during transport, the primary responsibility for ensuring that relevant prerequisites are met at the site lies with the consignor, although specific emergency arrangements may be made during the preparedness stage for the carrier, consignee or other private company to manage these actions.

3.43. The following aspects should be considered by the consignor and off-site response organizations during a transport emergency to help determine whether the necessary prerequisites for termination of the emergency have been met, consistent with the guidance and recommendations provided in GSG-11 [8]:

(a) All radioactive material and all packages have been brought under control and are in a safe and stable condition. In some extreme situations, such as foundering in deep water, it may not be feasible to recover the packages. In such situations, an assessment of safety and stability should still be conducted and the decision should be taken about whether or not to attempt recovery of the packages.

(b) Appropriate sites to receive the recovered items have been identified.

(c) The movement of all packages and radioactive material from the site, including the appropriate transport documents, has been prepared; any required authorization has been applied for; and any necessary logistical arrangements have been made.

3.44. When assessing the stability of the exposure situation, the consignor, in cooperation with any required technical experts (e.g. package designers), should assess the likely development of the situation in the future. This may include, for example, corrosion of a package's containment system after it has been submerged for an extended period.

3.45. In some cases, contamination levels may be high enough to warrant specific actions before terminating the emergency. When appropriate, several decontamination and restoration methods may be employed during the transition phase, including:

(a) Washing or vacuum sweeping roads and other objects and surfaces. This can be done with firefighting or industrial equipment; the water should be collected and disposed of safely.

(b) Washing and cleaning hard surfaces and equipment using water and appropriate detergents or other chemicals, and safely disposing of the liquids collected.

(c) Fixing contaminants using paints, strippable plastics and paving materials such as asphalt. Depending on the type of radioactivity involved, the fixing agent may be removed after it has solidified or it may be left in place.

(d) Removing or resurfacing of contaminated road surfaces or removing of contaminated soil.

DRAFT

TRAINING, DRILLS AND EXERCISES

3.46. The government should ensure that all relevant personnel who are likely to be involved in an emergency response receive training at an appropriate level, based on an assessment of the types of radioactive material that are transported in their response region or the types of radioactive material they may be required to deal with. Training programmes should be established for police, fire brigades, emergency medical services, radiological assessors, technical experts and representatives of the relevant authorities, based on their response roles and functions.

3.47. First responders who would be arriving first on the site area should receive training that, at a minimum, will enable them to recognize and identify an emergency involving radioactive material, implement protective actions, use personal protective equipment and notify the appropriate authorities.

3.48. Persons engaged in the transport of radioactive material should receive additional training commensurate with their responsibilities in the event of an emergency during transport [3].

3.49. All training should include information on implementation and communication within a unified command and control structure.

3.50. Provision should be made for periodic refresher training to maintain the proficiency of personnel involved in the emergency response, and to review past emergencies.

3.51. Drills are more limited in scope than exercises, and should be developed to maintain the skills of response personnel. Drills for shipments that have little to no potential to cause adverse radiological consequences should nevertheless test, at a minimum, notification procedures and channels, verification of the integrity of the package and re-packaging. In this case, there would be minimal interaction, or even no involvement whatsoever, from other response agencies.

3.52. Drills for shipments that may have radiological consequences but that would not exceed an OIL as a result of an incident or accident should be designed to test and maintain the skills of first responders and other response personnel.

3.53. Exercise programmes should be developed and implemented to ensure that scenarios involving shipments requiring a sizeable and resource intensive emergency response component are tested on a regular basis. These shipments may have the potential to exceed an OIL: the exercise programmes should therefore be designed to test all organizational interfaces, be based on a graded approach and include the participation of all the organizations concerned. The exercises should be systematically evaluated, and some of the exercises should even be evaluated by the appropriate regulatory body. Plans and procedures should be subject to review and revision based on exercise evaluation reports.

3.54. Radiological assessors and response organizations that have personnel with expertise in radiation protection or nuclear applications, and that may be called upon for technical support and response in the event of a transport accident, require a more extensive training programme. They

should be trained on the following on a regular basis, as appropriate for their assigned roles and responsibilities:

(a) Accident assessment techniques using radiological monitoring instruments, if field measurements are expected;

(b) Determination and practical implementation of protective actions and other response actions;

(c) Use of protective clothing and equipment;

(d) Meteorology;

(e) Collection of contaminated material;

(f) Sealing techniques for leaking packages;

(g) Overpacking of damaged packages;

(h) Dose estimation and/or reconstruction.

3.55. The representatives of the appropriate governmental authorities should be trained regarding the national emergency arrangements, the national transport safety regulations and their roles and responsibilities in responding to an emergency. They should have access to information about existing emergency response plans and the organizations that may be involved, as well as information about communication procedures and dealing with representatives of the news media.

3.56. As soon as possible after each drill, exercise and emergency, the services and personnel involved should take part in a debriefing session. Their reports and experiences should be documented and evaluated. The conclusions and lessons learned should be used for improving the plans, as appropriate.

DRAFT

4. CONSIDERATIONS FOR MODES OF TRANSPORT

4.1. This section provides additional guidance and recommendations for specific modes of transport. These considerations supplement the concept of operations described in Section 3. The considerations below are based on safety aspects. Additional considerations may be necessary for nuclear security aspects, as described in Section 5.

ROAD TRANSPORT

4.2. The majority of shipments worldwide are conducted by road; as such, a wide variety and quantity of radioactive material are transported by road. When only limited emergency response resources would be available, States may place restrictions on the transport of radioactive material through specific areas, such as areas with bridges, tunnels or seasonal routes. States may also completely close a transport route for an extended period of time when an emergency response would not be feasible. They may also pre-identify approved routes for the transport of dangerous goods.

4.3. States may consider implementing specific requirements for planning certain types of transport in line with the graded approach, based on the total activity of radioactive material and the type of radioactive material being transported. These requirements may also be based on the physical aspects of the transport, for example oversize or overweight transports. This may include requirements for route planning to avoid certain populated areas or critical infrastructure, or requirements to conduct the transport during specific time periods.

4.4. Emergencies during road transport can occur in very close proximity to the public and present unique challenges for initial response actions aimed at establishing the site area and a cordoned off area. Governments, especially first responders, should be prepared for emergencies during road transport anywhere in their territory, unless specific restrictions are in place as described above.

4.5. The response measures may differ between emergencies in urban areas and rural areas. These differences may include:

(a) Availability of emergency response resources, including specially trained response teams;

(b) Communications systems and coverage areas;

(c) Number of inhabitants in the vicinity of the emergency;

(d) Surrounding environment, terrain and geography;

(e) Social and economic activity in the area, including the cordoned off area.

Areas with buildings for special populations such as schools, nursing homes or hospitals should be given special consideration in the protection strategy.

4.6. Emergencies during road transport may result in the blocking or temporary closure of the road, causing traffic congestion. This may hinder response actions such as the arrival of emergency

responders and the recovery of the radioactive material and package; it may also increase the number of people who need to be surveyed and advised, e.g. vehicle occupants blocked on the road.

4.7. Compared to other modes of transport, road transport emergencies have a higher possibility of all or part of the route being re-opened during the emergency response when it is safe to do so.

RAIL TRANSPORT

4.8. A wide variety of types and quantities of radioactive material are transported by rail. In many cases, shipments are sent by rail due to size, weight or other operational considerations. Shipments by rail often involve large quantities of radioactive material that would require multiple road transports and should be considered in the hazard assessment.

4.9. Many of the considerations for emergency response to a road transport emergency are also generally applicable to rail transport (see 4.2–4.7).

4.10. Depending on the number of railcars being transported and other operational factors, there may be delays in identifying abnormal conditions that could result in an emergency, such as leaks or fires.

4.11. Rail transports of radioactive material are sometimes conducted by trains that are fully dedicated to this cargo only. When such trains are subject to a railway emergency, several railcars and therefore several packages may be damaged simultaneously, making the emergency response more complex.

4.12. Rail transports may include a combination of dangerous goods and non-dangerous goods. Emergency response organizations should consult the competent authorities for national transport to determine, during the preparedness stage, the possibility of encountering other dangerous goods during an emergency involving radioactive material.

4.13. The railway authority will be directly involved in the emergency response. Note that, in some States, the railway authority may be a private entity.

4.14. Consignors and carriers for rail transport should have pre-established communications networks and procedures that are utilized for notifying and activating an emergency response. However, they may have a limited ability to take initial response actions or mitigatory actions immediately after an emergency is declared.

4.15. Accessing the site area of an emergency during rail transport can be difficult if there is limited or no road access for emergency response organizations. Rail transport can transit remote locations with severe terrain. This should be taken into consideration in emergency arrangements; it can result in delays to initial response actions and the arrival on the site of emergency response organizations.

4.16. The location of the emergency site and the location of the affected consignment within the overall transport may present difficulties in restoring the damaged package to a stable state and

DRAFT

removing it from the site. This may result in an extended emergency response. Specialized equipment for operating on railways may be necessary to conduct the emergency response safely. This could include specially equipped rail cars with cranes, pumps and other safety equipment.

4.17. Compared to other modes of transport, there is a lower possibility of identifying short detours or partially re-opening the transport route to minimize the impact on the local population and normal economic activity.

MARITIME TRANSPORT

4.18. A wide variety of types and quantities of radioactive material are shipped by maritime transport, which should be considered part of the hazard assessment. This includes transport in international waters, ports or harbours and the territorial seas and contiguous zones of States. During the maritime transport of radioactive material, accidents may occur in two principal environments: (1) ports and (2) seas. The emergency may occur on the vessel or involve the release of radioactive material into the water.

4.19. Emergencies occurring in ports and harbours may have the benefit of the availability of specialized emergency response teams. These port and harbour teams are usually trained to respond to marine related emergencies involving dangerous goods, and they may be needed during an emergency. They should be provided with the appropriate level of training. The International Maritime Organization's (IMO) Revised Recommendations on the Safe Transport of Dangerous Cargoes and Related Activities in Port Areas [15] should be taken into account by the appropriate authorities, port operators, relevant cargo interests, emergency services and all others concerned.

4.20. An emergency may occur in a remote location where the crew of the vessel are the only personnel available to deal with the emergency. Crews of ships carrying radioactive material should be knowledgeable in determining when an emergency exists, and in the notification procedures to be followed to obtain quick and reliable information about the initial response actions to be taken. The crew should know that the primary technical expertise available in a timely manner may be advice given via radio or other communication means, based on information gathered on board the vessel. In this context, the crew should use the IMO's guidelines for dealing with accidents at sea, The Emergency Procedures for Ships Carrying Dangerous Goods (EmS Guide) [16], and The Medical First Aid Guide for Use in Accidents Involving Dangerous Goods (MFAG), published by the IMO, the International Labour Organization and the World Health Organization [17]. The EmS Guide provides specific instructions for fire and/or spillage emergencies on board a ship involving packaged dangerous goods, including radioactive material. The MFAG gives general information about how to diagnose, treat and prevent health problems in seafarers, with a focus on the first 48 hours after injury, in particular toxic effects, including radiological effects, and specific instructions on how to treat crew members who are affected by toxicity.

4.21. Maritime transports may include the transportation of a combination of different classes of dangerous goods. The possibility of encountering other dangerous goods during an emergency involving radioactive material should be taken into account by the emergency response organizations.

4.22. Establishing a cordoned off area on board a vessel should be carried out under the authority of the ship's master. In the event that the cordoned off area extends beyond the boundaries of the vessel to the open sea, the ship's master should communicate a warning to other vessels — e.g. via pan-pan or mayday message — given that establishing physical barriers is not possible. If the vessel is within a port or harbour, the ship's master should communicate a warning to the responsible authorities and coordinate actions with those authorities to enforce the cordoned off area if necessary.

4.23. If a seagoing vessel is seeking safe harbour during an emergency, the ship's master should communicate, as soon as possible, the current emergency situation and response actions to the responsible authorities in the port or harbour, or the relevant coastal authorities.

4.24. When an emergency involves the loss or likely loss overboard of radioactive material in packaged form into the sea, the ship's master should report the situation without delay and to the fullest extent possible to the nearest coastal State [17] and an atmospheric release that may impact vessels at sea or in port should be reported to the NAVAREA Coordinators.

4.25. For emergencies involving the release of radioactive material into the water, the spread of contamination in a maritime emergency has different kinetics compared to a land accident. Emergency responders may need access to capabilities for marine dispersion modelling, monitoring and sampling, in order to determine whether to implement protective actions or other response actions. These capabilities may be needed in the urgent response phase due to marine currents, and in the early phase or transition phase due to other factors such as corrosion [18].

4.26. In an emergency involving a possible release of radioactive material into the water, protective actions related to placing restrictions on normal activities, such as fishing, in the waters near the location of the emergency should be based on: an assessment of the package and the possible extent of the release; the chemical form of the radioactive material and its reactivity to water; and, in some cases, hydrological monitoring and sampling, as well as seafood sampling.

4.27. Retrieving sunken packages or vessels will require specialized teams capable of maritime salvage operations. In some cases, retrieval of the package may not be justified from a radiation protection perspective. This decision will be based on the protection strategy put in place by the national government responsible for the emergency site area, or the flag State of the vessel in case of an emergency in international waters. Packages sunk in shallow waters should be recovered unless it is not possible to do so [19].

4.28. Emergencies at sea may not be covered in detail in national radiation emergency plans. Accordingly, a ship's master should be in possession of information regarding which authorities in the

DRAFT

ports of call, or in States, to contact in an emergency along the transport route. The maritime authorities with whom the master may be in contact during a voyage should also know whom to contact in an emergency so that, should the vessel need to go into port, the emergency services will have been alerted in advance.

4.29. Vessels subject to the IMO's International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on board Ships (INF Code) [20] should have on board a shipboard emergency plan, developed in accordance with the Guidelines for Developing Shipboard Emergency Plans for Ships Carrying Materials Subject to the INF Code promulgated by the International Maritime Organization [21]. As a minimum, the plan should consist of:

(a) the procedure to be followed by the master or other persons having charge of the ship to report an incident involving INF cargo;

(b) the list of authorities or persons to be contacted in the event of an incident involving INF cargo;

(c) a detailed description of the action to be taken immediately by persons on board to prevent, reduce or control the release, and mitigate the consequences of the loss, of INF cargo following the incident;

(d) the procedures and points of contact on the ship for coordinating shipboard action with national and local authorities.

4.30. For emergencies on vessels subject to the INF code, coastal States may have relevant information provided through voluntary and confidential government-to-government communications. Response organizations notified of an emergency within their territorial seas, or vessels requesting safe harbour, should check with their national competent authorities to see if such information is available.

4.31. Carriers with vessels subject to the INF code should have criteria and procedures for emergency shore leave in the event of a conventional emergency while in-harbour that is commensurate with hazard assessment, such as an earthquake and/or a tsunami warning.

INLAND WATERWAY TRANSPORT

4.32. Inland waterway transport involves transport in proximity to land, on the landward side of the baseline of the territorial seas of a State. The requirements for inland waterway crafts are defined separately from seagoing crafts in the Transport Regulations [3] and, as such, this mode of transport presents unique hazards and emergency response challenges that should be considered by applicable States. Compared to seagoing vessels, the conveyance activity limits and transport index limits are generally lower. Inland waterway craft are generally smaller than seagoing vessels.

4.33. Many of the maritime transport emergency response considerations are generally applicable to inland waterway transport.

4.34. Compared to maritime transport, emergency response organizations and equipment may be closer and more readily available during inland waterway transport. However, emergency response in any marine environment presents common challenges compared to responses on land.

4.35. Transport through inland waterways occurs most often in national waterways. However, some inland waterways are designated as international waterways and have a unique legal status. Inland waterways may also serve as national borders, resulting in transboundary emergencies even when there are limited radiological consequences.

AIR TRANSPORT

4.36. A wide variety of types and quantities of radioactive material are shipped by air on both passenger and cargo planes and should be considered as part of the hazard assessment. This includes frequent transport of short-lived medical sources, samples and contaminated tools. In rare circumstances, it is also possible to transport high-activity material in Type C packages. Emergencies during the air transport of radioactive material may occur either at airports or at locations along the route of the aircraft.

4.37. Recognizing an emergency during air transport can be difficult, and the initial response actions will follow procedures for a conventional emergency. If available, the pilot-in-command will provide information of any dangerous goods, including radioactive material carried as cargo, on board the aircraft. If the pilot-in-command is unavailable, the airline should provide information as soon as possible.

4.38. An emergency that occurs as a result of a crash may require an emergency response in remote or inaccessible areas. Aircraft crashes often involve strong deceleration forces and a higher probability of fire compared to other modes of transport. The radioactive material may be scattered over a wide area and be difficult to locate and collect. Emergency responders should be aware of the possibility of high dose rates, inhalation and contamination resulting from potentially serious damage to packages and use necessary personal protective equipment.

4.39. When attempting to locate and recover the radioactive material, responders should be aware that some of the packages and their contents may have physical and chemical characteristics that are different from the characteristics before the crash. The particle size of the dispersed radioactive material may vary depending on the forces and temperatures involved in the initiating event.

4.40. Type C packages are designed to survive most aircraft crashes [22, 23]. For other types of packages, emergency responders at the site area of an aircraft crash of an aircraft carrying radioactive material should consider the possibility that the package may have been damaged or destroyed, and that its shielding may have been lost. If the aircraft was carrying packages of high activity radioactive

material, additional precautions should be taken by responders to ensure radiation protection of the public and responders.

4.41. The criticality hazard is limited after the crash of an aircraft carrying fissile packages, since these materials are likely to be spread over a large surface area. Nevertheless, a special assessment should be carried out to confirm the absence of criticality hazard and recommend appropriate arrangements. Special care would need to be exercised in collecting the fissile material.

4.42. Some aircraft may use radioactive material as part of their construction, for example with depleted uranium counterweights. These materials are not part of a consignment and are outside of the scope of the Transport Regulations [3].

5. INTERFACE WITH NUCLEAR SECURITY

5.1. An emergency during transport of radioactive material may occur irrespective of the cause, which may include a nuclear security event. This section provides considerations that should be addressed in the management of an emergency response whenever it is suspected that a nuclear security event may have initiated the emergency.

5.2. When developing emergency response plans, as required by GSR Part 7 [2], operating organizations (consignors, carriers, consignees) should ensure that appropriate transport security and contingency plans are considered. Thus, the response to a transport emergency involving radioactive material initiated by a nuclear security event should be integrated with the response to an emergency under a unified command and control system at the local, national, regional and/or international level, as appropriate. More information can be found in GSR Part 7 [2] and in the Nuclear Security Series publication, Developing a National Framework for Managing the Response to Nuclear Security Events, Nuclear Security Series [24].

5.3. Section 4 of GSR Part 7 [2] requires States to ensure that the hazard assessment takes into consideration the results of nuclear security threat assessments. Considerable effort is focused on the security of transport of nuclear material and, in particular, on high-activity radioactive sources (in excess of the 10 D-Value, or in Category 1 or 2 as per IAEA Safety Standards Series No. RS-G-1.9 [25]), which may lead to significant radiological consequences during an emergency. These materials may be vulnerable to attack during transport.

(a) Sabotage may lead to an immediate radiological emergency at the site area where the incident occurs. The site should be deemed a radiological crime scene. Therefore, the response to this scenario should include both emergency response actions and nuclear security measures. IAEA Nuclear Security Series No. 9 [12] provides for the grading of nuclear security measures based on the nature and the activity of the radioactive material involved in the event.

(b) Unauthorized removal of radioactive material in transport may lead to a radiological emergency at an unpredictable location. The response to this scenario is beyond the scope of this publication; the guidance in GSR Part 7 [2] and in the publications of the IAEA Nuclear Security Series provides considerations and arrangements for responding to this event.

5.4. Some shipments, especially those for nuclear materials (as defined in INFCIRC/225/Revision 5 [26]) or dangerous sources, incorporate safety measures on the package (such as stringent design features and seals) and the conveyance (e.g. tie-down requirements) that may serve the purpose of achieving varying degrees of security. These features may help to deter or delay an adversary from gaining access to the package or radioactive material.

DRAFT

5.5 Emergency workers and nuclear security response forces may face conflicting priorities when responding to an emergency during transport which was initiated by a nuclear security event. For example, from a nuclear security point of view, the integrity of a radiological crime scene should be maintained for criminal investigation and evidence collection. However, when necessary during the emergency response, life-saving actions and mitigatory actions take priority. The final decision on prioritizing specific tasks and actions should be made within the unified command and control system, as specified in GSR Part 7 [2].

5.6 Even in an emergency that is not initiated by a nuclear security event, there may be a need to implement nuclear security measures to secure the radioactive material.

CONSIDERATIONS FOR THE EMERGENCY RESPONSE WHEN A NUCLEAR SECURITY EVENT IS CONFIRMED TO BE THE INITIATING EVENT

5.7 A State should have a comprehensive national emergency response plan with an all-hazards approach that includes coverage of hazards from transport of radioactive material, in cooperation and coordination with, inter alia, the national response plan for a nuclear security event. As a generic consideration in the initial response, all emergency response actions should consider the possibility of a nuclear security event.

5.8 The response to a transport emergency involving radioactive material initiated by a nuclear security event needs to be integrated under a unified command and control system. Given that the response measures to an emergency, and to a nuclear security event, may be based on different approaches, considerations related to nuclear security measures should be included in the system from the preparedness stage. This will help to address possible conflicts.

5.9 The Nuclear Security Series contains information on nuclear security measures that may be necessary. These include:

(a) Radiological crime scene management [27]: The emergency site area associated with a nuclear security event may contain trace evidence of activities that may indicate a criminal or intentional unauthorized act involving nuclear or other radioactive material. Law enforcement operations and emergency response activities should be carried out simultaneously and in a coordinated manner, taking into consideration the need to protect emergency workers, helpers and the public. Actions for protecting persons, whether they are needed for radiation protection or for physical protection against malicious acts, should take priority over other activities such as collecting evidence, interviewing witnesses, taking photographic images and preparing written records of the scene.

(b) Forensic examination [28]: This includes traditional forensic examination conducted by law enforcement authorities and nuclear forensic examination conducted by special experts. When the emergency involves unknown radioactive material, nuclear forensic

examination should answer questions regarding the nature, history and origin of the radioactive material involved.

(c) Criminal investigation activities: There are investigative activities in accordance with national procedures for criminal investigations, which are aimed at obtaining evidence from individuals near the emergency site area who may have witnessed events leading up to, during or immediately following the emergency.

(d) Information analysis and public information: Effective, timely and clear communication within the government and with the media and the public is essential, as described in previous sections. Taking security issues into consideration, provisions should be in place for controlling sensitive information, e. g certain information dealing with the law enforcement response and crime scene investigations, so that law enforcement is not impeded.

5.10 Capabilities and resources related to nuclear security measures that should be available and integrated into the unified command and control system of the response to a nuclear or radiological emergency during transport may include, but are not limited to:

(a) Specialist law enforcement capabilities (such as fully trained responders and specialist investigators);

(b) Nuclear forensics support;

(c) Equipment for secure communications;

(d) Specialized equipment, such as explosives detectors or equipment for handling pyrophoric material, and the personnel able to use it;

(e) Resources for delivering and analysing evidence.

DRAFT

APPENDIX I: FEATURES OF THE TRANSPORT REGULATIONS RELEVANT TO EMERGENCY ARRANGEMENTS

I.1. This appendix summarizes how the regulatory requirements may influence emergency response in an emergency during the transport of radioactive material.

I.2. The transport of radioactive material is governed within States by national legislation. Since such transport may frequently involve transboundary operations, internationally agreed regulatory requirements have been developed. The Transport Regulations [3] are the basis for the safe transport of radioactive material in most States, by way of international modal and domestic transport regulations. The intention of the Transport Regulations is that the packages will be designed, manufactured and maintained in such a way that, even in the event of accidents, the potential for radiological impact would be acceptably small and, where fissile material is involved, accidental criticality would be avoided.

I.3. The Transport Regulations specify the basic design requirements to ensure the safety during the transport of radioactive material. These include:

(a) Stringent containment requirements for radioactive material;

(b) Limits on the acceptable dose rates;

(c) Controls for criticality safety of fissile material;

(d) Consideration of dissipation of any heat generated by the radioactive material.

I.4. Because the Transport Regulations are applicable to a wide variety of radioactive material spanning a wide range of radiotoxicity levels and physical and chemical forms, the package design requirements are imposed on a graded approach. In addition, the same graded approach is used in specifying requirements for the authorization of package design, the operations controls for the packages and shipments and the manner in which hazards are communicated. As the potential hazard of the contents increases, the design, authorization, operational control and communication requirements commensurately become more demanding.

MATERIALS, PACKAGES AND SHIPMENTS

I.5. In most transports, radioactive material is transported in packages using normal procedures. However, there are some shipments whose unique characteristics and circumstances can affect the arrangements for emergency preparedness and response.

I.6. Some shipments are designated as ‘exclusive use’, as defined in the Transport Regulations. These transports may have higher Transport Indices and maximum allowable activity limits than would otherwise be allowed for the type of package being transported. Although this scenario has no impact on the initial response actions, it could affect assessment and prognosis by the radiological

assessors, because detailed information about the contents in the consignment may be provided easily by a single consigner.

I.7. Special arrangements should be used only when it is impractical to ship the consignment under all the applicable requirements of the Transport Regulations. The special arrangement provisions should compensate for not meeting all the normal requirements of the Transport Regulations by providing an equivalent level of safety. Special precautions, administrative controls or operational controls are required, which may include emergency arrangements. Competent authority approval is required before transport; international shipments also require multilateral approval prior to transport.

I.8. Special form radioactive material is either an indispersible solid radioactive material or a sealed capsule containing radioactive material. The radioactivity limit for a Type A package containing special form radioactive material is A_1, which may be greater than the A_2 value. It is a requirement in the Transport Regulations that it should be able to withstand the various test conditions, including the 9 metre drop test and the heat test, and its design requires unilateral approval. If the package meets these conditions, it is regarded as showing a suitable level of resistance to potential emergencies during transport.

I.9. Radioactive material categorized as LSA-I (Low Specific Activity I) or SCO-I (Surface Contaminated Objects-I) can be transported packaged or unpackaged. An accident during the transport of this type of material, whether packaged or unpackaged, is unlikely to lead to an emergency.

I.10. The Transport Regulations allow for the unpackaged shipment of large solid objects that cannot be transported in a package described below, called SCO-III (Surface Contaminated Objects-III). Emergency response and other special precautions are required, as well as administrative or operational controls; these should all be described in a transport plan. Competent authority approval, including a transport plan, is also required before transport, and international shipments require multilateral approval. An example is a disused steam generator or pressurizer from a nuclear power plant.

TYPES OF PACKAGES

I.11. The various types of packages used for transporting radioactive material are described below. Depending on the type of package required, the graded approach used in the Transport Regulations specifies the tests for an individual package's design with respect to routine, normal and accident conditions of transport.

Excepted packages

I.12. Excepted packages are permitted to contain only small quantities of radioactive material. The design requirements imposed on them are minimal, and they are exempt from most marking and labelling requirements. Typically, excepted packages are constructed of fibreboard. Internally

DRAFT

contaminated but otherwise empty packaging may qualify for this category and be transported as excepted packages. Examples are packages that contain certain types of timepieces, smoke detectors, some radiopharmaceuticals and the very low level radioactive sources used for testing instruments. An accident during the transport of these types of packages is unlikely to lead to an emergency. However, the packages should still be handled with caution after an accident, as contamination may be present.

Industrial packages

I.13. Industrial packages are permitted to contain relatively large quantities of radioactive material, and dose rates outside the package are also limited. The materials permitted in these packages are of one of two types: material having low activity per unit mass (known as Low Specific Activity or LSA material) or non-radioactive objects having low levels of surface contamination, known as Surface Contaminated Objects, SCO-I or SCO-II.

I.14. The quantity of LSA material, SCO-I or SCO-II allowed in a single industrial package is restricted so that the external dose rate at 3 metres from the unshielded material does not exceed 10 mSv/h. In an emergency during the transport of this type of material, the radiological consequences will therefore be limited.

I.15. Three types of industrial packages are defined and allowed: Type IP-1, Type IP-2 and Type IP-3. The testing requirements and maximum activity limits increase from IP-1 to IP-3. The type of industrial package that is permitted depends on the characteristics of the LSA material or the SCO to be transported.

I.16. Although the specific activity of LSA material and the contamination of SCOs is generally low, the total activity in a consignment could be significant. Some examples of LSA material and SCOs are:

(a) LSA-I: This includes ores, unirradiated uranium and thorium, mill tailings and contaminated soil and debris with low activity concentrations. This material has a high degree of uniformity of activity distribution.

(b) LSA-II: This includes reactor process wastes, filter sludges, absorbed liquids and resins, activated equipment, laboratory wastes and decommissioning wastes. This material has a lower degree of uniformity than LSA-I; therefore, higher, localized concentrations of activity may be present, and more stringent packaging requirements are imposed.

(c) LSA-III: solidified liquids, resins, cartridge filters and irradiated material. This material is essentially uniformly distributed in a solid compact binding agent. Radioactive material may also be distributed throughout a single solid object or a collection of solid objects within the packaging. This material is allowed to have higher specific activities: therefore, more stringent packaging requirements or limited material characteristics are imposed.

(d) SCO-I and SCO-II: both of these categories cover non-radioactive solid objects that have internal or external contaminated surfaces. SCO-II allows for higher contamination levels than SCO-I. Examples would be decommissioning waste such as contaminated piping, tools, valves, pumps and other hardware. SCO-III material is not packaged and is discussed separately.

I.17. All industrial packages are required to meet general packaging requirements. Type IP-2 and Type IP-3 are required to satisfy certain additional test requirements. They need to demonstrate the ability to withstand the designated test conditions of transport without a loss or dispersal of their contents and the loss of integrity of adequate radiation shielding. Industrial packages are often boxes, steel drums, metal containers and tanks.

Type A packages

I.18. Type A packages are permitted to contain specified limited quantities of radioactive material. The Type A activity limits are determined based on the maximum acceptable radiological consequences following a failure under specified conditions. These activity limits, which are calculated values specified in the Transport Regulations for each radionuclide, are for radioactive material that is 'special form' (sealed capsules and indispersible solid radioactive material) and 'other than special form'. The limits are known as the A_1 and A_2 values, respectively.

I.19. Type A packages are required to withstand the normal conditions of transport without a loss or dispersal of their contents and the loss of adequate shielding integrity. They are not specifically designed to withstand accident conditions. They range from wood or fibreboard constructions with glass, plastic or metal inner containers to metal drums or lead filled steel packages. Examples of material transported in Type A packages include radiopharmaceuticals, radionuclides for industrial applications and some radioactive waste.

Type B(U) and B(M) packages

I.20. Type B(U) and B(M) packages are permitted to contain radioactive material in quantities greater than those allowed in Type A packages. Type B(U) and B(M) packages are required to be designed to withstand both normal conditions and accident conditions of transport, i.e. the drop, puncture, crush, thermal and immersion tests [3]. Type B(U) and B(M) packages may range in size from those with a gross mass of a few kilograms, containing radiography sources, to large packages having a gross mass up to about 100 metric tonnes, containing, for example, irradiated nuclear fuel (spent fuel from nuclear power plants). Typically, Type B(U) and B(M) packages are of a steel construction and incorporate substantial radiation shielding. The Transport Regulations require Type B(U) and B(M) package designs to be approved by the relevant competent authority or authorities.

DRAFT

Type C packages

I.21. Type C packages are designed to transport large activities (e.g. 3000 × A_2) of radioactive material by air. These packages are designed to withstand the drop, puncture, thermal and immersion tests for Type B(U) and B(M) packages; in addition, they are also designed to withstand more severe tests intended to simulate the conditions that may result from a severe aircraft accident. Type C package designs are subject to approval by the relevant competent authority or authorities.

Packages containing uranium hexafluoride (UF_6)

I.22. Uranium hexafluoride in quantities of 0.1 kg or more is required to be packaged and transported in accordance with the provisions of ISO 7195, Packaging of uranium hexafluoride (UF_6) for Transport [29], or alternatives thereto, and within the specific requirements of the Transport Regulations. Package designs that will contain uranium hexafluoride in quantities of 0.1 kg or more are subject to approval by the competent authority.

I.23. Although specific requirements are in place, emergencies involving UF_6 primarily present a chemical toxicity hazard.

Packages containing fissile material

I.24. Fissile material is capable of undergoing a self-sustaining neutron chain reaction. In the fission process, an atomic nucleus splits into fission products, resulting in the release of radiation and heat. Packages containing fissile material may be industrial packages or Type A, Type B(U) and B(M) or Type C packages. The designs of these packages are all subject to the approval of the relevant competent authority or authorities.

I.25. The Transport Regulations [3] include specific provisions for packages containing fissile material. Fissile material is a material containing any of the fissile nuclides, namely uranium-233, uranium-235, plutonium-239 and plutonium-241, except for masses less than 0.25 g.

I.26. The additional requirements for packages containing fissile material are intended to ensure criticality safety in the transport of this material by:

(a) Limiting the quantity and geometric configuration of the fissile material;

(b) Imposing strict package design features to ensure that criticality safety is provided under the tests for accident conditions;

(c) Controlling the number of packages that are permitted to be carried on a single conveyance or stowed together during transport and in-transit storage.

I.27. The Transport Regulations provide some exceptions to these requirements for packages containing fissile material: for example, if the uranium-235 concentration is less than 1%, or if the package contains only limited quantities of fissile material. These are known as ‘fissile excepted’

packages. In these cases, the other relevant packaging requirements related to the radioactive nature of the contents are applicable.

DOSE RATES AND CATEGORIES

I.28. Dose rates around a package are categorized and have specific acceptable limits. For packages other than excepted packages, the limits are:

(a) When transported not under exclusive use, dose rates are limited so that:

(i) The maximum dose rate at any point on the external surface of a package does not exceed 2 mSv/h;

(ii) The maximum dose rate at 1 metre from the external surface of the package does not exceed 0.1 mSv/h.

(b) When transported under exclusive use, dose rates are limited so that:

(i) The maximum dose rate at any point on the external surface of a package does not exceed 10 mSv/h.

I.29. The dose rate limit for excepted packages is 5 μSV/h at any point on the external surface of the package.

I.30. The maximum dose rate does not exceed 2 mSv/h at any point on the external surface and 0.1 mSv/h at 2 meters from the external surface of the vehicle.

I.31. These dose rate limits are included as part of the specification of categories of packages as summarized in Table 1. The labels placed on packages are defined using categories that provide information to assist in ensuring adequate radiation protection during handling, stowage and storage of the packages. The categorization of packages can also assist emergency responders in understanding the level of risk posed by the undamaged packages in an emergency.

TABLE 1. MAXIMUM DOSE RATES FOR EACH TYPE OF PACKAGE LABEL

Category of label	Conditions of transport		Maximum dose rate	
	Under exclusive use	Not under exclusive use	At the package surface (mSv/h)	At 1 metre from the package surface (mSv/h)
I-WHITE	X	X	0.005	< 0.0005
II-YELLOW	X	X	0.5	0.01
III-YELLOW		X	2	0.1
III-YELLOW	X		10	> 0.1

DRAFT

I.32. For Types IP-2, IP-3, A, B(U), B(M) and C package designs, after being subjected to the prescribed tests to demonstrate the ability to withstand the designated normal conditions of transport, the maximum dose rate on the external surface may increase by no more than 20%. For Type B(U), Type B(M) and Type C package designs, after being subjected to the prescribed tests to demonstrate the ability to withstand the designated accident conditions of transport, the dose rate may not exceed 10 mSv/h at 1 metre from the package surface. These requirements provide a significant radiation protection safety margin for those responding in an emergency involving these types of packages.

MARKING OF PACKAGES

I.33. All packages, other than excepted packages transported by post, which are permitted to carry only very small quantities of radioactive material, are required to have markings that facilitate identification and the proper actions to be taken in an emergency.

I.34. For all package types, the United Nations number is required to be legibly and durably marked on the outside of the packaging. The package should be marked with an identification of the consignor or the consignee, or both. Each package of a gross mass exceeding 50 kg is required to have its gross mass legibly and durably marked on the outside of the package.

In addition, such packages are required to be legibly and durably marked with the appropriate package type on the outside of the packaging.

— Each industrial package is required to be marked with ‘Type IP-1’, ‘Type IP-2’ or ‘Type IP-3’, as appropriate. Each Type IP-2 or Type IP-3 package is also required to be marked with the international vehicle registration code (VRI Code) of the State of origin of the package design and the name of the manufacturer.

— Each Type A package is required to be marked with ‘Type A’ and with the VRI Code of the State of origin of the package design and the name of the manufacturer.

— Each Type B(U), Type B(M) and Type C package design is required to be marked with the trefoil symbol (Fig. 1), with a serial number, with the identification number allocated to that design by the competent authority and with ‘Type B(U)’, ‘Type B(M)’ or ‘Type C’, as appropriate.

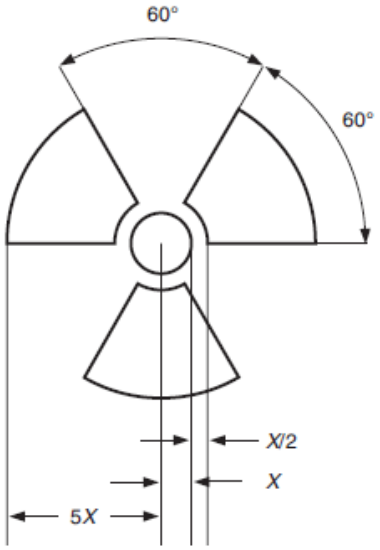

FIG. 1. Trefoil symbol marked on all Type B(U), Type B(M) and Type C packages.

I.35. The marking requirements for the different types of packages and the references from the Transport Regulations are summarized in Table 2. The paragraph numbers shown in the table refer to the Transport Regulations.

TABLE II. MARKING REQUIREMENTS FOR RADIOACTIVE MATERIAL PACKAGES

Marking	Package type							
	Excepted	Type IP-1	Type IP-2	Type IP-3	Type A	Type B(U)	Type B(M)	Type C
Consignor or consignee identification or both	×	×	×	×	×	×	×	×
UN number	×	×	×	×	×	×	×	×
Proper shipping name		×	×	×	×	×	×	×
For package mass greater than 50 kg, permissible gross mass		×	×	×	×	×	×	×
Type IP-1, IP-2, IP-3, A, as appropriate		×	×	×	×			
VRI Code of country of design origin and name of manufacturer			×	×	×			
Competent authority identification for design		×[a]	×[a]	×[a]	×[a]	×	×	×

DRAFT

Serial No.	×[a]	×[a]	×[a]	×[a]	×	×	×
Type B(U), B(M), C, as appropriate					×	×	×
Trefoil symbol					×	×	×

[a] The requirement applies only if the package contains fissile material or if the package contains 0.1 kg or more of UF_6.

LABELLING OF PACKAGES

I.36. Packages containing radioactive material (other than excepted packages) are required to bear labels indicating their category, i.e. I-WHITE, II-YELLOW and III-YELLOW. The I-WHITE label indicates very low dose rates outside a package, whereas II-YELLOW and III-YELLOW labels indicate dose rates of significance (see Table 1). In addition to the radioactive material labels, packages containing fissile material — if not excepted from the fissile material requirements — are required to bear a fissile label. These labels are depicted in Fig. 2. They serve to control the manner in which packages of radioactive material are handled and stowed during transport and stored during storage in transit. They also facilitate communication regarding the potential hazards associated with the package, to assist with a proper emergency response in the event of an emergency.

FIG. 2. Labels used on radioactive material packages and fissile material labels that can be added as appropriate.

I.37. The different types of labels indicate the relative radiation hazard outside the package. The maximum possible dose rates for each type of label are indicated in Table 1. Additionally, the label is required to display the names of the radionuclides and the total activity of the radionuclides in the package. For categories II-YELLOW and III-YELLOW, the labels will indicate the transport index (TI). The TI is a number used to provide control over radiation exposure and is an indicator of the dose rate at 1 metre from the external surface of the package.

I.38. Packages containing fissile material are additionally required to bear criticality safety labels, also shown in Fig. 2, displaying the criticality safety index (CSI) as stated in the appropriate approval certificate issued by the competent authority. The CSI is a number that provides information to assist in the control of criticality.

I.39. Packages containing radioactive material that has other dangerous properties are in addition required to bear the appropriate hazard label in compliance with the relevant transport regulations for dangerous goods.

PLACARDING

I.40. Rail and road vehicles carrying any labelled packages, large freight containers containing packages other than excepted packages, tanks containing radioactive material and certain consignments of LSA-I material or SCO-I in large freight containers or tanks are required to bear placards indicating the presence of radioactive material. The placards may take the form of one of those depicted in Fig. 3. They may display the United Nations number for the consignment, which facilitates communication regarding how best to respond in the event of an emergency.

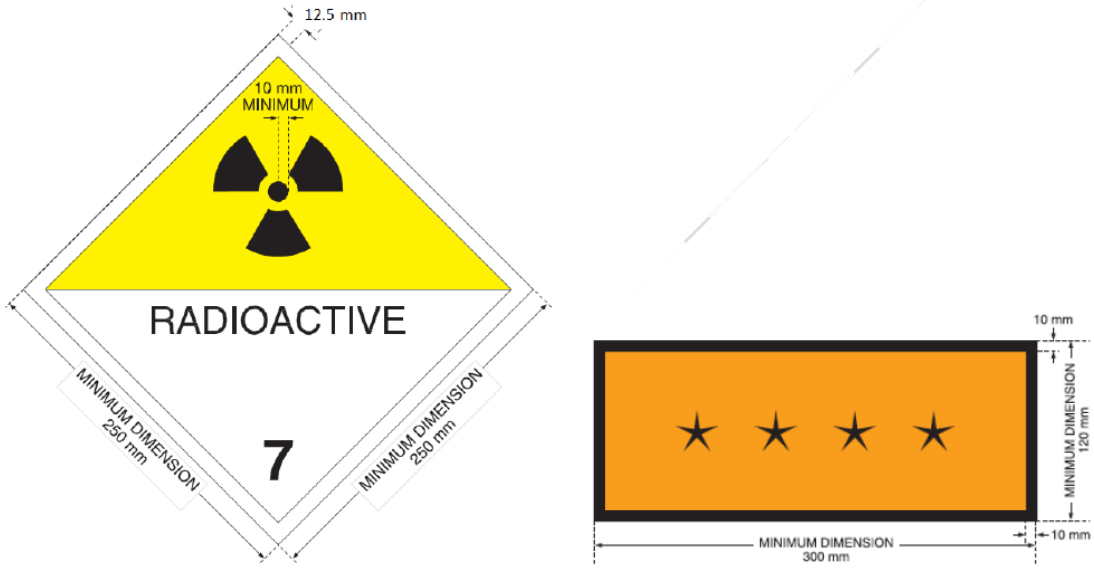

FIG. 3. Placards used on vehicles, tanks and freight containers carrying radioactive material.

TRANSPORT DOCUMENTS

I.41. Consignors are required to provide transport documents for shipments other than those in excepted packages. These documents are referred to in the Transport Regulations [3] as ‘particulars of consignment’, e.g. shipping documents, shippers’ declarations, freight bills, waybills, etc. One of the required documents indicates the emergency arrangements appropriate for the consignment, which are provided by the consignor to the carrier. This information can assist those responding to an emergency with identifying the contents of the consignment and helping to ensure the proper response to the emergency. In some cases, the information may not be immediately available at the emergency site if destroyed by the initiating event, and will be provided by the consignor later during the emergency response.

APPENDIX II: CONSIDERATIONS FOR DEVELOPING A NATIONAL CAPABILITY

II.1. This appendix describes specific actions that a State, especially a developing country, should complete so that it can respond effectively to a transport accident involving radioactive material. The level of emergency arrangements and plans required should be directly derived from the conclusions of the hazard assessment, i.e. via the normal process of drawing up emergency plans. However, at present, some difficulties may arise at different points in the process, associated with the limited knowledge, practical experience or regulatory infrastructure in such a State. The objective of this appendix is to draw attention to such considerations.

ESTABLISH THE COORDINATING ORGANIZATION AND THE NATIONAL POLICY

II.2. Developing a national capability requires extensive coordination between all the relevant ministries, agencies and organizations involved. It is a dynamic process, i.e. plans and procedures will likely need to be revised throughout. It is therefore crucial that one organization takes the lead role in the process and is designated as the leading organization in the national coordinating mechanism, as defined in GSR Part 7 [2]. The general duties of the selected organization should be consistent with the need to coordinate the contributions of all national level organizations that will be involved in preparedness and response for an emergency and the need to integrate these organizations' contributions into a national all-hazards emergency management system.

CONDUCT THE NATIONAL HAZARD ASSESSMENT

II.3. The national hazard assessment starts with identifying the different fundamental characteristics of the radioactive material transported within the State, before identifying the specific radioactive material that may transit through the State's territorial land or waters. The following list of activities and sites involving the use or transport of radioactive sources may help identify potential actors:

(a) Mining and separation and concentration plants (e.g. uranium ores and tailings, density gauges);

(b) Agricultural facilities and industrial buildings (e.g. density and moisture gauges, smoke detectors);

(c) Industrial radiography companies (e.g. gammagraphy devices);

(d) Hospitals and laboratories (e.g. radiopharmaceuticals, gamma therapy with cobalt-60, iridium-192);

(e) Nuclear facilities (e.g. research reactors, nuclear repositories or other nuclear facilities);

(f) In-transit facilities (e.g. ports, airports, rail terminals);

(g) Commercial or industrial operating organizations (e.g., sterilization facilities).

DRAFT

II.4. Following on from this, a survey of the transport activities involved should be carried out to determine:

(a) The nature and frequency of the transports performed (classified according to UN numbers);

(b) The types and quantities of radioactive material currently shipped;

(c) The types of package used for each type of shipment;

(d) Primary and representative routes used, and the locations within these that exhibit specific en-route risks (e.g. tunnels, bridges, mountains, seasonally-damaged roads);

(e) For each primary or representative route: the terrain, local geographic conditions and characteristics of the nearby human populations;

(f) Any existing nuclear security contingency plans.

II.5. A systematic assessment of these elements will help determine the potential magnitude and nature of the nuclear or radiological hazards that may be associated with a transport accident. The result of this analysis can then be used to implement a graded approach to emergency arrangements, commensurate with the potential magnitude and nature of each hazard.

DEVELOP THE PLANNING BASIS

II.6. Once the hazard assessment and the response policy have been developed, it is necessary to gather more information needed for the planning process. This may include but is not limited to:

(a) Laws or regulations establishing criteria for protection of emergency workers, helpers and the public;

(b) International agreements governing international trade or response to international emergencies (e.g. the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, regional transport agreements);

(c) Bilateral and multilateral emergency arrangements;

(d) Information on consignors, carriers and in-transit facilities;

(e) National coordinating mechanisms for emergency response planning and for conventional emergency response planning;

(f) Procedures for notifying other States and requesting international assistance;

(g) Making decisions on urgent, early and other protective actions, and implementing those actions;

(h) Providing emergency services support;

(i) Providing a response to criminal activities;

(j) Off-site monitoring and laboratory analysis;

(k) Communications available for decision makers;

(l) Communications available to alert and inform the public;

(m) Assistance available from other operating organizations that could be available near the site area to provide support in the response;

(n) Information regarding off-site environmental conditions, e.g. severe conditions that may result in an emergency.

II.7. The information should be documented and described in the plan. It provides a description of the nature of the possible transport accident involving radioactive material addressed by the plan as well as organizational and technical capabilities available to respond to such an event.

DEVELOP A CONCEPT OF OPERATIONS AND ALLOCATE DETAILED RESPONSIBILITIES

II.8. A basic concept of operations needs to be developed describing the response process.

II.9. On the basis of this concept of operations, the roles and responsibilities of each organization involved in emergency preparedness and response need to be determined and assigned. A list of critical responsibilities and tasks should be assigned for emergency management operations, for the initial response (identifying, notifying and activating) and for all other response actions (urgent protective actions, mitigatory and early response actions, other response actions).

II.10. Allocation of responsibilities is an interactive process and should be carried out in consultation with each organization, according to the realistic capabilities of that organization. The organizations to which roles and responsibilities are assigned should agree to the assignments. The allocation of responsibilities should be based on the related laws and regulations.

II.11. In practice, the plan is typically used in conjunction with other national emergency plans for responding to transport accidents involving dangerous goods. Typically, the arrangements are implemented separately for each mode of transport. The lead organization is mode dependent, and the lead role of emergency response may be taken by the organization or agency responsible for the mode of transport.

WRITE THE PLANS AND PROCEDURES, AND INTEGRATE THEM INTO THE NREP

II.12. Developing the response plan to a transport accident involving radioactive material should not be separated from developing the NREP (National Radiation Emergency Plan); indeed, the response plan is part of the NREP.

II.13. The plan prepares for representative emergencies derived from the hazard assessment by identifying appropriate response mechanisms to a variety of potential hazards that may come from the

DRAFT

transport of radioactive material and provides an incident management structure to guide response activities. It outlines the necessary resources, personnel and logistics that allow for a prompt, coordinated and rational approach to a broad range of transport incidents.

II.14. The plan should contain sufficient detail but be flexible enough to enable those involved in the response to carry out their duties effectively. All response organizations in the plan should be given an opportunity to review the plan.

IMPLEMENT DETAILED PLANS

II.15. Each organization that has a role in implementing the plan should develop its capabilities relative to the functional and infrastructural requirements. These arrangements include plans, procedures, staffing, organizational structure, facilities, equipment and training at each level. They should be addressed to the operator (consignor, carrier and/or consignee), the local authorities and the national authorities.

II.16. Through the national coordinating mechanism, a committee or work group should be assigned the responsibility of assisting with this effort. This coordinating group will:

(a) Prepare the requirements and schedule for the development of plans and procedures for each group involved;

(b) Provide assistance to individual groups in the development of plans and procedures to ensure compatibility and completeness of the planning process;

(c) Organize periodic meetings between key representatives to encourage coordination;

(d) Ensure that progress is consistent with the schedule or, if necessary, update the schedule.

TEST THE CAPABILITY

II.17. By itself, a finished plan does not ensure readiness. Drills and exercises should be conducted to test and demonstrate the adequacy of the arrangements. The numerous interactions that will take place between organizations, and the numerous authorities, organizations and transport users that will be involved, warrants extensive training and exercise activities so that all parties concerned are adequately prepared, which includes the interface with nuclear security. The plans, procedures and infrastructural capabilities should be reviewed and revised according to the evaluation results of the conducted drills and exercises.

APPENDIX III: TYPES OF EMERGENCIES DURING TRANSPORT

III.1. Packages and conveyances containing radioactive material are transported worldwide via road, rail, inland waterway, maritime and air. Accidents can occur while these packages and conveyances are being transported, handled (loading/unloading) or stored temporarily pending transport. This appendix provides some information on accidents during transport that may cause an emergency. In general, road, rail, maritime and air accidents are similar in that they involve moving conveyances carrying large quantities of goods, which sometimes includes substances that may cause direct or indirect hazards to the immediate vicinity of the packages and conveyances. The hazard level increases when the vehicles are transporting dangerous goods, such as radioactive material.

III.2. Nuclear security events, such as malicious acts, are not addressed below; they are covered in the publications of the IAEA Nuclear Security Series.

CONSIDERATIONS FOR EMERGENCIES

III.3. The loadings to which packages are subjected during different types of accidents may vary considerably. When performing their national hazard assessment, States will identify emergency scenarios and determine their potential consequences as a basis for establishing arrangements for preparedness and response. In determining potential radiological consequences, the range of potential initiating events and the parameters to be considered for all the scenarios selected are very wide. The assessment may be simplified by considering only those scenarios that would have the most severe consequences. To determine the parameters of these events, States may use data from international modal databases, such as the International Maritime Organization's Global Integrated Shipping Information System (IMO GISIS) for maritime transport events and the International Civil Aviation Organization's Accident/Incident Data Reporting system (ICAO ADREP) for air transport events. There may also be other sources of data available to States.

III.4. In setting the parameters, it is recommended to envisage scenarios such as fires of a long duration — i.e. longer than the regulatory thermal test time — that may occur for different modes of transport. For example, during road or rail transport, tunnel environments should be considered when shipments are authorized to pass through them. Additionally, packages may be impacted by other objects during transport, for example, if heavy objects are dropped onto a package at a seaport, airport or other facility where objects are frequently moved.

III.5. All of the events described below are considered irrespective of their cause, whether initiated by an accident or malicious act.

TYPES OF ROAD EVENTS CONSIDERED

III.6. There are inherent risks associated with road transport that may lead to an accident. The main types of road accident that need to be considered for emergency planning purposes are:

(a) Collision;

(b) Fire/explosion;

(c) Loss of load or spillage.

III.7. These may occur as a single event or as a sequence of events, but commonly the initiating event of a road accident is a collision. This occurs when a vehicle collides with another vehicle or a stationary object such as a tree, a pole or a wall, possibly resulting in injury, death and damage to property. A number of factors contribute to the risk of road vehicle collisions, such as vehicle design, speed of operation, driver skill and behaviour, defective roads, traffic and weather conditions (e.g. rain, ice, fog).

The likelihood of an initiating event

III.8. Road accidents are the most frequent type of transport accident, given that roads are the most frequently used mode of transport of radioactive material. These accidents are mainly the result of vehicle collisions. When the vehicle is transporting radioactive material, the event could lead to package damage. Depending on the scale of the accident this may result in contamination of a small area or a moderately sized area. Fires and explosions are likely to be the most severe scenarios for planning purposes, having a larger impact on the public in the immediate vicinity due to the loss of containment of the package.

TYPES OF RAIL EVENTS CONSIDERED

III.9. Reports on railway accidents have been provided in some countries and reference sources. The types of possible rail accidents are similar to road accidents, and may involve single events or a sequence of events:

(a) Collision;

(b) Fire/ explosion;

(c) Loss of load or spillage.

III.10. Rail accidents can occur when trains travelling on the same tracks collide; when trains derail because of technical faults in the rolling stock, the rails or the systems for securing the wagon; because of excess speed; or because of landslides, avalanches or objects obstructing the rails potentially caused by deliberate actions such as terrorist attacks). The frequency of rail transport accidents varies between different States. There may also be a correlation between these and the distribution and number of radioactive material packages transported by this mode of transport in each State.

The likelihood of an initiating event

III.11. When rail cars are transporting radioactive material, the impact due to collision or derailment could lead to package damage, as may occur in a road transport accident. Rail transport often carries large quantities of goods, and serious rail accidents can damage several rail cars at once, resulting in contamination of a larger area compared to a road transport accident. Fire/explosion is likely the most

severe scenario for planning purposes, and it would probably have a larger impact on the public in the immediate vicinity than lesser accidents due to the loss of containment and dispersal of radioactive material.

TYPES OF MARITIM EVENTS CONSIDERED

III.12. Maritime accidents are divided into the following categories:

(a) Collision;

(b) Grounding;

(c) Contact;

(d) Fire/explosion;

(e) Hull failure;

(f) Loss of control;

(g) Ship/equipment damage;

(h) Capsize/listing;

(i) Flooding/foundering;

(j) Ship missing.

These events may occur alone or in combination. The reporting of casualty events to the International Maritime Organization is required by the SOLAS and MARPOL Conventions through the Global Integrated Shipping Information System (GISIS). The information is available to IMO Member States.

The likelihood of an initiating event

III.13. Collision, grounding and contact represent the most common events. For planning purposes, fires and explosions are likely to be the most severe cases. The remaining events vary in likelihood depending on the different types of vessels carrying the dangerous goods.

TYPES OF AIR EVENTS CONSIDERED

III.14. Air accidents can be divided into the following categories:

(a) Ground impact;

(b) Impact in-flight/collision;

(c) Post-impact fire, i.e. ground fire (during ground operation, post-impact or landing);

(d) Non post-impact fire, i.e. in-flight fire;

(e) Explosion, i.e. in-flight explosion;

(f) Immersion;

DRAFT

(g) Loading/unloading events at airports.

III.15. More information on air accidents can be found in the ICAO ADREP system, which is available to ICAO Member States. Air accidents can be of natural, technical or human origin, such as severe weather, mechanical issues, negligence, pilot error or terrorist attack.

III.16. The majority of air accidents are single event airplane accidents resulting in ground impact and post-impact fire. The frequency of air transport accidents is low compared to that of other modes of transport.

The likelihood of an initiating event

III.17. If an accident occurs involving an aircraft, various consequent accident environments may be generated in a sequential manner, imposing stresses on packages containing radioactive material. For planning purposes, the most severe consequences are likely to involve a high impact accident and/or a fire where the cargo includes Type B(U) or B(M) packages. Such accidents may result in extensive damage to the package and the subsequent loss of its containment function, resulting in a significant dose rate increase in the package's vicinity.

ADDITIONAL CONSIDERATIONS

III.18. Additional considerations for developing the postulated scenarios related to specific accidents can be found in Appendix IV.

APPENDIX IV: POSTULATED EVENTS AND POTENTIAL CONSEQUENCES FOR THE HAZARD ASSESSMENT

IV.1. The following events are hypothetical emergency scenarios based on a combination of real-world events and postulated plausible events. The examples below are intended to be representative so that emergency planners and transport safety experts can develop their planning basis and determine their emergency arrangements. The specific radioactive material and modes of transport used in these scenarios are not based on any study of probability or likelihood. Each State should conduct its own hazard assessment based on the modalities of the transport in its territory.

IV.2. On the basis of the hazard assessment developed for different accident scenarios, an appropriate concept of operations for each scenario can be developed. When an emergency involving a shipment of radioactive material occurs, the applicable response actions should be implemented. The response actions and the equipment required to implement these effectively should be made available by the national emergency response authority to its network of regional and local response units, including first responders.

Scenario 1 — A high-energy collision, plus fire, involving a Type B(U) package

IV.3. A road vehicle carrying international cargo is involved in a high-energy collision accident, followed by a fire lasting about 50 minutes. The vehicle is badly damaged and the driver and his assistant are injured. The placard is obscured by the fire.

IV.4. The first responders arrive at the site area, rescue injured persons, extinguish the fire and observe that the vehicle is carrying international cargo. Looking at the markings and labelling on the package, they identify a Class 7 cargo that is a Type B(U) package containing caesium-137 sources in special form. The first responders notify the emergency response centre and establish the cordoned off area. Radiological assessors are mobilized, and the team immediately proceeds to the site of the emergency.

IV.5. On reaching the emergency site, the radiological assessors survey both the site and the first responders and confirm that there is no contamination to the environment or the responders. They also visually assess the package and find that it appears intact, but it needs to be assessed to ensure that all safety functions are intact. The team confirms that there is no contamination on the package surface, confirms that the dose rate measurements are consistent with the transport documents (obtained from the consignor), retightens loose closures on the package and forwards the package to a secure site for further work. The site is re-opened to the public as soon as the damaged vehicles have been removed, approximately 10 hours after the incident occurred.

Hazard assessment and potential consequences

IV.6. The vehicle crew and the response personnel could have been exposed to radiation if the package was damaged.

DRAFT

IV.7. If the radioactive material was in dispersible form, radioactive contamination of the environment may have occurred. Though it is a Type B(U) package, the duration of the fire being about 50 minutes may have affected its integrity.

IV.8. Even before first responders arrived at the emergency site, some individuals in the immediate vicinity of the site may have been exposed to radiation.

IV.9. If the environment is contaminated, members of the public who happen to be present around the emergency site could incur internal and external exposure.

IV.10. When response actions are being taken, the response personnel may be exposed to radiation depending on the distance from which they operate and the period of exposure.

IV.11. The radiation dose received by all individuals could likewise be estimated and, where possible, verified using measurements taken by appropriate instrumentation.

IV.12. On the basis of the considerations outlined above regarding hazard potential, appropriate strategies should be developed for preparedness and response.

Scenario 2 — Derailment of a consignment of uranium ore concentrate

IV.13. The derailment of a rail wagon carrying uranium ore concentrate during inclement weather results in the railway track being blocked. The wagon has 50 IP-1 packages on board in 200 litre drums. Twelve drums are thrown out of the wagon by the derailment; the other 38 remain in the wagon. The 12 ejected drums land between one and ten metres from the vehicle and suffer different levels of damage. Some have visible holes and puncture marks.

IV.14. The first responders from the nearest town reach the site of the emergency. From the placards on the vehicle they identify the radioactive contents in the packages. They establish the cordoned off area and notify the appropriate authorities. The crew who were injured in the incident are rescued and transported to a hospital for treatment. The first responders decontaminate themselves using water while waiting for the radiological assessors to arrive on site.

IV.15. On reaching the site, the radiological assessors confirm that there is no contamination on the first responders. However, there is some contamination near the railway track, and the water used for decontamination is itself now contaminated. The cordoned off area is maintained while the consignor deploys resources to clean up the site. The spilled ore concentrate is recovered and placed in new drums. The undamaged drums are surveyed and transferred to a new vehicle. The railway track is subsequently re-opened when the damaged wagons have been removed, approximately 28 hours after the incident occurred. Meanwhile, radiological assessors proceed to the hospital, and it is confirmed that there is no contamination to the injured crew, the ambulance or its crew or the hospital.

Hazard assessment and potential consequences

IV.16. In this incident, there is potential radioactive contamination of the area near the railway track where the drums fell out of the wagon. There could also be contamination on the wagon itself if any of the drums on the wagon suffered an impact during the accident.

IV.17. Any contamination could result in internal and external exposure, but, given that the material is LSA-I, the exposure levels would not be high.

IV.18. The location of the emergency site could impede communication between personnel at the site and the local/regional emergency response units and delay the arrival of first responders and the radiation protection personnel. Direct public exposure would not be a serious hazard, and a cordoned off area can be established and maintained during the response actions.

IV.19. The inclement weather could interfere with the response actions and result in the spread of contamination.

IV.20. The affected area needs to be decontaminated to the level specified in the Protection Strategy. Low level radioactive waste should be collected and sent for safe disposal to an appropriate facility. The area can then be declared fit for public use again.

IV.21. On the basis of the above considerations regarding hazard potential, appropriate strategies should be developed for preparedness and response.

Scenario 3 — A truck carrying low level waste veers off the road and crashes down an embankment into a stream

IV.22. A truck carrying low level radioactive waste in IP-2 packages veers off the road and crashes down a 10-metre embankment, plunging into the stream below. The packages are ruptured and the package contents is spread on the embankment. Some of the contents remains in the truck, which is partially submerged in 1 metre of water in the stream. The first responders rescue the driver, notify the emergency response centre and establish the cordoned off area.

IV.23. A radiation protection team arrives at the site within a few hours. They set up temporary dykes in the stream. They survey the embankment and take water samples. They observe that radioactive contamination has spread over approximately 500 m^2 of land. The water samples taken a few metres downstream show very slightly elevated levels of radioactivity. The public are instructed not to swim in the stream, use the water or fish until further notice. Contaminated surface soil up to a depth of 10 cm is collected from an area of 500 m^2 and is removed, placed in boxes and sent for safe disposal. The area is closed to the public for four days, during which time the tasks required for decontamination are completed. Thereafter, the area is declared safe for public use; all restrictions on using the stream are withdrawn.

Hazard assessment and potential consequences

DRAFT

IV.24. External exposure would be a distinct possibility in this scenario. If the truck driver, the driver's assistant and any other persons had remained in the stream for a significant period of time, the contaminated water could have resulted in contamination of their clothes and skin. There could also have been intake of radioactive material from ingestion and through open wounds.

IV.25. Air sampling and water sampling capabilities should be available.

IV.26. External exposure would be limited, since the consignment was of low level waste.

IV.27. The internal and external exposure received by the response personnel would need to be assessed.

Scenario 4 — Emergency response to a road transport accident involving excepted and Type A packages of radiopharmaceuticals

IV.28. A delivery van carrying a consignment of radiopharmaceuticals is involved in an accident on a highway. The vehicle has on board 82 Type A and excepted packages originating from five different consignors for delivery to a number of medical institutions. The severity of the impact causes all the cargo to be ejected and dispersed on both sides of the road over a distance of about 200 metres. Thirty packages are damaged. Two of these packages — one containing gallium-67 (200 MBq) and the other iodine-131 (40 MBq) — suffer a loss of containment. Vials containing the radioactive material escape from their shielding and are subsequently broken.

IV.29. A crew member contacts the local police and the relevant emergency management agency. Within 15 minutes, police officials reach the site area, followed by the local fire department. A representative of the local civil defence department arrives at the site area, equipped with a radiation monitor. A superficial survey confirms elevated levels of radiation at the site area. The police cordon off the area and wait for radiological assistance.

IV.30. The emergency management agency duly notifies the appropriate response centre about the incident. A radiation protection team reaches the site within two hours of its occurrence. Based on the information provided by the transport documents, the team prepares an inventory of the sources involved in the event and conducts an extensive survey of the area with a suitable instrument. The emergency vehicles at the site area, the civil defence personnel, the police officers and the damaged van are also surveyed. No radioactivity is found on any of them, and the area survey indicates no public health hazard. The personnel provided by the carrier and consignor clean up the area.

IV.31. Under the guidance of the radiation protection team, small debris and packing material is collected in plastic bags, then placed in cardboard boxes and sent for safe disposal together with the damaged packages. In the area where the iodine-131 source was found broken, approximately 0.08 m^3 of topsoil is removed, placed in boxes and sent for safe disposal. A thorough and systematic survey of the area is then carried out. Background radiation levels of about 0.1 μSv/h are measured. Sixteen

hours after the accident occurred, and after being thoroughly washed, the highway is reopened for public use.

Hazard assessment and potential consequences

IV.32. The potential hazards arising from an accident involving many Type A packages could be potentially significant on account of possible contamination of persons and the environment.

IV.33. Damage to Type A packages containing radiopharmaceuticals (unsealed sources), accompanied by the release of the contents, could result in both internal and external exposure. Even if there was only damage to the shielding and therefore no release of contents, external exposure could still occur.

IV.34. The vehicle crew, the bystanders and the response personnel may be expected to have suffered possible radiation exposure. Similarly, exposure during the decontamination of persons, the locality and the collection of radioactive waste would contribute to the dose received by the response personnel.

IV.35. Spread of contamination could occur due to wind and the movement of vehicles on the road. The latter can be minimized by stopping vehicular movement on the road until the emergency is terminated.

IV.36. A problem that may be encountered in an accident of this type is the possible lack of information concerning the exact composition of the consignment. It is typical for a carrier to make several deliveries and pickups during a particular assignment. The original integrated bill of lading, therefore, may not correctly indicate the exact contents at various stages of the journey, e.g. after the first delivery or the second pickup has been made.

Scenario 5 — Incident involving transport of iridium-192 pellets in a package with reduced shielding integrity

IV.37. Iridium-192 irradiating pellets housed within a lead shielded Type B package are being shipped from State A to State C by air via State B, and then on to their final destination in State C by road. On route by road in State C, the driver's personal dosimeter sounds an alarm. Given that the dosimeter indicates that the individual dose received by the driver has exceeded a pre-set value, he stops the vehicle, moves 30 metres away, and calls the first responders, as per the emergency instructions given to him.

IV.38. The first responders arrive at the site area and based on the information given to them by the driver, establish a cordoned off area of 30 metres. In accordance with pre-established arrangements between the consignor and consignee, the consignee sends radiological assessors to the site area.

IV.39. Dose rates at the 30 metres cordoned off area are found to be 5 mSv/h, hence the cordoned off area is expanded by the first responders to 100 metres, where a lower dose rate of 100 μSv/h is

measured. Dose rate variations along the cordon indicate that one side of the package has lost its shielding function, for unknown reasons. The consignee is able to apply temporary additional shielding to the package and moves it to the final destination. The roadway is re-opened to the public 6 hours after the initial actions by the driver.

IV.40. The competent authorities in all three countries are notified, and the personnel who handled the shipment are identified. Blood samples are taken for biodosimetry, and a total of 4 personnel from all three countries are shown to have received individual effective doses in the range of 100 mSv.

Hazard assessment and potential consequences

IV.41. An incident like this involves external exposure to package handlers, vehicle crew and pedestrians and bystanders.

IV.42. Since the reason for the reduction in shielding integrity is not known, it can be assumed that there has been a loss of shielding, until the extent of loss of integrity has been determined. Such an event could have been initiated by an operational error, or by equipment being in a poor condition due to lack of maintenance.

IV.43. Verification that a source has escaped from the package is obtained by carefully surveying the site. The consignee should be able to confirm this, given the arrangements by which they are involved in the response, e.g. they are sending radiological assessors.

IV.44. The measured/estimated dose rates at the relevant distances from the package would be required for calculating the estimated dose received by the exposed persons.

IV.45. The driver would have received external exposure while at the wheel, while attending to the vehicle when it was stationary and while loading the package into the vehicle. Typical distances from the package and the period of exposure should be considered, to compare the dose recorded on the driver's individual monitor with the estimated dose, given that the driver may have worn the monitor only some of the time during the total period of exposure.

IV.46. During the initial period when the cordon was established at only 30 metres, persons who were outside the cordon were exposed to increased levels of radiation. The doses received by those present in the zone between 30 and 100 metres should be determined.

IV.47. The possible doses received by persons at the airports in Countries A, B and C where the consignment was handled could be estimated based on time–motion studies. However, it should be borne in mind that, without correct information regarding when and where the impairment of shielding integrity occurred, estimated dose values for these persons are speculative.

IV.48. The persons who need to be subjected to biological dosimetry should also be identified.

Scenario 6 — Collision of a truck carrying a UF6 package, followed by fire

IV.49. A truck carrying a 48Y cylinder, secured on an ISO flatrack container containing 12 tonnes of natural uranium hexafluoride (UF_6) complying with an H(M) package design approval, is involved in a collision with a mobile tank containing liquid hydrocarbon fuel. The collision results in a fire engulfing the 48Y cylinder. The truck driver who is only slightly hurt notifies the national emergency contact points for radiological safety and nuclear security, respectively, and the consignor. The public authority immediately alerts the local fire brigade and the other organizations identified in the local emergency plan, including radiological assessors and an expert in chemical toxicity of hydrogen fluoride (HF). This plan recommends a cordoned off area at 100 metres and sheltering downwind at least 1000 metres from the package. The fire brigade intervenes upwind to fight the fire, wearing a hazmat suit with a self-contained breathing apparatus and using water.

IV.50. Approximately one hour after the initial collision, the cylinder ruptures and disperses an unknown quantity of liquid and UF_6 vapour in the downwind direction. The UF_6 reacts with the moisture from air, fire and firefighting activities and produces HF and uranyl fluoride (UO_2F_2).

IV.51. After the rupture of the cylinder, the fire brigade stops using water on the fire and spreads foam instead. In addition, water is sprayed downwind in order to flush down remaining emission of HF and UO_2F_2.

IV.52. Approximately one hour and a half after the initial collision, the fire is extinguished.

IV.53. The radiological assessors who arrived at the site area take air and ground samples outside the cordoned off area, both of which indicate normal levels of radioactivity, except that, in one downwind direction, contamination is detected up to a distance of several kilometres. The cordoned off area is then extended accordingly.

IV.54. The persons and emergency responders present in the contaminated area at the passage of the HF/UO_2F_2 plume are sent to hospital for checking for possible chemical and radiological exposure.

IV.55. The consignor makes arrangement for recovery package operations (e.g. preparation of a rescue container) in order to secure the package before moving it forward to a safe location.

IV.56. UO_2F_2 deposits within and outside the cordoned off area are retrieved in drums, and the vehicle wrecks are removed from the site area 3 days after the incident; the wrecks are sent to a cordoned off area of a neighbouring scrapyard, waiting for complete decontamination. The damaged cylinder is removed from the site area to a safe location. Cleaning and decontamination of the road is then performed, and the road is re-opened. Detailed monitoring of property and the environment, and decontamination when needed, are then performed. Surface and underground water reserves are checked. Agricultural products from the contaminated area are collected and destroyed.

Hazard assessment and potential consequences

IV.57. The fire accident could release a significant quantity (i.e. between 8 and 12 tonnes) of UF_6, HF and UO_2F_2.

IV.58. Persons who were present under the plume released by the rupture of the cylinder and the fire could have incurred intake of these chemicals, as could those who were engaged in firefighting, in cleaning of UO_2F_2 and in handling the damaged cylinder..

IV.59. Rupture of the cylinder could have occurred before the effective sheltering of all persons that might have been present within 1 km from the package, depending on the nature of the environment (rural or urban).

IV.60. Measured values of the concentrations of UF_6, HF and UO_2F_2 in the environment, and the duration of exposure of persons to these compounds, could be useful in determining the intake quantity, but it appears difficult to be able to perform such measurements 1 hour after the accident. These concentrations can also be estimated by calculation, knowing the wind speed and stability and using realistic assumptions for the plume heights and release rates, as well as other weather conditions.

IV.61. Inhalation of these hazardous chemicals is an important exposure pathway. To estimate the possible intake of the chemicals, it would need to be identified which kind of protective gear or shelter was used by the responders or the public present in the vicinity and downwind of the damaged cylinder.

IV.62. Radiological hazards would be a subsidiary hazard, but not negligible.

Scenario 7 — Sinking of a cargo vessel with three irradiators containing Cs-137 sources

IV.63. A general cargo ship carrying cargo, including a consignment of radioactive material, collides with a submerged object and sinks in territorial waters on a major shipping route in a depth of 30 metres.

IV.64. The consignment consists of 1 Type B(U) package in one freight container. The package carries caesium-137 encapsulated sources in approved special form radioactive material, with a total activity of 110 TBq. There are no other dangerous goods on board the vessel.

IV.65. While taking on water, the vessel notifies the appropriate notification point and the shipping company headquarters. All of the crew are rescued by a nearby vessel.

IV.66. The shipping company contacts the consignor of the Type B(U) package. The notification point and the consignor inform the emergency notification point of the potential emergency. The emergency notification point contacts the radiological assessors, the consignor and the carrier to assess the potential for damage to the consignment and any possible radiological consequences.

IV.67. The consignor advises the authorities that containment of the radioactive material is ensured by special form capsules only. While there is no suspicion of release of radioactivity at the time of sinking, the radiological assessors estimate that corrosion of the capsules by sea water could lead to release of caesium after a few months.

IV.68. Water samples are collected near the sunken vessel and show no contamination.

IV.69. The authorities and the consignor discuss the necessity/possibility of the salvage and assess the time required for maritime salvage operations of the sunken ship and cargo with a marine salvage company.

IV.70. Considering all the factors, including the popularity of tourism and fisheries in the area, a decision is made to try to salvage the ship and recover the freight container carrying the radioactive material within 4 months to limit the corrosion hazards in the worst case scenario. Regular monitoring and sampling of the marine environment in the immediate area are scheduled and conducted.

IV.71. The consignor and the public safety authorities work with the marine salvage company and are able to locate the container with the consignment. The ship is salvaged, with the freight container, 3 months after the sinking and moved to a nearby port. Marine environmental monitoring does not show any indication of contamination.

IV.72. After isolating the freight container, the package is inspected for general condition and surveyed for contamination. It is assessed to be safe for being moved to the consignee's site, which is nearer than the consignor's, under special arrangement approved by the competent authority. The package is then shipped by road to the consignee's site.

Hazard assessment and potential consequences

IV.73. The decision on the salvage may differ depending on the depth of the water, corrosion assessment, radioactivity and other factors.

IV.74. An assessment of the potential radiological consequence via seafood consumption is performed by the radiological assessors.

IV.75. Sampling of sea water and marine life immediately performed in the area of sinking and six months later confirms the absence of contamination.

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ANNEX I: EXAMPLE EVENT NOTIFICATION FORM

The checklist below is an example of an Event Notification Form. Based on the national hazard assessment, event notification forms should be developed to meet the needs of each State and emergency response organization.

Event notification forms should be completed as information from the site area of an emergency during transport becomes available. Initial information provided by emergency services or the carrier should be provided to the notification point as soon as a visual inspection on the site has been undertaken. The notification point can relay this information to other emergency response organizations, and they can use this information to determine whether additional resources are required. The information gathered can also be used in instructions, warnings and information for the public.

As the response efforts continue and more information becomes available, the form should be updated accordingly.

Part 1 of the form focuses on gathering information while initial response actions are being taken. The information is based on observables and indicators, not on measurements. Depending on the nature of the emergency, the information could be provided by the carrier or by first responders.

Part 2 of the form focuses on allowing the radiological assessor to provide advice and assessments and to prepare to deploy to the emergency site. Depending on the nature of the emergency, the information may be provided by a combination of sources, including emergency responders at the site and offices of the carrier or consignor.

Event Notification Form		
Part 1		
Note: Do not delay emergency response actions or additional notifications to complete this form. Gather the information that is readily available.		
1.1	Name/Contact information of person reporting the event:	
1.2	Date/Time of the event: *Specify time zone*	

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1.3	Exact location of the emergency: *Address or GPS*	
1.4	Vehicle information: *Registration number, vessel name, flight number, etc.*	
1.5	Description of the event: *Collision, sinking, etc.*	
1.6	Critical observable conditions: — Description of package(s)? *Drums? Cardboard boxes? Number, if known.* — Fire? *Duration? Extinguished?* — Visible damage to package? *Describe* — Suspected release of package contents? *Leak, spill, venting?* — Package/conveyance status? *Overturned? Sunken?* — Presence of other dangerous goods?	
1.7	Description of initial response actions: *Number of victims, rescues, first aid, cordon off area established?*	

	Note: Confirm that there is no delay in transport of injured victims due to possible contamination.	
1.8	Transport document information: — Number of package(s) — Radionuclide(s) and activities — Carrier information — Consignor information — Consignee information — UN number — Chemical and physical forms	
1.9	Marking and labelling information: — Contents of labels — UN number — Radionuclide(s) and activities	
1.10	Basic meteorological information: *Rain, storms, strong wind, etc.*	
1.11	Photographs and/or sketch of the emergency site:	
1.12	Photographs and/or sketch of the package(s), including labels and markings:	
Part 2		

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Note: Continue to gather information from Part 1 if this was not previously available.		
2.1	Detailed description of initiating event: *Drop height, collision speed, fire duration, etc.*	
2.2	Status of protective actions and other response actions:	
2.3	Description of transport modality: *Modes, route, locations*	
2.4	Information on: — Package(s) — Freight container(s) — Conveyance	
2.5	Measurement results, if available*:* — *Dose rates* — *Contamination surveys*	
2.6	Package type(s) and design certificate:	
2.7	Nature of radioactive material: — Physical form — Chemical form	

2.8	Other hazards present at the site: *Severe weather, conventional hazards*	
2.9	Subsidiary hazards:	
2.10	Accessibility of the site:	
2.11	Meteorological data:	
2.12	Logistical support available at the site:	
2.13	Description of surrounding area: — Population — Agriculture — Drinking water supply — Protected/restricted areas	

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ANNEX II: SAMPLE EMERGENCY INSTRUCTIONS

This annex provides a sample of the emergency instructions to be provided by the consignor to the carrier. The instructions should accompany the shipment. They are an essential part of the emergency arrangements described in the body of the publication.

The emergency instructions may be implemented by the emergency response organizations. They may be a standalone document or combined with other information, such as in the IMO's Emergency Response Procedure for Ships Carrying Dangerous Goods (EmS Guide) [II–1].

The emergency instructions should provide the carrier with guidance for all postulated emergencies. Specific instructions — and especially the emergency actions — may be grouped together, or separated to balance necessary specificity with ease of use (e.g. emergency actions for fire, emergency actions for collision or impact).

The samples below are representative examples of Transport Emergency Cards (TREM CARD) from India. The complete set of TREM CARDs contains instructions for all types of radioactive material transported in India, based on the UN number of the consignment.

2.10 RADIOACTIVE MATERIAL, TYPE A PACKAGE, Non-Special Form, Non-Fissile Or Fissile-Excepted (e.g. UNSEALED RADIOISOTOPES IN TYPE A PACKAGE)

Nature of Material

Class 7 Radioactive Dispersible unsealed form, non-special form, non-fissile or fissile-excepted; this poses potential for external as well as internal exposure to transport workers, emergency response personnel, and the public during transport accidents, if package is damaged.

Protective kit carried in the vehicle

- Boots, surgical gloves, change of clothes — one set each for the driver and his assistants
- 1 pack of disposable face mask
- Empty polythene bags (3 m × 3 m) for collecting contaminated material: 20 Nos.
- Polythene sheets (3 m × 3 m) for covering contaminated area: 20 Nos.
- Detergent soap, towels
- Caution plastic tape for cordoning (self-illuminating type)
- Fire-fighting equipment: Dry Chemical, dry sand or calcium / magnesium fluoride

Emergency action

In the event of injury to persons

- Cover face with kerchief.
- Shift affected person to fresh air.
- Get immediate medical care.
- Wash hands and face thoroughly with detergent soap.

In the event of fire

- Cover face with kerchief.
- Fight fire with CO_2, water spray or foam.
- Do not direct the water jet or foam to the contents of the package.
- Packages which are exposed to flames should be cooled with water from the sides of the packages, even after the fire is extinguished.
- Carefully move undamaged packages out of the fire zone.
- Do not move damaged packages.
- If not possible withdraw the package from the area quickly.
- Isolate package by cordoning of at least 10 m in all directions.

In the event of Spill or Leak

- Cover face with kerchief.
- Mark the area contaminated by the spill.
- Remove any object such as fuel that may cause ignition and start a fire.
- Do not touch damaged packages or spilled material.
- Do not enter the contaminated area except to save life; if you do, come out quickly.
- Do not clean up or dispose until radiation safety expert arrives at the scene.
- Wash hands and face thoroughly with detergent soap.
- Isolate spill or leak area by cordoning of at least 3m in all directions.

In the event of minor dents with no visual cracks/no expected release of activity/no fire accident.

Isolate the package by cordoning of 1 m in all directions.

In the event of the package falling in a river or any water body

Recover the package out of the water body. If not possible, note where exactly the package fell and inform the expert team when it arrives.

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Other precautionary actions

- Wear protective clothing.
- Stay in the upwind direction.
- Keep idle onlookers away.
- Remove packages carefully and clear the road/rail track for traffic to resume.

Immediately contact the persons for advice and assistance at the addresses given below

Contact details (telephone number, fax number, email) for advice and assistance

- The consignor (Address can be found on the package / transport documents)
- National Emergency Response Agency

2.11 RADIOACTIVE MATERIAL, TYPE B(U) PACKAGE, Non-Fissile Or Fissile Excepted / RADIOACTIVE MATERIAL, TYPE B(M) PACKAGE, Non-Fissile Or Fissile-Excepted (e.g. RADIOISOTOPES IN TYPE B(U)/ (M) PACKAGE)

Nature of Material

Class 7 Radioactive non-fissile or fissile-excepted; this poses potential for external exposure to transport workers, emergency response personnel, and the public during transport accidents, even if package is damaged.

Protective kit carried in the vehicle

- Boots, surgical gloves, change of clothes — one set each for the driver and his assistants
- 1 pack of disposable face mask
- Empty polythene bags (3 m × 3 m) for collecting contaminated material: 20 Nos.
- Polythene sheets (3 m × 3 m) for covering contaminated area: 20 Nos.
- Detergent soap, towels
- Caution plastic tape for cordoning (self-illuminating type)
- Fire-fighting equipment: Dry Chemical, dry sand or calcium / magnesium fluoride
- Lead sheets (300 mm × 300 mm and 10 mm thick):10 Nos.

Emergency action

In the event of injury to persons

- Shift affected person to fresh air
- Get immediate medical care

In the event of fire

- Cover face with kerchief/face mask
- Fight fire with CO_2, water spray, fog or foam; dyke fire-control water for later disposal.
- Do not direct the water jet or foam to the contents of the package.
- Packages which are exposed to flames should be cooled with water from the sides of the packages, even after the fire is extinguished.
- Carefully move undamaged packages out of the fire zone.
- Do not move damaged packages.
- If this is not possible withdraw the package from the area quickly.
- Isolate package by cordoning of at least 10 m in all directions.

In the event of Spill or Leak

- Cover face with kerchief
- Isolate spill or leak area by cordoning at least 3 meters in all directions. Cover liquid spill with sand, earth or other non-combustible absorbent material

In the event of minor dents with no visual cracks/no expected release of activity/no fire accident

isolate the package by cordoning of at least 1 m in all directions.

In the event of the package falling in a river or any water body

Recover the package out of the water body. If necessary, with police help, obtain an appropriate mechanical facility such as a boat/crane with manpower to recover the package. Note where exactly the package fell and inform the expert team when it arrives.

Other precautionary actions

- Wear protective clothing.
- Keep idle onlookers away.
- Stay in the upwind direction.

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- Inspect package visually. If it is intact, continue shipment in the same vehicle; if vehicle is damaged transfer package to another vehicle using appropriate crane.
- Remove packages carefully and clear the road/rail track for traffic to resume.
- Obtain names and addresses of persons who might have been exposed to radiation and communicate details to the addresses given below.

Immediately contact for advice and assistance at the addresses given below

Contact details (telephone number, fax number, email) for advice and assistance

- The consignor (Address can be found on the package / transport documents)
- National Emergency Response Agency

ANNEX III: TEMPLATE FOR THE 'CARRIER AND CONSIGNOR EMERGENCY RESPONSE PLAN'

TITLE (COVER) PAGE

On the title (cover) page write the title of the plan, approval date, version number and signatures. The signatures should include the heads of all the participating organizations.

CONTENTS

1. INTRODUCTION

This section should describe the objectives of the plan. It should include a description of the contents of the plan, e. g. as a contents page. It should state the scope of the plan and what phases of the emergency it covers. It should also describe any relevant regulatory or legal frameworks that it satisfies.

1.1. Responsibility

This section should list the individual responsible for implementation and maintenance of the plan.

2. OVERVIEW OF SHIPMENTS

This section provides a general description of the different types of packages that will be transported, along with how they should be handled and the appropriate transport conditions. Documents that could provide more information in this regard are also referred to, along with where to find these documents.

3. INTERNAL ORGANIZATION OF THE RESPONSE ENTITIES

This section presents the transporting party's organizational plans and provisions for managing an incident or emergency situation. These must be consistent with public authority plans.

The following key points should be addressed:

(a) The organizational approach to detecting a possible event, and the dissemination of the subsequent alert;

(b) The organizational approach to the response following the alert, both for the initial phase and the longer term;

(c) The organizational approach to a long term emergency;

(d) The organizational approach to the exit period of the emergency phase.

For each scenario, the roles and responsibilities of each actor in the planned organization are presented, specifying the measures that will be taken to guarantee the availability of the actors and their replacements over the long term, if required.

The plan should also describe the locations of the actors, their decision making levels (including the level of outside communication) and the interactions that should take place between them.

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The interactions with public authorities and the procedures involved must also be specified, and flowcharts/organizational diagrams are included.

4. PROCEDURES FOR TRIGGERING THE PLAN AND MAKING NOTIFICATIONS

This section should describe all the means for detecting an incident or emergency involving a shipment of radioactive substances, the criteria for triggering the emergency response plan, and the procedures for alerting external actors and/or the public authorities who need to be informed, so that they can deploy the planned response.

4.1. Notification points and notification procedures (including an event notification form such as provided in Annex I)

This section should list the response organizations which should be contacted when an emergency occurs.

5. CONCEPT OF OPERATIONS

5.1. Personnel capable of intervening and any expertise or partnerships

This section should describe the capacity to bring in entities and personnel with the required skills and experience necessary for public authorities to be able to respond. It should state which parties are liable to intervene, their training/qualifications and a time frame for intervention. If these measures include using an external company, the particulars of that company and the scope of its contribution should be specified.

5.2. Emergency scenarios to be considered

This section should identify the emergency scenarios to be considered, along with their consequences. It should include single or combined failures of safety functions, alongside human error. The level of detail for each of these scenarios should be proportional to the perceived risk.

In particular, the identification of consequences should include cover the individual doses received and an evaluation of the toxic consequences.

5.3. Material resources available for deployment to the site of the event

This section should list the equipment necessary if an event occurs, and how to procure it if needed. It should include equipment required during all phases of the emergency. The time and resources needed to make this equipment available should be stipulated, and a link should be made to the emergency scenarios in section 5.2 of the plan.

5.4. Provisions for the emergency response phase

This section should specify the steps to be taken to manage emergency situations.

5.5. Reception area for damaged packages

This section should identify characteristics of representative sites where damaged packages could be routed while maintaining an adequate level of safety. Agreements or partnerships with the various sites shall be specified, along with the steps necessary to gain authorization for the movement of damaged packages.

5.6. Provisions for the transition phase

This section should make provisions for organizational measures for the transition phase, as preparation for recovery. In particular, this entails identifying the conditions for exiting the emergency response phase and the termination phase.

6. EMERGENCY MANAGEMENT TOOLS

This section should outline the operational tools that may be included as part of a plan to help manage the emergency; examples are given below.

6.1. Decision aid

This could include practical tools, such as a logic diagrams, to direct the user to the most appropriate recommendation for dealing with the situation encountered.

6.2. Reflex response sheets

This is a sheet for each step in the emergency plan, for each actor involved, outlining the steps to be taken in chronological order. It should include details of the conditions for using the sheet, the expected results and the conditions for ending use of the sheet.

6.3. Standard messages

A standard approach to formatting is recommended for transmitting messages and listing the information to be provided, such as date, time, sender details, reference, event concerned.

6.4. External communication

External communication tools are recommended for responding to the public, to other authorities and to queries from local, national and international media.

6.5. Recording and archiving of communications

This should describe how the various communications are logged during management of the emergency, and how they are archived and made available.

7. EMERGENCY PREPAREDNESS

This section should describe how the emergency response capability will be maintained to sustain operational readiness.

7.1. Training of personnel

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This should include details of the training of all the actors described in the plan and a method to ensure that a sufficient number of qualified and trained personnel are always available to implement the plan when required.

7.2. Exercises

This should outline details of the exercises needed to test the plan's adequacy and the intervals at which they will take place. The frequency and scope of exercises testing different areas of the plan should be described, as well as the level of involvement from other parties external to the carrier/consignor.

7.3. Experience feedback

This should describe how learning from exercises, real emergencies and external sources is included in the plan, and the frequency with which these learning opportunities are reviewed.

7.4. Renewal of partnerships

The procedures for the renewal of any partnerships or agreements are specified.

7.5. Quality assurance

This should describe how the quality of the plan is maintained. The provisions for the management of any documentation related to quality assurance should be described, e.g. monitoring, updating, accessibility.

Annex I Contact Information

Annex II Notification Form

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