From: OST01 HOC
Sent: Friday, April 01, 2011 12:58 AM
To: ET07 Hoc; RST01 Hoc; PMT02 Hoc; PMT11 Hoc; Hoc, PMT12
Cc: FOIA Response.hoc Resource
Subject: FW: Basis for IAEA review of Japan OILs
Attachments: GSG-2 Criteria for use in preparedness and response for nuclear or radiological emergency.pdf

From: HOO Hoc
Sent: Friday, April 01, 2011 12:55 AM
To: LIA07 Hoc; OST01 HOC; OST02 HOC; OST03 HOC
Subject: FW: Basis for IAEA review of Japan OILs

Headquarters Operations Officer
U.S. Nuclear Regulatory Commission
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e-mail: hoo.hoc@nrc.gov

From: IEC14@iaea.org [mailto:IEC14@iaea.org]
Sent: Friday, April 01, 2011 12:48 AM
To: HOO Hoc; Hoc, PMT12
Cc: IEC3@iaea.org
Subject: [WARNING: MESSAGE ENCRYPTED]Basis for IAEA review of Japan OILs

Dear NRC,
Further to our recent telephone call, please find attached a the pre-release version of the IAEA document: GSG-2 Criteria for use in preparedness and response for nuclear or radiological emergency. It has also been posted on ENAC under Documents (but not under the emergency).

This document has been used as the basis of the review the IAEA conducted as summarized below.

Based on measurements of I-131 and Cs-137 in soil, sampled from 18 to 26 March in 9 municipalities at distances of 25 to 58 km from the Fukushima Nuclear Power Plant, the total deposition of iodine-131 and cesium-137 has been calculated. The results indicate a pronounced spatial variability of the total deposition of iodine-131 and cesium-137. The average total deposition determined at these locations for iodine-131 range from 0.2 to 25 Megabecquerel per square metre and for cesium-137 from 0.02-3.7 Megabecquerel per square metre. The highest values were found in a relatively small area in the Northwest from the Fukushima Nuclear Power Plant. First assessment indicates that one of the IAEA operational criteria for evacuation is exceeded in Iitate village. We advised the counterpart to carefully assess the situation. They indicated that they are already assessing.

Should you have any questions please do not hesitate to ask.

Regards,

AK/141

Pat Kenny

ERM on duty
Emergency Response Manager, IEC
x26622

Attachment GSG-2 Criteria for use in preparedness and response for nuclear or radiological emergency.pdf(1314325 bytes) cannot be converted to PDF format.

IAEA Safety Standards

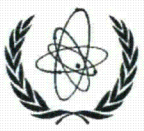
for protecting people and the environment

Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency

Jointly sponsored by the
FAO, IAEA, ILO, PAHO, WHO

General Safety Guide

No. GSG-2



IAEA
International Atomic Energy Agency

IAEA SAFETY RELATED PUBLICATIONS

IAEA SAFETY STANDARDS

Under the terms of Article III of its Statute, the IAEA is authorized to establish or adopt standards of safety for protection of health and minimization of danger to life and property, and to provide for the application of these standards.

The publications by means of which the IAEA establishes standards are issued in the **IAEA Safety Standards Series**. This series covers nuclear safety, radiation safety, transport safety and waste safety. The publication categories in the series are **Safety Fundamentals**, **Safety Requirements** and **Safety Guides**.

Information on the IAEA's safety standards programme is available at the IAEA Internet site

http://www-ns.iaea.org/standards/

The site provides the texts in English of published and draft safety standards. The texts of safety standards issued in Arabic, Chinese, French, Russian and Spanish, the IAEA Safety Glossary and a status report for safety standards under development are also available. For further information, please contact the IAEA at PO Box 100, 1400 Vienna, Austria.

All users of IAEA safety standards are invited to inform the IAEA of experience in their use (e.g. as a basis for national regulations, for safety reviews and for training courses) for the purpose of ensuring that they continue to meet users' needs. Information may be provided via the IAEA Internet site or by post, as above, or by email to Official.Mail@iaea.org.

OTHER SAFETY RELATED PUBLICATIONS

The IAEA provides for the application of the standards and, under the terms of Articles III and VIII.C of its Statute, makes available and fosters the exchange of information relating to peaceful nuclear activities and serves as an intermediary among its Member States for this purpose.

Reports on safety and protection in nuclear activities are issued as **Safety Reports**, which provide practical examples and detailed methods that can be used in support of the safety standards.

Other safety related IAEA publications are issued as **Radiological Assessment Reports**, the International Nuclear Safety Group's **INSAG Reports**, **Technical Reports** and **TECDOCs**. The IAEA also issues reports on radiological accidents, training manuals and practical manuals, and other special safety related publications. Security related publications are issued in the **IAEA Nuclear Security Series**.

CRITERIA FOR USE IN
PREPAREDNESS AND
RESPONSE FOR A
NUCLEAR OR RADIOLOGICAL
EMERGENCY

IAEA SAFETY STANDARDS SERIES No. GSG-2

CRITERIA FOR USE IN PREPAREDNESS AND RESPONSE FOR A NUCLEAR OR RADIOLOGICAL EMERGENCY

GENERAL SAFETY GUIDE

JOINTLY SPONSORED BY THE
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS,
INTERNATIONAL ATOMIC ENERGY AGENCY,
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FOREWORD

by Yukiya Amano
Director General

The IAEA's Statute authorizes the Agency to "establish or adopt… standards of safety for protection of health and minimization of danger to life and property" — standards that the IAEA must use in its own operations, and which States can apply by means of their regulatory provisions for nuclear and radiation safety. The IAEA does this in consultation with the competent organs of the United Nations and with the specialized agencies concerned. A comprehensive set of high quality standards under regular review is a key element of a stable and sustainable global safety regime, as is the IAEA's assistance in their application.

The IAEA commenced its safety standards programme in 1958. The emphasis placed on quality, fitness for purpose and continuous improvement has led to the widespread use of the IAEA standards throughout the world. The Safety Standards Series now includes unified Fundamental Safety Principles, which represent an international consensus on what must constitute a high level of protection and safety. With the strong support of the Commission on Safety Standards, the IAEA is working to promote the global acceptance and use of its standards.

Standards are only effective if they are properly applied in practice. The IAEA's safety services encompass design, siting and engineering safety, operational safety, radiation safety, safe transport of radioactive material and safe management of radioactive waste, as well as governmental organization, regulatory matters and safety culture in organizations. These safety services assist Member States in the application of the standards and enable valuable experience and insights to be shared.

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

Safety is not an end in itself but a prerequisite for the purpose of the protection of people in all States and of the environment — now and in the future. The risks associated with ionizing radiation must be assessed and controlled without unduly limiting the contribution of nuclear energy to equitable and sustainable development. Governments, regulatory bodies and operators everywhere must ensure that nuclear material and radiation sources are used beneficially, safely and ethically. The IAEA safety standards are designed to facilitate this, and I encourage all Member States to make use of them.

PREFACE

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

The Convention on Early Notification of a Nuclear Accident ('the Early Notification Convention') and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency ('the Assistance Convention') (IAEA Legal Series No. 14), adopted in 1986, place specific obligations on the Parties and on the IAEA. Under Article 5a(ii) of the Assistance Convention, one function of the IAEA is to collect and disseminate to States Parties and Member States information concerning methodologies, techniques and available results of research relating to response to such emergencies.

This Safety Guide is intended to assist Member States in the application of the Safety Requirements publication on Preparedness and Response for a Nuclear or Radiological Emergency (IAEA Safety Standards Series No. GS-R-2), and to help in the fulfilment of the IAEA's obligations under the Assistance Convention. It provides generic criteria for protective actions and other response actions in the case of a nuclear or radiological emergency, including numerical values of these criteria. It also presents operational criteria derived from specific generic criteria.

The Food and Agriculture Organization of the United Nations (FAO), the International Labour Office (ILO), the Pan American Health Organization (PAHO) and the World Health Organization (WHO) are joint sponsors of this Safety Guide.

THE IAEA SAFETY STANDARDS

BACKGROUND

Radioactivity is a natural phenomenon and natural sources of radiation are features of the environment. Radiation and radioactive substances have many beneficial applications, ranging from power generation to uses in medicine, industry and agriculture. The radiation risks to workers and the public and to the environment that may arise from these applications have to be assessed and, if necessary, controlled.

Activities such as the medical uses of radiation, the operation of nuclear installations, the production, transport and use of radioactive material, and the management of radioactive waste must therefore be subject to standards of safety.

Regulating safety is a national responsibility. However, radiation risks may transcend national borders, and international cooperation serves to promote and enhance safety globally by exchanging experience and by improving capabilities to control hazards, to prevent accidents, to respond to emergencies and to mitigate any harmful consequences.

States have an obligation of diligence and duty of care, and are expected to fulfil their national and international undertakings and obligations.

International safety standards provide support for States in meeting their obligations under general principles of international law, such as those relating to environmental protection. International safety standards also promote and assure confidence in safety and facilitate international commerce and trade.

A global nuclear safety regime is in place and is being continuously improved. IAEA safety standards, which support the implementation of binding international instruments and national safety infrastructures, are a cornerstone of this global regime. The IAEA safety standards constitute a useful tool for contracting parties to assess their performance under these international conventions.

THE IAEA SAFETY STANDARDS

The status of the IAEA safety standards derives from the IAEA's Statute, which authorizes the IAEA to establish or adopt, in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, standards of safety for protection of health and minimization of danger to life and property, and to provide for their application.

With a view to ensuring the protection of people and the environment from harmful effects of ionizing radiation, the IAEA safety standards establish

fundamental safety principles, requirements and measures to control the radiation exposure of people and the release of radioactive material to the environment, to restrict the likelihood of events that might lead to a loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source of radiation, and to mitigate the consequences of such events if they were to occur. The standards apply to facilities and activities that give rise to radiation risks, including nuclear installations, the use of radiation and radioactive sources, the transport of radioactive material and the management of radioactive waste.

Safety measures and security measures[1] have in common the aim of protecting human life and health and the environment. Safety measures and security measures must be designed and implemented in an integrated manner so that security measures do not compromise safety and safety measures do not compromise security.

The IAEA safety standards reflect an international consensus on what constitutes a high level of safety for protecting people and the environment from harmful effects of ionizing radiation. They are issued in the IAEA Safety Standards Series, which has three categories (see Fig. 1).

Safety Fundamentals

Safety Fundamentals present the fundamental safety objective and principles of protection and safety, and provide the basis for the safety requirements.

Safety Requirements

An integrated and consistent set of Safety Requirements establishes the requirements that must be met to ensure the protection of people and the environment, both now and in the future. The requirements are governed by the objective and principles of the Safety Fundamentals. If the requirements are not met, measures must be taken to reach or restore the required level of safety. The format and style of the requirements facilitate their use for the establishment, in a harmonized manner, of a national regulatory framework. Requirements, including numbered 'overarching' requirements, are expressed as 'shall' statements. Many requirements are not addressed to a specific party, the implication being that the appropriate parties are responsible for fulfilling them.

Safety Guides

Safety Guides provide recommendations and guidance on how to comply with the safety requirements, indicating an international consensus that it is necessary to take the measures recommended (or equivalent alternative measures). The Safety Guides present international good practices, and increasingly they reflect best

[1] See also publications issued in the IAEA Nuclear Security Series.

FIG 1. The long term structure of the IAEA Safety Standards Series.

practices, to help users striving to achieve high levels of safety. The recommendations provided in Safety Guides are expressed as 'should' statements.

APPLICATION OF THE IAEA SAFETY STANDARDS

The principal users of safety standards in IAEA Member States are regulatory bodies and other relevant national authorities. The IAEA safety standards are also used by co-sponsoring organizations and by many organizations that design, construct and operate nuclear facilities, as well as organizations involved in the use of radiation and radioactive sources.

The IAEA safety standards are applicable, as relevant, throughout the entire lifetime of all facilities and activities — existing and new — utilized for peaceful purposes and to protective actions to reduce existing radiation risks. They can be used by States as a reference for their national regulations in respect of facilities and activities.

The IAEA's Statute makes the safety standards binding on the IAEA in relation to its own operations and also on States in relation to IAEA assisted operations.

The IAEA safety standards also form the basis for the IAEA's safety review services, and they are used by the IAEA in support of competence building, including the development of educational curricula and training courses.

International conventions contain requirements similar to those in the IAEA safety standards and make them binding on contracting parties. The IAEA safety standards, supplemented by international conventions, industry standards and detailed national requirements, establish a consistent basis for protecting people and the environment. There will also be some special aspects of safety that need to be assessed at the national level. For example, many of the IAEA safety standards, in particular those addressing aspects of safety in planning or design, are intended to apply primarily to new facilities and activities. The requirements established in the IAEA safety standards might not be fully met at some existing facilities that were built to earlier standards. The way in which IAEA safety standards are to be applied to such facilities is a decision for individual States.

The scientific considerations underlying the IAEA safety standards provide an objective basis for decisions concerning safety; however, decision makers must also make informed judgements and must determine how best to balance the benefits of an action or an activity against the associated radiation risks and any other detrimental impacts to which it gives rise.

DEVELOPMENT PROCESS FOR THE IAEA SAFETY STANDARDS

The preparation and review of the safety standards involves the IAEA Secretariat and four safety standards committees, for nuclear safety (NUSSC), radiation safety (RASSC), the safety of radioactive waste (WASSC) and the safe transport of radioactive material (TRANSSC), and a Commission on Safety Standards (CSS) which oversees the IAEA safety standards programme (see Fig. 2).

All IAEA Member States may nominate experts for the safety standards committees and may provide comments on draft standards. The membership of the Commission on Safety Standards is appointed by the Director General and includes senior governmental officials having responsibility for establishing national standards.

A management system has been established for the processes of planning, developing, reviewing, revising and establishing the IAEA safety standards. It articulates the mandate of the IAEA, the vision for the future application of the

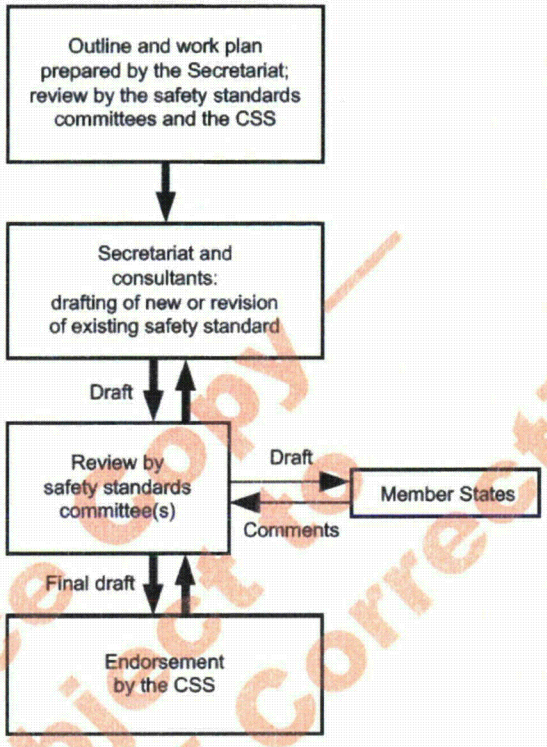

FIG. 2. The process for developing a new safety standard or revising an existing standard.

safety standards, policies and strategies, and corresponding functions and responsibilities.

INTERACTION WITH OTHER INTERNATIONAL ORGANIZATIONS

The findings of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and the recommendations of international expert bodies, notably the International Commission on Radiological Protection (ICRP), are taken into account in developing the IAEA safety standards. Some safety standards are developed in cooperation with other bodies in the United Nations system or other specialized agencies, including the Food and Agriculture Organization of the United Nations, the United Nations Environment Programme, the International Labour Organization, the OECD Nuclear Energy Agency, the Pan American Health Organization and the World Health Organization.

INTERPRETATION OF THE TEXT

Safety related terms are to be understood as defined in the IAEA Safety Glossary (see http://www-ns.iaea.org/standards/safety-glossary.htm). Otherwise, words are used with the spellings and meanings assigned to them in the latest edition of The Concise Oxford Dictionary. For Safety Guides, the English version of the text is the authoritative version.

The background and context of each standard in the IAEA Safety Standards Series and its objective, scope and structure are explained in Section 1, Introduction, of each publication.

Material for which there is no appropriate place in the body text (e.g. material that is subsidiary to or separate from the body text, is included in support of statements in the body text, or describes methods of calculation, procedures or limits and conditions) may be presented in appendices or annexes.

An appendix, if included, is considered to form an integral part of the safety standard. Material in an appendix has the same status as the body text, and the IAEA assumes authorship of it. Annexes and footnotes to the main text, if included, are used to provide practical examples or additional information or explanation. Annexes and footnotes are not integral parts of the main text. Annex material published by the IAEA is not necessarily issued under its authorship; material under other authorship may be presented in annexes to the safety standards. Extraneous material presented in annexes is excerpted and adapted as necessary to be generally useful.

CONTENTS

1. INTRODUCTION

BACKGROUND

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

1.2. In March 2002, the IAEA's Board of Governors approved a Safety Requirements publication, Preparedness and Response for a Nuclear or Radiological Emergency, which establishes the requirements for an adequate level of preparedness for and response to a nuclear or radiological emergency in any State. This was jointly sponsored by seven international organizations and was issued as IAEA Safety Standards Series No. GS-R-2 [2].

1.3. A rigorous assessment of experience in Member States has shown that there is a need for additional consistent international guidance on taking protective actions and other response actions[1], and for placing this guidance in a context that is comprehensive for decision makers and that can be explained to the public. In 2005, the IAEA issued a publication, jointly sponsored by the World Health Organization (WHO) [3], that presents numerical values for generic criteria for emergency response and provides additional guidance. The criteria are described and needs for their development on the basis of lessons learned from experience and related scientific knowledge are explained. The framework proposed in Ref. [3] was used as the starting point for developing revised international guidance on emergency preparedness and response.

1.4. Principle 9 of the Fundamental Safety Principles establishes that arrangements for emergency preparedness and response include "[c]riteria set in advance for use in determining when to take different protective actions" (Ref. [4], para. 3.36). The present Safety Guide provides recommendations on such criteria.

[1] Examples of other response actions include the provision of public information, medical treatment and long term health monitoring.

1.5. Safety related terms used in this Safety Guide are to be understood as defined in the IAEA Safety Glossary [5].

OBJECTIVE

1.6. The primary objective of this Safety Guide is:

— To present a coherent set of generic criteria (expressed numerically in terms of radiation dose) that form a basis for developing the operational levels needed for decision making concerning protective actions and other response actions necessary to meet the emergency response objectives. The set of generic criteria:
  - Addresses the requirements of Ref. [2] for emergency preparedness and response;
  - Addresses lessons learned from responses to past emergencies;
  - Provides an internally consistent foundation for the application of principles of and insights into radiation protection for the conceivable range of protective actions and other response actions, and of emergency conditions.

— To propose a basis for a plain language explanation of the criteria for the public and for public officials that addresses the risks to human health of radiation exposure and provides a basis for a response that is commensurate with the risks.

1.7. This Safety Guide should be used in conjunction with Ref. [2], which it supports. It provides recommendations on meeting the requirements of Ref. [2] by providing generic criteria, and numerical values for these criteria, for protective actions and other response actions in the event of a nuclear or radiological emergency. This Safety Guide also presents operational criteria derived from specific generic criteria and as such represents the revision of Ref. [6].

SCOPE

1.8. The recommendations presented in this Safety Guide concern the values of the generic criteria needed to develop operational criteria for implementing protective actions and other response actions to protect emergency workers and the public in the event of a nuclear or radiological emergency.

1.9. Examples of default operational criteria for implementing protective actions and other response actions are also provided. The method used for the development of operational criteria is described only in general terms.[2]

1.10. This Safety Guide addresses the criteria for initiating protective actions and other response actions and criteria to support decision making in an emergency.

1.11. This Safety Guide excludes recommendations for actions that might be required in an existing exposure situation.

1.12. This Safety Guide does not provide detailed guidance on the arrangements necessary for developing and maintaining an effective emergency response capability. Detailed recommendations on developing and maintaining an effective emergency response capability are provided in Refs [7–9].

1.13. This Safety Guide cannot take into account all factors that are site specific, local, State specific or specific to a particular type of emergency. Emergency planners should remain flexible in their use of the guidance and should work with interested parties to adapt the recommendations so as to take account of local, social, political, economic, environmental, demographic and other factors.

1.14. Protective actions and other response actions are not based on attributes relating to radiation protection alone. Decision makers should consider various social, economic, environmental and psychological factors before making any final decision on actions to be taken in response to an emergency. However, the recommendations on generic and operational criteria presented in this Safety Guide relate solely to that input into the decision making process that is based on considerations of radiation protection.

1.15. Decision makers in an emergency and the public may have only a limited or no understanding of the principles of radiation protection, the risks associated with radiation exposure and the appropriate actions that can be taken to reduce these risks. This Safety Guide therefore also provides a plain language explanation of the operational criteria, to assist in the communication of the purpose of each of the criteria and the associated protective actions and other response actions.

[2] A manual for assessment of field data in a nuclear or radiological emergency is in preparation.

STRUCTURE

1.16. This Safety Guide has five sections. Section 2 provides a discussion of the basic considerations used in the development of the recommendations. Sections 3 and 4 provide recommendations on emergency response criteria for protective actions and other response actions for protecting the public and on guidance values for emergency workers, respectively. Section 5 discusses operational criteria. The four appendices provide further elaboration on and clarification of the recommendations provided in the main text.

2. BASIC CONSIDERATIONS

2.1. Experience has clearly shown that an internationally endorsed, fully integrated system of guidance is necessary for taking consistent protective actions and other response actions in an emergency that will best ensure public safety. This system should build on existing international guidance and experience, should be based on international consensus and should subsequently be implemented at the national level. Implementing compatible systems at the national level in different States will allow the objectives of emergency response to be met and will contribute towards establishing a harmonized system for emergency preparedness and response worldwide.

2.2. The framework of generic criteria for emergency response presented in this Safety Guide was developed on the understanding that it should be simple and consistent.

2.3. This Safety Guide was developed with due consideration of the relevant international guidance that provides recommendations for the response to a nuclear or radiological emergency [2, 6, 10–15].

2.4. The recommendations presented in the Safety Guide address health consequences due to external exposure and internal exposure of specific target organs, for which the generic criteria were developed. For the recommendations on how to meet the requirements of Ref. [2], thresholds for severe deterministic effects[3] for both external exposure and internal exposure were developed that could be directly related to the full range of important radionuclides.

[3] A deterministic effect is considered to be a severe deterministic effect if it is fatal or life threatening or if it results in a permanent injury that reduces quality of life [2, 5].

2.5. Generic criteria are based on current knowledge of deterministic and stochastic effects (see Ref. [3] for the basis for the numerical values of the criteria addressing deterministic and stochastic effects).

3. FRAMEWORK FOR EMERGENCY RESPONSE CRITERIA

SYSTEM OF PROTECTIVE ACTIONS AND OTHER RESPONSE ACTIONS

3.1. The system of protective actions and other response actions in an emergency (see Table 1) includes numerical values of generic criteria as well as of the corresponding operational criteria that form the basis for decision making in an emergency.

TABLE 1. SYSTEM OF PROTECTIVE ACTIONS AND OTHER RESPONSE ACTIONS IN AN EMERGENCY

Types of possible health consequences of exposure	Basis for implementation of protective actions and other response actions	
	Projected dose	Dose received
Severe deterministic effects[a]	Implementation of precautionary urgent protective actions, even under adverse conditions, to prevent severe deterministic effects	Other response actions[b] for treatment and management of severe deterministic effects
Increase in stochastic effects	Implementation of urgent protective actions and initiation of early protective actions[c] to reduce the risk of stochastic effects as far as reasonably possible	Other response actions[d] for early detection and effective management of stochastic effects

[a] Generic criteria are established at levels of dose that are approaching the thresholds for severe deterministic effects.

[b] Such actions include immediate medical examination, consultation and treatment as indicated, contamination control, decorporation where applicable, registration for long term health monitoring, and comprehensive psychological counselling.

[c] Such actions include relocation and long term restriction of consumption of contaminated food.

[d] Such actions include screening based on individual doses to specific organs, to consider the need for registration for medical follow-up and counselling to allow informed decisions to be made in individual circumstances.

3.2. The following considerations form the basis of this system:

— The following possible outcomes should be considered during the planning and implementation of protective actions and other response actions in an emergency:
  - Development of severe deterministic effects[4];
  - Increase in stochastic effects;
  - Adverse effects on the environment and property;
  - Other adverse effects (e.g. psychological effects, social disorder, economic disruption).
— The following types of exposure should be taken into account in the planning and implementation of protective actions and other response actions in an emergency:
  - The projected dose that could be prevented or reduced by means of precautionary urgent protective actions;
  - The dose that has been received, the detriment due to which may be minimized by, for example, medical actions, as required, and may be addressed by public reassurance or counselling.
— Precautionary urgent protective actions should be implemented before the event (on the basis of a substantial risk of a release or exposure) under any circumstances, in order to prevent the development of severe deterministic effects for very high levels of dose (generic criteria are presented in Table 2).
— If the risk of stochastic effects is the main concern and the risk of the development of severe deterministic effects is negligible, urgent and early protective actions and other response actions, all of which are justified and optimized, should be implemented to reduce the risk of stochastic effects (generic criteria are presented in Table 3).
— If the dose exceeds a particular generic criterion identified in Table 2 or 3, individuals should be provided with appropriate medical attention, including medical treatment[5], long term health monitoring and psychological counselling.

[4] See Appendix I.

[5] Medical actions should be initiated and performed on the basis of medical symptoms and observations. However, dosimetric information (e.g. based on radiation survey data, dose measurements or dose calculations) can provide a valuable input for determining the medical treatment.

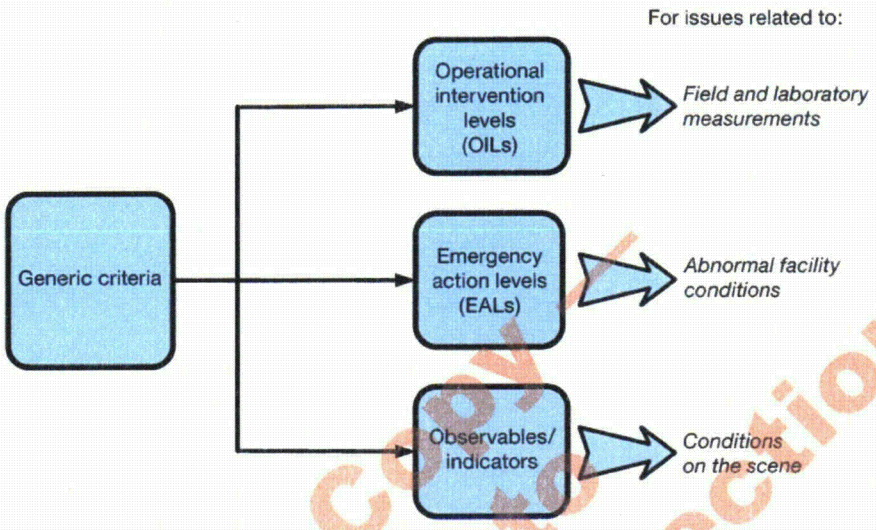

FIG. 1. System of generic criteria and operational criteria.

— For all levels of dose that may result in an emergency exposure situation, a plain language explanation of the risks should be provided to decision makers and the public to allow them to make informed decisions about what actions they will take.

3.3. Table 1 summarizes, for different types of possible health consequences of exposure, the basis for implementation of protective actions and other response actions. A summary of the dose concepts and the dosimetric quantities is provided in Appendix I.

3.4. The system of generic criteria and operational criteria is illustrated in Fig. 1. Generic criteria are provided in terms of dose that can be projected or dose that has already been received. The operational criteria[6] are values of measurable quantities or observables that include operational intervention levels (OILs), emergency action levels (EALs), specific observables and other indicators of conditions on the scene that should be used in decision making during an

[6] These operational criteria are used as 'triggers' at the early stage of an emergency, and in some publications the term 'trigger' is used.

emergency. The operational criteria can be used immediately and directly to determine the need for appropriate protective actions and other response actions.

3.5. Generic criteria have been established on the basis of generic optimization in consideration of the range of conditions that prevail in an emergency. Generic criteria are established for urgent protective actions and early protective actions, as well as for other response actions that may be required in an emergency. Urgent protective actions (e.g. evacuation) should be taken promptly (e.g. within hours) to be effective, because their effectiveness will be reduced by delay [6]. Early protective actions should be implemented within days or weeks to be effective. They can be long lasting, even after the emergency (e.g. temporary relocation). In no case should urgent protective actions and early protective actions based on the generic criteria cause more detriment than they avert. Event specific conditions may warrant modification of the generic criteria.

3.6. The generic criteria replace the system of generic intervention levels (GILs) and generic action levels (GALs) that have been described in previous standards [6, 10]. This use of generic criteria meets the need for a common term for the system of values that would be used as the basis for the implementation of protective actions (e.g. evacuation or food replacement) and other response actions (e.g. medical follow-up).

3.7. A protection strategy, comprising specific protective actions and other response actions, should be developed. It should include, but should not be limited to, the following aspects:

— Generic criteria for implementing precautionary urgent protective actions to prevent severe deterministic effects should be established (see Table 2).
— A reference level should be set, typically an effective dose of between 20 and 100 mSv, expressed in terms of residual dose, which includes dose contributions via all exposure pathways. The protection strategy should be optimized to reduce exposures below the reference level.
— On the basis of the outcome of the optimization of the protection strategy, and by using the reference level, generic criteria for particular protective actions and other response actions, expressed in terms of projected dose or dose that has been received, should be developed. If the numerical values of the generic criteria are expected to be exceeded, those actions, either individually or in combination, should be implemented. Table 3 provides a set of generic criteria for use in the protection strategy that are compatible with reference levels within a range of 20–100 mSv, as well as further details for specific actions in different time frames. The implementation of

protective actions and other response actions, given in Table 3, would prevent a significant amount of dose.

— Once the protection strategy has been optimized and a set of generic criteria has been developed, default triggers for initiating the different parts of an emergency response plan, primarily for the early phase, should be derived from the generic criteria. Default triggers, such as conditions on the scene, OILs and EALs, should be expressed in terms of parameters or observable conditions. Arrangements should be established in advance to revise these triggers, as appropriate, in an emergency exposure situation, with account taken of the prevailing conditions as they evolve.

3.8. Table 2 presents generic criteria (expressed in terms of the dose that is projected or dose that has been received) for taking precautionary urgent protective actions under any circumstances to prevent severe deterministic effects.

3.9. Table 3 provides a set of generic criteria expressed in terms of the dose that has been projected or the dose that has been received. The set of generic criteria expressed in terms of the projected dose compatible with reference levels within a range of 20–100 mSv. Taking protective actions at this level of dose will allow the occurrence of all deterministic effects to be avoided and the risk of stochastic effects to be reduced to acceptable levels. If a protective action is implemented effectively, the majority of the projected dose can be averted. The concept of averted dose is therefore useful for the assessment of the efficiency of individual protective actions or their combination. The concept of averted dose represents an important component of the optimization of emergency response planning [15]. In the application of generic criteria for individual protective actions, the process of optimization of emergency response planning should be applied.

3.10. The generic criterion provided in Table 3 for iodine thyroid blocking is applied for an urgent protective action: (a) if exposure due to radioactive iodine is involved, (b) before or shortly after a release of radioactive iodine, and (c) within only a short period after the intake of radioactive iodine. Less disruptive protective actions such as sheltering could be implemented for lower doses.

3.11. In the absence of national guidance, the generic criteria presented in Tables 2 and 3 could be used as a basis for the development of criteria at the national level. If a reference level different from 20–100 mSv is chosen, appropriate scaling of the values of the generic criteria in Table 3 should be carried out, with account taken of the time frame (acute or annual) of the

TABLE 2. GENERIC CRITERIA FOR ACUTE DOSES FOR WHICH PROTECTIVE ACTIONS AND OTHER RESPONSE ACTIONS ARE EXPECTED TO BE TAKEN UNDER ANY CIRCUMSTANCES TO AVOID OR TO MINIMIZE SEVERE DETERMINISTIC EFFECTS

Generic criteria		Examples of protective actions and other response actions
External acute exposure (<10 hours)		If the dose is projected: — Take precautionary urgent protective actions immediately (even under difficult conditions) to keep doses below the generic criteria — Provide public information and warnings — Carry out urgent decontamination
$AD_{\text{Red marrow}}$ [a]	1 Gy	
AD_{Fetus}	0.1 Gy	
AD_{Tissue} [b]	25 Gy at 0.5 cm	
AD_{Skin} [c]	10 Gy to 100 cm^2	
Internal exposure from acute intake (Δ = 30 days)[d]		If the dose has been received: — Perform immediate medical examination, consultation and indicated medical treatment — Carry out contamination control — Carry out immediate decorporation[f] (if applicable) — Carry out registration for long term health monitoring (medical follow-up) — Provide comprehensive psychological counselling
$AD(\Delta)_{\text{Red marrow}}$	0.2 Gy for radionuclides with $Z \geq 90$[e] 2 Gy for radionuclides with $Z \leq 89$[e]	
$AD(\Delta)_{\text{Thyroid}}$	2 Gy	
$AD(\Delta)_{\text{Lung}}$ [g]	30 Gy	
$AD(\Delta)_{\text{Colon}}$	20 Gy	
$AD(\Delta')_{\text{Fetus}}$ [h]	0.1 Gy	

[a] $AD_{\text{Red marrow}}$ represents the average RBE weighted absorbed dose to internal tissues or organs (e.g. red marrow, lung, small intestine, gonads, thyroid) and to the lens of the eye from exposure in a uniform field of strongly penetrating radiation.

[b] Dose delivered to 100 cm^2 at a depth of 0.5 cm under the body surface in tissue due to close contact with a radioactive source (e.g. source carried in the hand or pocket).

[c] The dose is to the 100 cm^2 dermis (skin structures at a depth of 40 mg/cm^2 (or 0.4 mm) below the body surface).

[d] $AD(\Delta)$ is the RBE weighted absorbed dose delivered over the period of time Δ by the intake (I_{05}) that will result in a severe deterministic effect in 5% of exposed individuals.

[e] Different criteria are used to take account of the significant difference in the radionuclide specific intake threshold values for the radionuclides in these groups [3].

[f] The generic criterion for decorporation is based on the projected dose without decorporation. Decorporation is the biological processes, facilitated by a chemical or biological agent, by which incorporated radionuclides are removed from the human body.

[g] For the purposes of these generic criteria, 'lung' means the alveolar-interstitial region of the respiratory tract.

[h] For this particular case, Δ' means the period of in utero development.

TABLE 3. GENERIC CRITERIA FOR PROTECTIVE ACTIONS AND OTHER RESPONSE ACTIONS IN EMERGENCY EXPOSURE SITUATIONS TO REDUCE THE RISK OF STOCHASTIC EFFECTS

Generic criteria		Examples of protective actions and other response actions
Projected dose that exceeds the following generic criteria: Take urgent protective actions and other response actions		
$H_{Thyroid}$	50 mSv in the first 7 days	Iodine thyroid blocking
E	100 mSv in the first 7 days	Sheltering; evacuation; decontamination; restriction of consumption of food, milk and water; contamination control; public reassurance
H_{Fetus}	100 mSv in the first 7 days	
Projected dose that exceeds the following generic criteria: Take protective actions and other response actions early in the response		
E	100 mSv per annum	Temporary relocation; decontamination; replacement of food, milk and water; public reassurance
H_{Fetus}	100 mSv for the full period of in utero development	
Dose that has been received and that exceeds the following generic criteria: Take longer term medical actions to detect and to effectively treat radiation induced health effects		
E	100 mSv in a month	Screening based on equivalent doses to specific radiosensitive organs (as a basis for medical follow-up), counselling
H_{Fetus}	100 mSv for the full period of in utero development	Counselling to allow informed decisions to be made in individual circumstances

Note: H_T — equivalent dose in an organ or tissue T; E — effective dose.

reference level. In exceptional circumstances, higher values of the generic criteria may be necessary.

3.12. Examples of when such higher values of generic criteria in exceptional circumstances may be warranted include cases in which replacement food or water is not available, cases of extreme weather conditions, natural disasters, the rapid progression of a situation and cases of malicious acts. Generic criteria used in such cases should not exceed those presented in Table 3 by a factor of more than 2–3.

SUBSTANTIAL RISK AS A BASIS FOR OPERATIONAL CRITERIA

3.13. The risk associated with a radioactive release or exposure is considered to be a 'substantial risk' if the release or exposure could result in early deaths or other severe deterministic effects.

3.14. The term 'substantial risk' is the basis for operational criteria for decision makers to take actions to prevent severe deterministic effects by keeping doses below those approaching the generic criteria set out in Table 2. These precautionary urgent protective actions are warranted under any circumstances [2].

3.15. Emergencies can result in early deaths or other severe deterministic effects unless urgent protective actions are taken. Examples include a nuclear emergency in a facility in threat category I [2], such as severe core damage at a nuclear power plant, a criticality accident or a radiological emergency in threat category IV involving a lost or stolen source or the malicious use of radioactive material [16]. For such emergencies, observed conditions indicating a substantial risk associated with a release or exposure that could result in severe deterministic effects should warrant precautionary urgent protective actions.

3.16. Reference [2] addresses this issue by stating that facilities in threat categories I, II and III[7] shall have appropriate arrangements in place for promptly detecting, classifying and responding to emergencies for which precautionary urgent protective actions should be taken to protect workers and the public from severe deterministic effects. Generic criteria, based on projected dose, for precautionary urgent protective actions to prevent severe deterministic effects, as provided in Table 2, should be used as the dosimetric criteria in defining those emergencies that have the potential to result in such health effects.

3.17. For emergencies in threat category IV [2] involving dangerous sources[8], precautionary urgent protective actions should also be undertaken before or shortly after the start of a release or exposure. These include transport and other authorized activities involving dangerous sources such as industrial radiography

[7] Threat categories I, II and III represent decreasing levels of threat at facilities and of the corresponding stringency of requirements for emergency preparedness and response arrangements. See para. 3.6 and table I of Ref. [2] for more details.

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

sources, nuclear powered satellites or radiothermal generators, as well as events involving possible unauthorized activities. Reference [2] establishes that the operator of a practice using a dangerous source shall make arrangements to respond promptly to an emergency involving the source in order to mitigate any consequences (Ref. [2], para. 4.37). The generic criteria in Table 2 are used as the dosimetric criteria in defining those sources that are considered dangerous [8, 17]. In addition, local officials should develop predetermined criteria for initiating precautionary urgent protective actions upon identifying a situation that could result in severe deterministic effects if no action were taken [18].

PROJECTED DOSE AS A BASIS FOR OPERATIONAL CRITERIA

3.18. The projected dose is the basis for operational criteria for decision makers to take actions that meet the following three objectives [2]:

- To prevent severe deterministic effects by keeping the dose below levels approaching the generic criteria in Table 2 at which urgent protective actions are warranted under any circumstances;
- To take effective protective actions and other response actions to reasonably reduce the risk of stochastic effects by keeping the dose below levels approaching the generic criteria in Table 3;
- To ensure the safety of emergency workers in the tasks being undertaken through the use of the guidance values in Table 4.

3.19. Urgent protective actions should always be introduced to avoid doses approaching levels at which, if received, severe deterministic effects could occur. It should be recognized that the doses received before implementation of the protective action could contribute to the induction of deterministic effects.

3.20. When assessing projected doses, the dose distribution should be considered together with the uncertainty in the dose distribution in the population under consideration. When exposure is being assessed for members of the public, the possibility of the presence of children and pregnant women should be considered.

3.21. The generic criteria in Table 2 are given separately for intake of radioactive material and for external exposure. For external exposure, the threshold for the development of deterministic effects depends on the dose, the dose rate and the relative biological effectiveness (RBE) of the radiation. For internal exposure, the threshold depends on many factors, such as intake activity, half-life, route of intake, the radionuclide emitted and the metabolism of the radionuclide. In order

to take all of these factors into account, the threshold for the development of specific deterministic effects following intake is best established in terms of intake activity [3]. However, the thresholds in terms of intake range over six orders of magnitude [3]. Establishing threshold values in terms of the 30 day committed RBE weighted dose relative to the intake thresholds leads to a decrease in the range of threshold values from six orders of magnitude (for the intake) down to a factor of three (for the dose). Therefore, in the case of inhalation or ingestion of radioactive material, a value of the 30 day committed RBE weighted absorbed dose is used to specify the threshold for the possible onset of severe deterministic effects in the organ concerned.

3.22. The RBE weighted averaged absorbed dose in an organ or tissue (RBE weighted absorbed dose) is defined as the product of the averaged absorbed dose in an organ or tissue and the RBE. The unit used to express the RBE weighted absorbed dose is the gray (Gy). For details see Appendix I.

3.23. In the case of combined internal and external exposure, the sum of the RBE weighted absorbed doses for intake of radioactive material and for external exposure may be used as a basis for calculation of OILs for decision making purposes, as discussed in detail in para. II.5 of appendix II of Ref. [3].

3.24. The generic criteria in Table 2 should be used to derive OILs for taking precautionary urgent protective actions and other response actions to prevent severe deterministic effects. For the purpose of taking actions to reduce the risk of stochastic effects, the principles of both justification and optimization require consideration of the benefit that would be achieved by the protective actions and other response actions and of the harm, in its broadest sense, that would result from them. Actions to prevent doses approaching those in Table 2 are always justified.

3.25. Table 3 provides the generic criteria that should be used to derive OILs for taking urgent and early protective actions and other response actions. The protection provided by applying these generic criteria has been optimized on a generic basis for the general population, assuming that other hazardous conditions do not prevail at the time the actions are implemented. The proposed values do not need to be adjusted to take account of any particular members of the population (e.g. children or pregnant women) because protective action taken to avert these doses will satisfy the basic principle for the whole population.

DOSE THAT HAS BEEN RECEIVED AS A BASIS FOR OPERATIONAL CRITERIA

3.26. In describing the dose that has been received, there is a need to distinguish between the planning stage and an actual situation. In the planning stage, the hypothetical dose that will be received falls under the definition of residual dose (the dose expected to be incurred in the future after protective actions have been terminated or a decision has been taken not to implement protective actions). In an actual situation, the dose that has been received is the actual dose received via all exposure pathways.

3.27. The dose that has been received is the basis for operational criteria to support the following actions:

— To provide medical care, as required, when the dose received exceeds the levels in Table 2 (see footnote 3 on page 4);
— To consider the need for medical follow-up for early detection and effective treatment of radiation induced cancers if the dose received exceeds the levels in Table 3;
— To provide counselling to those exposed, including pregnant women, so that they can make informed decisions concerning the further course of their treatment if the dose received exceeds the levels in Tables 2 and 3;
— To provide a basis for reassuring those who were not exposed above the levels specified in Tables 2 and 3 that there is no need for concern.

3.28. The dose that has been received supports decisions for urgent and longer term medical actions. Examples of urgent actions are medical triage on the scene of an emergency and specialized treatment in hospital shortly after an emergency. These actions are initiated and performed on the basis of medical symptoms and observations. However, in the performance of medical triage on the scene, observables (e.g. radiation signs and placards) and radiation survey data should be taken into account when they become available. Decisions on the implementation of medical actions in the hospital (e.g. the extent of exposed tissue to be excised during surgical treatment for local radiation injury and the efficiency of decorporation for internal contamination) are strongly supported by the dosimetric information. Long term health monitoring of exposed persons starts early during the response and continues for an extended period of time.

3.29. Medical records made during an emergency (especially on the site) should be focused on clinical symptoms and other observed facts, without including assumptions of causal association with radiation exposure. Such assumptions

might lead to anxiety and unjustified medical examination. Determining the cause of the symptoms requires analysis by experts.

3.30. There are different reasons to perform long term health monitoring of the persons affected, such as to provide advanced medical care, to reduce their concern with regard to their health status and to advance scientific knowledge. The reason for follow-up studies should be carefully explained to those involved.

3.31. Long term medical follow-up is justified to detect and treat late deterministic effects and their complications as well as radiation induced cancers. Long term health monitoring should be justified on the basis of one of the following levels of exposure:

— Long term health monitoring is always justified at levels of dose above the thresholds for deterministic effects [3].
— Justification of long term health monitoring at levels of dose below the thresholds for deterministic effects requires proper identification of populations at higher risk of developing radiation induced cancers. Medical follow-up should always result in more benefit than harm in terms of public health. One reason for establishing a registry and providing medical follow-up is for the early detection of disease. This is on the basis of the assumption that earlier diagnosis of cancer will result in more efficient treatment and thus in reduced morbidity and mortality. The level of exposure of radiosensitive organs expressed in equivalent dose and the possibility of detecting cancer among the exposed population should be taken into account when establishing the registry.

3.32. Current epidemiological data show that radiation induced cancers (the excess number of cancer cases above background cancer cases) could be statistically detected in large populations exposed at doses above 0.1 Sv delivered at high dose rates. These data are based on epidemiological studies of well defined populations (e.g. the survivors of the atomic bombings in Japan and patients undergoing radiological medical procedures). Epidemiological studies have not demonstrated such effects in individuals exposed at low doses (less than 0.1 Sv) delivered over a period of many years [19]. The inclusion in long term health monitoring programmes of persons who have received very low doses may cause unnecessary anxiety. Moreover, it is not cost effective in terms of public health care.

3.33. Assessment of long term follow-up after the Chernobyl accident in 1986 revealed that medical follow-up of persons receiving doses below 1 Gy may not

be justified, except in the case of absorbed doses to the thyroid. As cited in the WHO Report on Health Effects of the Chernobyl Accident and Special Health Care Programmes [20], cancer screening tests for asymptomatic persons have not been beneficial in terms of improving either survival or quality of life, except screening for breast cancer and cervical cancer through mammography and Pap[9] tests, respectively. Thyroid cancer screening following emergencies involving the release of radioactive isotopes of iodine has proved very effective for earlier diagnosis and treatment of children exposed following the Chernobyl accident.

3.34. Exposed persons should be provided with adequate information about the long term risk due to their radiation exposure, including assurance of no further actions being required.

4. GUIDANCE VALUES FOR EMERGENCY WORKERS

4.1. An emergency worker is a person having specified duties as a worker in response to an emergency, who might be exposed while taking actions in response to the emergency. Emergency workers may include those employed by registrants and licensees as well as personnel from response organizations, such as police officers, firefighters, medical personnel, and drivers and crews of evacuation vehicles.

4.2. Reference [2], para. 4.60, states that

> "National guidance that is in accordance with international standards…shall be adopted for managing, controlling and recording the doses received by emergency workers. This guidance shall include default operational levels of dose for emergency workers for different types of response activities, which are set in quantities that can be directly monitored during the performance of these activities (such as the integrated dose from external penetrating radiation). In setting the default operational levels of dose for emergency workers the contribution to doses via all exposure pathways shall be taken into account."

[9] The Papanicolaou test.

4.3. Table 4 recommends guidance values to be used for the protection of emergency workers responding to an emergency.

4.4. Life saving actions resulting in doses that approach or exceed the threshold for severe deterministic effects should be considered only if (a) the expected benefit to others would clearly outweigh the emergency worker's own risk and (b) the emergency worker volunteers to take the action, and understands and accepts this risk.

4.5. Emergency workers who undertake actions in which the doses received might exceed 50 mSv do so voluntarily and should have been clearly and comprehensively informed in advance of the associated health risks, as well as of available protective measures, and should be trained, to the extent possible, in the actions that they may be required to take. The voluntary basis for response actions by emergency workers is usually covered in the emergency response arrangements.

4.6. Emergency workers should receive medical attention appropriate for the dose they may have received (actions according to Tables 2 and 3). The doses received and information concerning the consequent health risks should be communicated to the workers. Female workers who are aware that they are pregnant should be encouraged to notify the appropriate authority and would typically be excluded from emergency duties.

4.7. In almost all emergencies, at best only the dose from external penetrating radiation will be measured continuously. Consequently, the operational guidance provided to emergency workers should be based on measurements of penetrating radiation (e.g. as displayed on an active or self-reading dosimeter). The dose from intake or skin contamination should be limited by means of the use of protective equipment, the use of stable iodine prophylaxis and the provision of instructions concerning operations in potentially hazardous radiological conditions[10]. Available information about radiation conditions on the site should be used in aiding decisions on the appropriate protection of emergency workers.

[10] Instructions will cover the application of time, distance and shielding principles, the prevention of ingestion of radioactive material and the use of respiratory protection.

TABLE 4. GUIDANCE VALUES FOR RESTRICTING EXPOSURE OF EMERGENCY WORKERS

Tasks	Guidance value[a]
Life saving actions	$H_p(10)$[b] <500 mSv This value may be exceeded under circumstances in which the expected benefits to others clearly outweigh the emergency worker's own health risks, and the emergency worker volunteers to take the action and understands and accepts this health risk
Actions to prevent severe deterministic effects and actions to prevent the development of catastrophic conditions that could significantly affect people and the environment	$H_p(10)$ <500 mSv
Actions to avert a large collective dose	$H_p(10)$ <100 mSv

[a] These values apply only for the dose from exposure to external penetrating radiation. Doses from exposure to non-penetrating external radiation and from intake or skin contamination need to be prevented by all possible means. If this is not feasible, the effective dose and the equivalent dose to an organ that are received have to be limited to minimize the health risk to the individual in line with the risk associated with the guidance values given here.

[b] $H_p(10)$ is the personal dose equivalent $H_p(d)$ where d = 10 mm.

5. OPERATIONAL CRITERIA

5.1. Projected dose and dose that has been received are not measurable quantities and cannot be used as a basis for quick actions in an emergency. There is a need to establish — in advance — operational criteria (values of measurable default quantities or observables) as a surrogate for the generic criteria for undertaking different protective actions and other response actions. Precautionary urgent protective actions and, as applicable, urgent protective actions should be taken on the basis of precalculated default operational criteria. The majority of urgent protective actions and early protective actions are also implemented on the basis of precalculated default operational criteria. However, if the characteristics of an emergency differ from those assumed in the calculations of default operational criteria, the criteria should be recalculated. Methods for the recalculation to address prevailing conditions in an actual emergency should be established during the planning phase.

5.2. The operational criteria[11] are the EALs, OILs, observables and indicators of conditions on the scene.

5.3. The EALs are the specific, predetermined, observable operational criteria used to detect, recognize and determine the emergency class of an event at facilities in threat categories I, II and III [2]. The EALs are used for classification and for decisions on the implementation of precautionary urgent protective actions corresponding to the emergency class. These criteria should be predefined as stated in Ref. [2] and implemented as described in Refs [7, 8]. Appendix III provides a discussion of the EAL development process and gives examples of EALs for the classification of emergencies at a light water reactor nuclear power plant.

5.4. For emergencies in threat category IV [2], the operational criteria for implementing urgent protective actions should be predetermined on the basis of information that will be observable on the scene. Usually observations that indicate a radiation hazard will be made by first responders or operators on the scene (e.g. upon seeing a placard on a vehicle that has been involved in an accident). References [7, 8, 18] provide guidance on the approximate radius of the inner cordoned area in which urgent protective actions would initially be taken on the basis of information observable by responders upon their arrival on the scene. The size of the cordoned area may be expanded on the basis of dose rate OILs and other environmental measurement OILs (see Appendix II) when these data become available. Reference [18] provides a list of observables that can be used by responders to identify a dangerous source, together with the actions to be taken to protect responders and the public. Reference [17] provides guidance on the activity of a radionuclide that, if not controlled, should be considered to constitute a dangerous source.

5.5. The OIL is a calculated quantity that corresponds to one of the generic criteria. The OILs are used with the other operational criteria (EALs and observables) to determine appropriate protective actions and other response actions. If the OILs are exceeded, the appropriate protective action should be promptly invoked. The OILs are typically expressed in terms of dose rates or activity of radioactive material released, time integrated air concentrations, ground or surface concentrations, or activity concentration of radionuclides in the environment, in food, in water or in biological samples. OILs can be measured by

[11] These operational criteria are used as triggers at the early stage of an emergency; in some publications the term 'trigger' is used.

means of instruments in the field or can be determined by means of laboratory analysis or assessment.

5.6. Reference [2], in para. 4.71, states that "arrangements shall be made for promptly assessing the results of environmental monitoring and monitoring for contamination on people in order to decide on or to adapt urgent protective actions to protect workers and the public, including the application of operational intervention levels (OILs) with arrangements to revise the OILs as appropriate to take into account the conditions prevailing during the emergency." In addition, para. 4.89 of Ref. [2] states that default OILs shall be established together with the means to revise the OILs for "environmental measurements (such as dose rates due to deposition and deposition densities) and food concentrations; the means to revise the OILs; timely monitoring...for ground contamination in the field; the sampling and analysis of food and water; and the means to enforce agricultural countermeasures."

5.7. Every effort should be made to keep the system simple by keeping the number of OILs to a minimum. In principle, the default OILs should be a minimum set for each operational quantity (e.g. dose rate due to skin contamination) that, with due consideration of the uncertainties, reasonably encompasses the protective action (e.g. urgent decontamination), applicable generic criteria and associated assumptions (e.g. the type of emergency or the characteristics of the radiological hazard).

5.8. It is possible that, during an emergency, individuals might receive doses that give rise to a high risk of incurring radiation induced cancers. Although it is unlikely, there might be a detectable increase in the incidence of cancers among the population group that has been exposed, owing to radiation induced cases of cancer. Emergencies have occurred for which no criteria for long term health monitoring and treatment had been pre-established. Criteria that have been established after emergencies have occurred have often been set at too low a level of dose received or have not been set on the basis of radiation dose criteria at all. This has led to the designation of groups for follow-up for which it would have been impossible, because of the inherent limitations of epidemiological studies, to detect any increase in the incidence of cancers, owing to the relatively small number of cases of radiation induced cancer to be expected. Default operational criteria are therefore needed for determining whether a person should be considered for long term health monitoring and treatment.

5.9. Reference [2] states a requirement for guidelines relating to the diagnosis and treatment of radiation injuries. These guidelines should include operational criteria used in the dosimetric support of medical management of the patient [21].

5.10. The dosimetric models for developing the OILs should be established during the planning phase. These models should include a full set of parameters important for the purposes of decision making for dose assessment. For internal dose assessment and the development of corresponding OILs, the application of computer codes is necessary.

5.11. The dosimetric models and data should provide reliable assurance that all members of the public, including those that are most sensitive to radiation (e.g. pregnant women), are considered. In the development of the default operational criteria, the public needs to be assured that all groups (e.g. children playing outdoors) have been considered. Consequently, the OILs must be accompanied by a plain language explanation of the situation to which they apply (see Appendix II), the way in which they address a safety or health concern and what their application means in terms of the risk to individuals.

5.12. These default OILs should be developed on the basis of assumptions regarding the emergency, the affected population and the prevailing conditions; these assumptions, however, may not accurately reflect the emergency in question. Consequently, Ref. [2] requires that means be established to revise the default OILs to take into account prevailing emergency conditions. However, revising the OILs during an emergency may be disruptive, and they should therefore only be revised if the situation is well understood and there are compelling reasons to do so. The public should be informed of the reasons for any change in the OILs applied in an actual emergency.

5.13. Appendix II provides selected examples of default OILs for deposition, levels of individual contamination, and contamination levels for food, milk and water, together with a plain language explanation of the OILs.

Appendix I

DOSE CONCEPTS AND DOSIMETRIC QUANTITIES

I.1. There are different dose concepts that are relevant to preparedness for and response to an emergency: projected dose, residual dose and averted dose [5].

I.2. The dosimetric quantities of effective dose, equivalent dose and RBE weighted absorbed dose are used in evaluating radiation induced consequences of a nuclear or radiological emergency. They are listed in Table 5 and illustrated in Fig. 2, and are discussed in the following.

I.3. The RBE weighted averaged absorbed dose in an organ or tissue (RBE weighted absorbed dose, AD_T) is defined as the product of averaged absorbed dose ($D_{R,T}$) of radiation (R) in an organ or tissue (T) and the relative biological effectiveness ($RBE_{R,T}$):

$$AD_{R,T} = \sum_R D_{R,T} \times RBE_{R,T} \quad (1)$$

TABLE 5. DOSIMETRIC QUANTITIES USED IN EMERGENCY EXPOSURE SITUATIONS

Dosimetric quantity	Symbol	Purpose
	Radiation protection quantities	
RBE weighted absorbed dose	AD_T	For evaluating deterministic effects induced as a result of exposure of an organ or tissue
Equivalent dose	H_T	For evaluating stochastic effects induced as a result of exposure of an organ or tissue
Effective dose	E	For evaluating detriment related to the occurrence of stochastic effects in an exposed population
	Operational quantities	
Personal dose equivalent	$H_P(d)$	For monitoring external exposure of an individual
Ambient dose equivalent	$H^*(d)$	For monitoring a radiation field at the site of an emergency

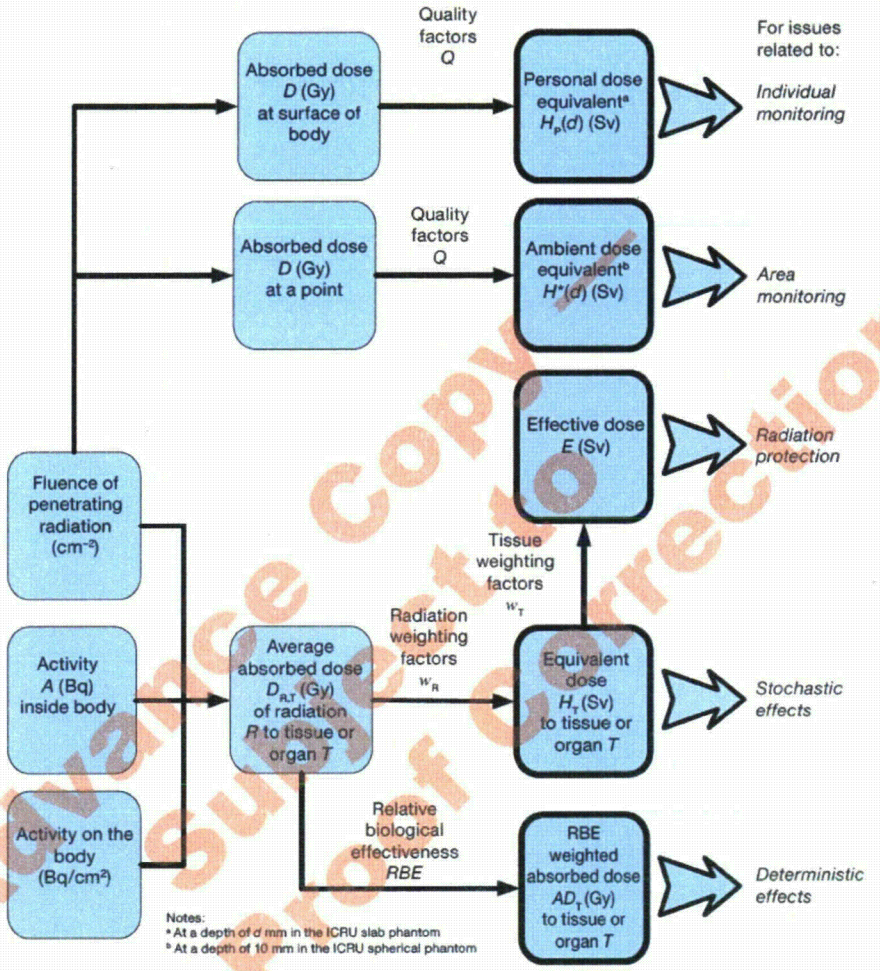

FIG. 2. Dosimetric quantities and their application in emergency exposure situations.

I.4. The value of RBE should be selected with account taken of the type of radiation, the dose and the health effects of concern, as shown in Table 6.

I.5. The International System of Units (SI) unit used to express the RBE weighted absorbed dose is $J \cdot kg^{-1}$, which is called the gray (Gy) [14, 22, 23].

TABLE 6. TISSUE SPECIFIC AND RADIATION SPECIFIC VALUES OF RBE FOR THE DEVELOPMENT OF SELECTED SEVERE DETERMINISTIC EFFECTS [3, 17]

Health effect	Critical organ	Exposure[a]	$RBE_{T,R}$
Haematopoietic syndrome	Red bone marrow	External and internal γ	1
		External and internal *n*	3
		Internal β	1
		Internal α	2
Pneumonitis	Lung[b]	External and internal γ	1
		External and internal *n*	3
		Internal β	1
		Internal α	7
Gastrointestinal syndrome	Colon	External and internal γ	1
		External and internal *n*	3
		Internal β	1
		Internal α	0[c]
Necrosis	Soft tissue[d]	External β, γ	1
		External *n*	3
Moist desquamation	Skin[e]	External β, γ	1
		External *n*	3
Hypothyroidism	Thyroid	Intake of iodine isotopes[f]	0.2
		Other thyroid seekers	1

[a] External β, γ exposure includes exposure due to bremsstrahlung produced within the material of the source.

[b] Tissue of the alveolar-interstitial region of the respiratory tract.

[c] For alpha emitters uniformly distributed in the contents of the colon, it is assumed that irradiation of the walls of the intestine is negligible.

[d] Tissue at a depth of 5 mm below the skin surface over an area of more than 100 cm^2.

[e] Tissue at a depth of 0.5 mm below the skin surface over an area of more than 100 cm^2.

[f] Uniform irradiation of the tissue of the thyroid gland is considered to be five times more likely to produce deterministic effects than internal exposure due to low energy beta emitting isotopes of iodine, such as ^{131}I, ^{129}I, ^{125}I, ^{124}I and ^{123}I. Thyroid seeking radionuclides have a heterogeneous distribution in thyroid tissue. The isotope ^{131}I emits low energy beta particles, which leads to a reduced effectiveness of irradiation of critical thyroid tissue owing to the dissipation of the energy of the particles within other tissues.

I.6. The weighted averaged absorbed dose (equivalent dose, H_T) is defined as the product of the averaged absorbed dose in the organ or tissue (D) and the radiation weighting factor w_R [11, 24]:

$$H_T = \sum_R D_{R,T} \times w_R \quad (2)$$

I.7. The weighted averaged absorbed dose (equivalent dose, H_T) is expressed in sieverts (Sv) [22, 24]. It is an organ specific quantity that may be used for assessment of the risk of incurring any radiation induced cancer in an organ.

I.8. The effective dose is widely used in justifying and optimizing protective actions [10] Its unit is the sievert (Sv) [22]. The total effective dose (E) includes the doses due to external penetrating radiation and due to intake:

$$E = \sum_T H_T \times w_T \quad (3)$$

I.9. The quantities used for radiation monitoring are:

— Ambient dose equivalent ($H^*(d)$); that is, the dose equivalent that would be produced by the corresponding aligned and expanded field in the International Commission on Radiation Units and Measurements (ICRU) sphere at a depth d on the radius opposing the direction of the aligned field;
— Personal dose equivalent ($H_p(d)$); that is, the dose equivalent in soft tissue below a specified point on the body at an appropriate depth d.

The SI unit for these quantities is $J \cdot kg^{-1}$, and they are expressed in Sv.

I.10. Ambient dose equivalent and personal dose equivalent are the operational quantities based on the quantity of dose equivalent. The dose equivalent is the product of the absorbed dose at a point in the tissue or organ and the appropriate quality factor (Q_R) for the type of radiation giving rise to the dose [25]:

$$H = \sum_R D_R \times Q_R \quad (4)$$

TABLE 7. CRITICAL RADIATION INDUCED HEALTH EFFECTS IN A NUCLEAR OR RADIOLOGICAL EMERGENCY [3]

Health effect	Target organ or entity
Deterministic effects	
Fatal	
Haematopoietic syndrome	Red marrow[a]
Gastrointestinal syndrome	Small intestine for external exposure[a] Colon for internal exposure[b]
Pneumonitis	Lung[a,c]
Death of embryo/fetus	Embryo/fetus in all periods of gestation
Non-fatal	
Moist desquamation	Skin[d]
Necrosis	Soft tissue[e]
Cataract	Lens of the eye[a,f]
Acute radiation thyroiditis	Thyroid[a]
Hypothyroidism	Thyroid[a]
Permanently suppressed ovulation	Ovaries[a]
Permanently suppressed sperm count	Testes[a]
Severe mental retardation	Embryo/fetus 8–25 weeks of gestation
Verifiable reduction in intelligence quotient (IQ)	Embryo/fetus 8–25 weeks of gestation
Malformation	Embryo/fetus 3–25 weeks of gestation [26]
Growth retardation	Embryo/fetus 3–25 weeks of gestation [26]
Stochastic effects	
Thyroid cancer	Thyroid
All stochastic effects	All organs taken into account in definition of effective dose

[a] External exposure to the red bone marrow, lung, small intestine, gonads, thyroid and lens of the eye as irradiation in a uniform field of strongly penetrating radiation is addressed by $AD_{\text{Red marrow}}$.

[b] Different targets for gastrointestinal syndrome are proposed because of the difference in the dose formation in the small intestine and colon in the case of internal exposure. This is due to differences in the kinetics of ingested material in the gastrointestinal tract, which lead to much higher doses in the colon than in the small intestine after intake.

[c] For the alveolar-interstitial region of the respiratory system.

[d] Skin structures at a depth of 50 mg/cm^2 (or 0.5 mm) below the surface and over an area of 100 cm^2.

[e] To a depth of 5 mm in tissue.

[f] Lens structures at a depth of 300 mg/cm^2 (or 3 mm) below the surface.

I.11. Table 7 presents a list of radiation induced health effects that would be critical during an emergency. Experience and research indicate that evaluation of the dose to the target organs as presented in the table should provide a basis for selecting operational criteria for making decisions that will address the full range of possible health effects.

Appendix II

EXAMPLES OF DEFAULT OILs FOR DEPOSITION, INDIVIDUAL CONTAMINATION AND CONTAMINATION OF FOOD, MILK AND WATER

GENERAL

II.1. In this appendix, examples of default OILs are provided for use in responding to an emergency that results in contamination, together with a plain language explanation of these OILs and guidance on the use of the OILs (see Tables 8–10). The following example default OILs are provided[12,13]:

(1) OIL1 is a measured value of ground contamination calling for:
   — Urgent protective actions (e.g. evacuation) to keep the dose to any person living in a contaminated area below the generic criteria for urgent protective actions provided in Table 3;
   — Medical actions, as required, because the dose received by evacuees may be above the generic criteria for medical actions provided in Table 3.

(2) OIL2 is a measured value of ground contamination calling for early protective actions to keep the dose for one year to any person living in the area below the generic criteria for taking actions to reasonably reduce the risk of stochastic effects provided in Table 3.

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[12] OILs for rates or air concentrations in a plume resulting from an ongoing release are not provided because the example criteria are intended to be very general and practical. OILs for air doses or air concentrations from a plume are not included because: (a) in many cases the significant release will be over by the time results of environmental measurements are available; (b) it is difficult to take and analyse air concentrations in a sample in a timely manner; (c) there is a great variation in time and location of the plume concentrations at any location during a release; and (d) OILs of these types are highly dependent on the nature of the release, which makes it very difficult to develop OILs that apply to the full range of possible releases. During the period of significant release, therefore, protective actions (e.g. evacuation or sheltering, to a predetermined distance) are best taken on the basis of observable criteria. Operating organizations of facilities at which there could be emergencies that result in airborne releases of long duration should develop EALs and possibly facility specific OILs for measurements taken in a plume, for possible airborne releases from the facilities. Examples of OILs for dose rates in a release from a light water reactor resulting from core melt are provided in Ref. [27].

[13] OILs for air concentrations arising from resuspension are not provided because doses arising from resuspension have been considered in the deposition OILs.

(3) OIL3 is a measured value of ground contamination calling for immediate restrictions on the consumption of leaf vegetables, milk from animals grazing in the area and rainwater collected for drinking to keep the dose to any person below the generic criteria for taking the urgent protective actions provided in Table 3.

(4) OIL4 is a measured value of skin contamination calling for performing decontamination or providing instructions for self-decontamination and for limiting inadvertent ingestion so as:
— To keep the dose due to skin contamination to any person below the generic criteria for taking urgent protective action provided in Table 3;
— To initiate medical treatment or screening, as required, because the dose received by any person may exceed the generic criteria for medical actions provided in Table 3.

(5) OIL5 and OIL6 are measured values of concentrations in food, milk or water that warrant the consideration of restrictions on consumption so as to keep the effective dose to any person below 10 mSv per annum.

II.2. For the purposes of describing the use of the OILs, nuclear or radiological emergencies resulting in contamination can be thought of as being of three types:

(1) A nuclear or radiological emergency resulting in contamination of a large area (hundreds of square kilometres) with the possible involvement of a large number of people; that is, contamination of an area so large that, in order to be effective, implementation of urgent protective actions and early protective actions should be performed in two phases: first, urgent protective actions (e.g. evacuation) are taken, followed by early protective actions (e.g. relocation). An emergency of this type could occur at nuclear facilities such as nuclear power plants that are in threat category I or II [2].

(2) A nuclear or radiological emergency resulting in contamination of a moderate area (tens of square kilometres) with the possible involvement of a large number of people; that is, contamination of an area small enough that urgent protective actions and early protective actions can be effectively performed at the same time without the need for a phased response. An emergency of this type could be the result of the explosion of a radiological dispersal device or could be caused by a damaged dangerous radioactive source [28].

(3) A nuclear or radiological emergency resulting in contamination of small areas and/or with the possible involvement of a small number of people; that is, contamination of small areas that can easily and quickly be isolated, with the involvement of a small number of people who can all be decontaminated and medically assessed by using available resources,

without causing any major disruptions. This type of emergency includes those confined to a single room or a single spill. For this type of emergency, the response involves isolating the potentially contaminated area and decontaminating all those involved without necessarily using the OILs.

RESPONDING TO A NUCLEAR OR RADIOLOGICAL EMERGENCY THAT RESULTS IN CONTAMINATION OF A LARGE AREA

II.3. The process of assessing and responding to an emergency of this type through the implementation of protective actions is shown in Fig. 3. First protective actions should be taken on the basis of conditions observed on the scene [7, 18] or on the basis of an emergency classification (see Appendix III, and appendix IV of Ref. [7]) before data from radiological monitoring become available.

II.4. Within hours, areas where ground deposition levels exceed or are likely to exceed OIL1, the default OIL, should be identified and the appropriate urgent protective actions should be taken, such as evacuation, stopping the consumption of local produce, and medical evaluation of evacuees.

II.5. Within hours, actions should also be taken to reduce the consequences of contamination for those people who were in the area where OIL1 was exceeded. If OIL4 is exceeded, the evacuees should be monitored and decontaminated (if these actions can be carried out promptly). If monitoring and decontamination are not immediately possible, the evacuees should be released and instructed to take actions to reduce inadvertent ingestion, and to shower and change their clothing as soon as possible. OIL4 levels may be very difficult to detect under emergency conditions. Therefore, any person who may have been contaminated, including those who were monitored and had contamination levels below OIL4, should take actions to reduce inadvertent ingestion, and should shower and change their clothing as soon as possible. The dose to evacuees should also be evaluated and the medical actions called for in Tables 2 and 3 should be taken, as appropriate.

II.6. Within a day, the areas where ground deposition levels exceed default OIL2 should be identified and early protective actions should be taken, such as stopping the consumption of locally produced vegetables and milk and commencing the process of implementing temporary relocation. Relocation should be accomplished within a week.

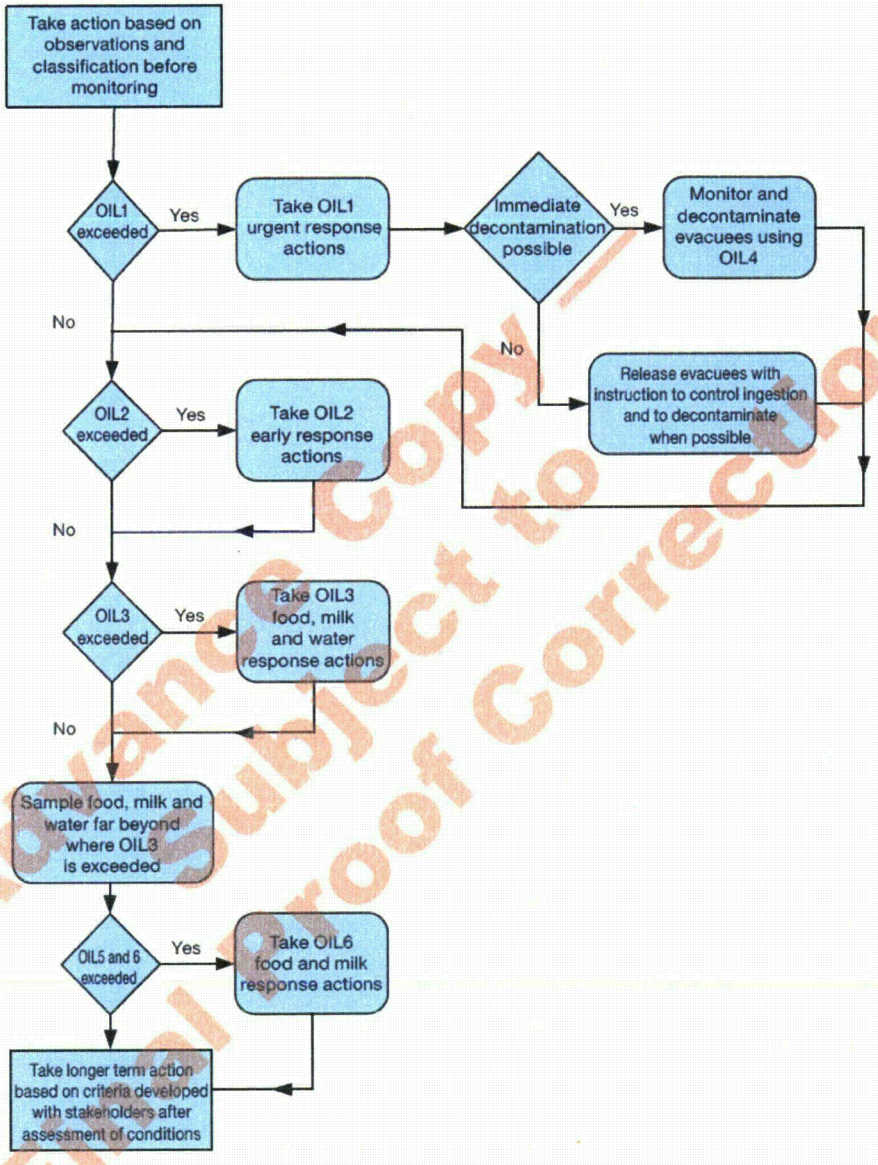

FIG. 3. Process of assessment of a nuclear or radiological emergency resulting in contamination of a large area.

II.7. Within days, the areas where ground deposition levels exceed default OIL3 should be identified and actions should be taken to stop consumption of locally produced vegetables and milk, and of rainwater collected for drinking, until they have been screened and analysed. Within a week, food, milk and water should be screened and analysed, possibly out to a distance of more than 100 km, and actions should be taken to restrict consumption of food, milk and water with concentrations of radionuclides in excess of OIL5 and OIL6.

II.8. Within days, the mixture of the radionuclides over the affected area should be determined and the OILs being used to make decisions should be revised, if warranted.

II.9. Any recommendation to the public to take any protective actions should be accompanied by a plain language explanation of the criteria.

II.10. After the emergency is over, further actions should be taken on the basis of criteria developed after careful assessment of conditions and in consultation with interested parties.

RESPONDING TO A NUCLEAR OR RADIOLOGICAL EMERGENCY RESULTING IN CONTAMINATION OF A MODERATE AREA

II.11. The process of assessing and responding to a nuclear or radiological emergency resulting in contamination of a moderate area through the implementation of protective actions is shown in Fig. 4. First protective actions are taken on the basis of conditions observed on the scene [7, 18] or on the basis of an emergency classification (see Appendix III, and appendix IV of Ref. [7]) before data from radiological monitoring become available.

II.12. Within hours, areas where ground deposition levels exceed default OIL2 should be identified, and the appropriate urgent protective actions and early protective actions should be taken where OIL2 is exceeded. The dose to evacuees should also be evaluated and the medical actions called for in Tables 2 and 3 should be taken.

II.13. Evacuees should be monitored and if OIL4 is exceeded, evacuees should be decontaminated, if this can be done promptly. If monitoring and/or decontamination are not immediately possible, the evacuees should be released

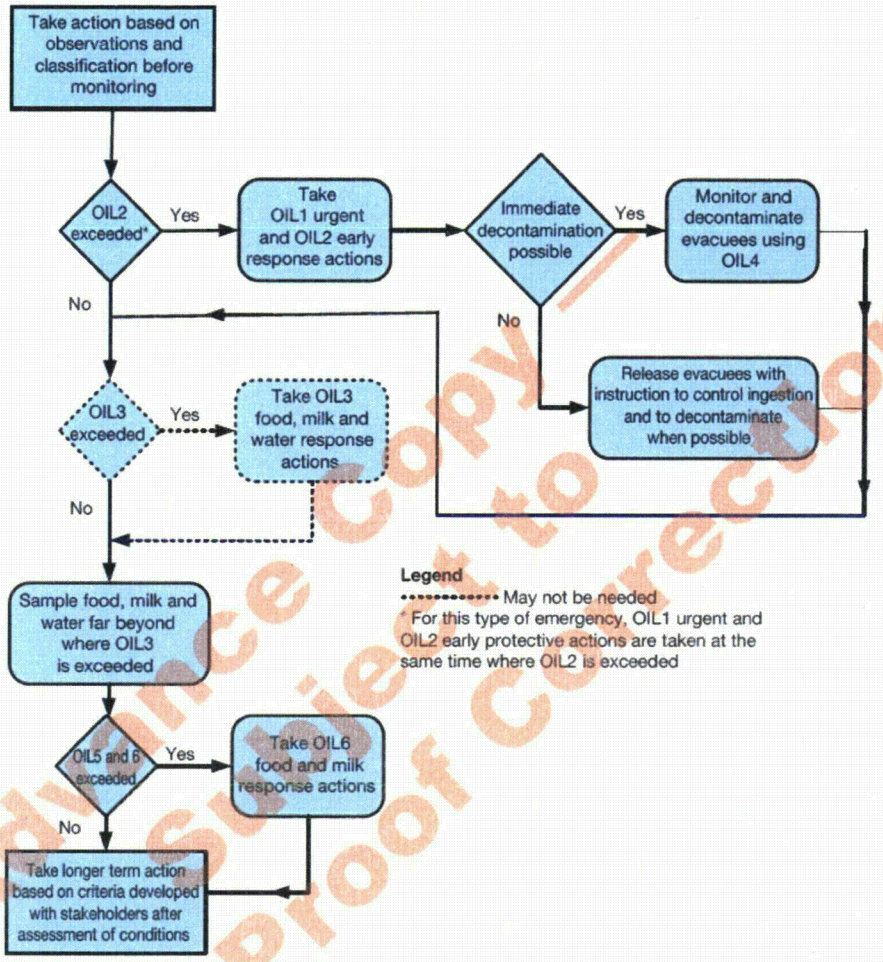

FIG. 4. Process of assessment of a nuclear or radiological emergency resulting in contamination of a moderate area.

and should be instructed to take actions to reduce inadvertent ingestion, and to shower and change their clothing as soon as possible. OIL4 levels may be very difficult to detect under emergency conditions. Any person who may have been contaminated, including those who were monitored and had contamination levels below OIL4, should therefore take actions to reduce inadvertent ingestion, and should shower and change their clothing as soon as possible.

II.14. Within days, areas where ground deposition levels exceed default OIL3 should be identified and actions should be taken to stop the consumption of rainwater and locally produced vegetables and milk until they have been screened and analysed. However, if only limited amounts of food (e.g. fruit and vegetables from local gardens) and non-essential food could have been affected, this step may be omitted, and instead restrictions should be placed on the consumption of all the food that could be contaminated until it can be screened and analysed. Finally, food, milk and rainwater should be screened and analysed, out to a distance of several kilometres, and actions should be taken to restrict the consumption of food, milk and rainwater having concentrations of radionuclides in excess of OIL5 and OIL6.

II.15. Within days, the mixture of radionuclides over the affected area should be determined and the OILs being used to make decisions should be revised, if warranted.

II.16. Any recommendations to the public to take any protective actions should be accompanied by a plain language explanation of the criteria.

II.17. After the emergency is over, further actions should be taken on the basis of criteria developed after careful assessment of the conditions and in consultation with the interested parties.

DEFAULT OILs

II.18. Table 8 contains OILs for assessing the results of field monitoring of contamination of the ground, skin and clothing. Three types of OIL are provided in the units measured by field survey instruments: dose rate (OIL(γ)); beta counts per second (counts/s) for beta radiation (OIL(β)); and alpha counts/s for alpha radiation (OIL(α)). An OIL is exceeded if any of its types are exceeded. These OILs apply for emergencies involving all radionuclides, including fission products released by melting reactor fuel.

II.19. The OILs in Table 8 were established for implementing the protective actions and other response actions in a way consistent with the generic criteria in Tables 2 and 3. In the development of these OILs, all members of the population (including children and pregnant women) as well as all usual activities (such as children playing outdoors) were considered. The OILs were calculated to ensure that the protective actions to be taken protect against the most radiotoxic radionuclides. As a result, the OILs are overly conservative for many

TABLE 8. DEFAULT OILs FOR FIELD SURVEY MEASUREMENTS

OIL	OIL value	Response action (as appropriate) if the OIL is exceeded
	Environmental measurements	
OIL1	Gamma (γ) 1000 μSv/h at 1 m from surface or a source 2000 counts/s direct beta (β) surface contamination measurement[e] 50 counts/s direct alpha (α) surface contamination measurement[f]	— Immediately evacuate or provide substantial shelter[a] — Provide for decontamination of evacuees[b] — Reduce inadvertent ingestion[c] — Stop consumption of local produce[d], rainwater and milk from animals grazing in the area — Register and provide for a medical examination of evacuees — If a person has handled a source with a dose rate equal to or exceeding 1000 μSv/h at 1 m[e], provide an immediate medical examination
OIL2	Gamma (γ) 100 μSv/h at 1 m from surface or a source 200 counts/s direct beta (β) surface contamination measurement[f] 10 counts/s direct alpha (α) surface contamination measurement[f]	— Stop consumption of local produce[d], rainwater and milk from animals grazing in the area until they have been screened and contamination levels have been assessed using OIL5 and OIL6 — Temporarily relocate those living in the area; before relocation, reduce inadvertent ingestion[c]; register and estimate the dose to those who were in the area to determine if medical screening is warranted; relocation of people from the areas with the highest potential exposure should begin within days — If a person has handled a source with a dose rate equal to or exceeding 100 μSv/h at 1 m[e], provide medical examination and evaluation; any pregnant women who have handled such a source should receive immediate medical evaluation and dose assessment
OIL3	Gamma (γ) 1 μSv/h at 1 m from surface 20 counts/s direct beta (β) surface contamination measurement[f,i] 2 counts/s direct alpha (α) surface contamination measurement[f,i]	— Stop consumption of non-essential[g] local produce[d], rainwater and milk from animals[h] grazing in the area until it has been screened and contamination levels have been assessed using OIL5 and OIL6 — Screen local produce, rainwater and milk from animals[h] grazing in the area out to at least 10 times the distance to which OIL3 is exceeded and assess samples using OIL5 and OIL6 — Consider providing iodine thyroid blocking[j] for fresh fission products[k] and for iodine contamination if replacement for essential[g] local produce or milk is not immediately available — Estimate the dose of those who may have consumed food, milk or rainwater from the area where restrictions were implemented to determine if medical screening is warranted

TABLE 8. DEFAULT OILs FOR FIELD SURVEY MEASUREMENTS (cont.)

OIL	OIL value	Response action (as appropriate) if the OIL is exceeded
		Skin contamination
OIL4	Gamma (γ) 1 μSv/h at 10 cm from the skin 1000 counts/s direct beta (β) skin contamination measurement[f] 50 counts/s direct alpha (α) skin contamination measurement[f]	— Provide for skin decontamination[b] and reduce inadvertent ingestion[c] — Register and provide for a medical examination

Note: The OILs should be revised as soon as it is known which radionuclides are actually involved. The OILs should also be revised, if necessary, as part of the preparedness process, to be more consistent with the instruments to be used during the response. However, the default OILs in this table can be used without revision to make a conservative assessment immediately.

[a] Inside closed halls of large multi-storey buildings or large masonry structures and away from walls or windows.

[b] If immediate decontamination is not practicable, advise evacuees to change their clothing and to shower as soon as possible. Guidance on performing decontamination can be found in Refs [18, 21].

[c] Advise evacuees not to drink, eat or smoke and to keep hands away from the mouth until hands are washed.

[d] Local produce is food that is grown in open spaces that may be directly contaminated by the release and that is consumed within weeks (e.g. vegetables).

[e] This external dose rate criterion applies only to sealed dangerous sources and does not need to be revised in an emergency.

[f] Performed using good contamination monitoring practice.

[g] Restricting essential foods could result in severe health effects (e.g. severe malnutrition), and therefore essential foods should be restricted only if replacement food is available.

[h] Use 10% of OIL3 for milk from small animals (e.g. goats) grazing in the area.

[i] Deposition by rain of short lived naturally occurring radon progeny can result in count rates of four or more times the background count rate. These rates should not be confused with the deposition rates due to the emergency. Count rates due to radon progeny will decrease rapidly after the rain stops and should be back to typical background levels within a few hours.

[j] Only for several days and only if replacement food is not available.

[k] Fission products that were produced within the last month, thus containing large amounts of iodine.

radionuclides and should be revised as soon as it is known which radionuclides are involved.

II.20. As a minimum criterion, a contamination monitoring instrument is considered suitable for applying the OIL if it will provide a response equal to or more conservative than that assumed in development of the OILs. The following procedure may be used for checking whether or not a particular instrument meets the minimum criterion and can be used in applying the operational criteria for OIL1, OIL2 and OIL4 in Table 8:

(1) Ensure that the instrument can display counts/s (or counts/min) over the ranges of the OIL values in Table 8.

(2) For a beta monitor, ensure that it can detect both high (e.g. ^{32}P) and low (e.g. ^{14}C) energy beta emitters. It is not required that very weak emitters (e.g. ^{63}Ni) be detectable.

(3) Calculate the instrument coefficients (ICs) using measured (i.e. derived from the calibration factor) or known 4π efficiencies (e.g. those provided by the manufacturer) for high energy and low energy beta emitting radionuclides and an alpha emitting radionuclide (as applicable) using the formula:

$$IC = W_{\text{monitor}} \times \theta_{\text{monitor}} \quad (5)$$

where

IC is the instrument coefficient ((counts/s $\times$ cm^2)/Bq);
W_{monitor} is the effective area of the detector window (cm^2);
θ_{monitor} is the energy dependent efficiency for 4π geometry close to the surface and under ideal conditions (counts/s $\times$ Bq^{-1}).

(4) If the calculated IC values are greater than or equal to the following, the instrument is suitable:

— For medium or high energy beta emitters (e.g. ^{36}Cl) — 1;
— For low energy beta emitters (e.g. ^{14}C) — 0.2;
— For alpha emitters — 0.5.

A beta monitor should meet both the high energy and the low energy beta criteria.

These criteria were established so that the majority of commonly available contamination monitoring instruments will give a response that is equal to or

higher (i.e. more conservative) than the response assumed in developing the default OILs. However, the response of instruments that meet these minimum criteria may vary by a factor of as much as 20, primarily owing to differences in the effective area of the detector. Therefore, the OILs in Table 8 should be revised, if necessary, to be more consistent with the characteristics of the instruments to be used during the response. This should be done as part of the preparedness process.

II.21. The process of assessing radionuclide concentrations in food, milk and water is shown in Fig. 5. First the potentially contaminated food should be screened over a wide area and analysed to determine the gross alpha and beta concentrations if this can be done more promptly than assessing the concentration of individual radionuclides. If the OIL5 (see Table 9) screening levels are not exceeded, the food, milk and water are safe for consumption during the emergency phase. If an OIL5 level is exceeded, the radionuclide specific concentrations in the food, milk or water should be determined. If the OIL6 levels in Table 10 are exceeded, consumption of non-essential food, milk or water should be stopped, and essential food, milk and water should be replaced or the people should be relocated if replacements are not available. Finally, as soon as possible the guidance in Ref. [29] should be used to determine whether the food, milk or water is suitable for international trade, and national criteria or WHO guidance [30] should be used to determine whether the food, milk or water is suitable for long term consumption after the emergency phase.

II.22. Tables 9 and 10 give OILs for assessing food, milk and water (see also Table 11). These OILs apply to radionuclides in food, milk and water destined for human consumption (they are not applicable for dried food or concentrated food). The food, milk and water OILs in Tables 9 and 10 were calculated on the basis of the following conservative assumptions:

- All of the food, milk and water are initially contaminated and are consumed throughout a full year.
- The most restrictive age dependent dose conversion factors and ingestion rates (i.e. those for infants) are used.

The generic criterion of 10 mSv per year (and not 100 mSv per year, as in Table 3, at which early protective actions are to be taken) was used to ensure that those people in areas from which they were not relocated will not receive a total dose (including the dose from ingestion) greater than 100 mSv per year.

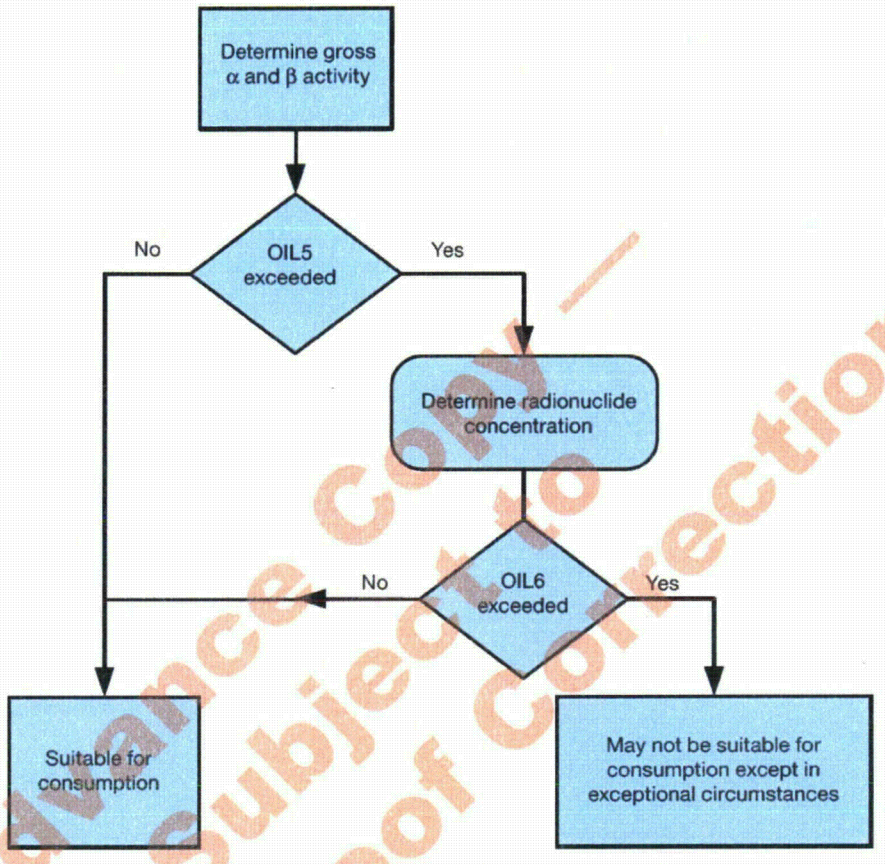

FIG. 5. Process of assessing radionuclide concentrations in food, milk and water.

II.23. Radioactive ^{40}K is commonly found in food and water. It does not accumulate in the body but is maintained at a constant level independent of intake[14] [30]. The contribution of ^{40}K should therefore be subtracted, following a separate determination of total potassium content. The beta activity of the ^{40}K included in natural potassium is 27.6 Bq/g. This is the factor that should be used to calculate the beta activity due to ^{40}K (Ref. [29], para. 9.4.2).

Text cont. on p. 49.

[14] In the response to the Chernobyl accident in 1986, in some cases ^{40}K was confused with ^{137}Cs and produce was discarded even though it contained virtually no radioactive caesium [31].

TABLE 9. DEFAULT SCREENING OILs FOR FOOD, MILK AND WATER CONCENTRATIONS FROM LABORATORY ANALYSIS

OIL	OIL value	Response action if the OIL is exceeded
OIL5	Gross beta (β): 100 Bq/kg or Gross alpha (α): 5 Bq/kg	Above OIL5: Assess using OIL6 Below OIL5: Safe for consumption during the emergency phase

TABLE 10. DEFAULT RADIONUCLIDE SPECIFIC OILs FOR FOOD, MILK AND WATER CONCENTRATIONS FROM LABORATORY ANALYSIS

Radionuclide	OIL6 (Bq/kg)	Radionuclide	OIL6 (Bq/kg)
H-3	2×10^5	Sc-44	1×10^7
Be-7	7×10^5	Sc-46	8×10^3
Be-10	3×10^3	Sc-47	4×10^5
C-11	2×10^9	Sc-48	3×10^5
C-14	1×10^4	Ti-44 +	6×10^2
F-18	2×10^8	V-48	3×10^4
Na-22	2×10^3	V-49	2×10^5
Na-24	4×10^6	Cr-51	8×10^5
Mg-28 +[a]	4×10^5	Mn-52	1×10^5
Al-26	1×10^3	Mn-53	9×10^4
Si-31	5×10^7	Mn-54	9×10^3
Si-32 +	9×10^2	Mn-56	3×10^7
P-32	2×10^4	Fe-52 +	2×10^6
P-33	1×10^5	Fe-55	1×10^4
S-35	1×10^4	Fe-59	9×10^3
Cl-36	3×10^3	Fe-60	7×10^1
Cl-38	3×10^8	Co-55	1×10^6
K-40	NA[b,c]	Co-56	4×10^3
K-42	3×10^6	Co-57	2×10^4

[a] '+' indicates radionuclides with progeny listed in Table 11 that are assumed to be in equilibrium with the parent radionuclide and therefore do not need to be considered independently when assessing compliance with OILs.

[b] NA: not applicable.

[c] The dose from ingestion of ^{40}K is considered not to be relevant because ^{40}K does not accumulate in the body and is maintained at a constant level independent of intake [29].

TABLE 10. DEFAULT RADIONUCLIDE SPECIFIC OILs FOR FOOD, MILK AND WATER CONCENTRATIONS FROM LABORATORY ANALYSIS (cont.)

Radionuclide		OIL6 (Bq/kg)	Radionuclide		OIL6 (Bq/kg)
K-43		4×10^6	Co-58		2×10^4
Ca-41		4×10^4	Co-58m		9×10^7
Ca-45		8×10^3	Co-60		8×10^2
Ca-47	+	5×10^4	Ni-59		6×10^4
Ni-63		2×10^4	Sr-89		6×10^3
Ni-65		4×10^7	Sr-90	+	2×10^2
Cu-64		1×10^7	Sr-91		3×10^6
Cu-67		8×10^5	Sr-92		2×10^7
Zn-65		2×10^3	Y-87	+	4×10^5
Zn-69		6×10^8	Y-88		9×10^3
Zn-69m	+	3×10^6	Y-90		9×10^4
Ga-67		1×10^6	Y-91		5×10^3
Ga-68		2×10^8	Y-91m		2×10^9
Ga-72		1×10^6	Y-92		1×10^7
Ge-68	+	3×10^3	Y-93		1×10^6
Ge-71		5×10^6	Zr-88		3×10^4
Ge-77		6×10^6	Zr-93		2×10^4
As-72		4×10^5	Zr-95	+	6×10^3
As-73		3×10^4	Zr-97	+	5×10^5
As-74		3×10^4	Nb-93m		2×10^4
As-76		4×10^5	Nb-94		2×10^3
As-77		1×10^6	Nb-95		5×10^4
Se-75		4×10^3	Nb-97		2×10^8
Se-79		7×10^2	Mo-93		3×10^3
Br-76		3×10^6	Mo-99	+	5×10^5
Br-77		5×10^6	Tc-95m	+	3×10^4
Br-82		1×10^6	Tc-96		2×10^5
Rb-81		8×10^7	Tc-96m		2×10^9
Rb-83		7×10^3	Tc-97		4×10^4
Rb-84		1×10^4	Tc-97m		2×10^4
Rb-86		1×10^4	Tc-98		2×10^3
Rb-87		2×10^3	Tc-99		4×10^3

TABLE 10. DEFAULT RADIONUCLIDE SPECIFIC OILs FOR FOOD, MILK AND WATER CONCENTRATIONS FROM LABORATORY ANALYSIS (cont.)

Radionuclide		OIL6 (Bq/kg)	Radionuclide		OIL6 (Bq/kg)
Sr-82	+	5×10^3	Tc-99m		2×10^8
Sr-85		3×10^4	Ru-97		2×10^6
Sr-85m		3×10^9	Ru-103	+	3×10^4
Sr-87m		3×10^8	Ru-105		2×10^7
Ru-106	+	6×10^2	Sb-126		3×10^4
Rh-99		1×10^5	Te-121		1×10^5
Rh-101		8×10^3	Te-121m	+	3×10^3
Rh-102		2×10^3	Te-123m		5×10^3
Rh-102m		5×10^3	Te-125m		1×10^4
Rh-103m		5×10^9	Te-127		1×10^7
Rh-105		1×10^6	Te-127m	+	3×10^3
Pd-103	+	2×10^5	Te-129		2×10^8
Pd-107		7×10^4	Te-129m	+	6×10^3
Pd-109	+	2×10^6	Te-131		4×10^8
Ag-105		5×10^4	Te-131m		3×10^5
Ag-108m	+	2×10^3	Te-132	+	5×10^4
Ag-110m	+	2×10^3	I-123		5×10^6
Ag-111		7×10^4	I-124		1×10^4
Cd-109	+	3×10^3	I-125		1×10^3
Cd-113m		4×10^2	I-126		2×10^3
Cd-115	+	2×10^5	I-129		NA[d]
Cd-115m		6×10^3	I-131		3×10^3
In-111		1×10^6	I-132		2×10^7
In-113m		4×10^8	I-133		1×10^5
In-114m	+	3×10^3	I-134		2×10^8
In-115m		5×10^7	I-135		2×10^6
Sn-113	+	1×10^4	Cs-129		1×10^7
Sn-117m		7×10^4	Cs-131		2×10^6
Sn-119m		1×10^4	Cs-132		4×10^5
Sn-121m	+	5×10^3	Cs-134		1×10^3
Sn-123		3×10^3	Cs-134m		3×10^8

[d] Not a significant source of radiation because of the low specific activity.

TABLE 10. DEFAULT RADIONUCLIDE SPECIFIC OILs FOR FOOD, MILK AND WATER CONCENTRATIONS FROM LABORATORY ANALYSIS (cont.)

Radionuclide		OIL6 (Bq/kg)	Radionuclide		OIL6 (Bq/kg)
Sn-125		2×10^4	Cs-135		9×10^3
Sn-126	+	5×10^2	Cs-136		4×10^4
Sb-122		2×10^5	Cs-137	+	2×10^3
Sb-124		5×10^3	Ba-131	+	1×10^5
Sb-125	+	3×10^3	Ba-133		3×10^3
Ba-133m		9×10^5	Eu-156		2×10^4
Ba-140	+	1×10^4	Gd-146	+	8×10^3
La-137		4×10^4	Gd-148		1×10^2
La-140		2×10^5	Gd-153		2×10^4
Ce-139		3×10^4	Gd-159		2×10^6
Ce-141		3×10^4	Tb-157		9×10^4
Ce-143		5×10^5	Tb-158		3×10^3
Ce-144	+	8×10^2	Tb-160		7×10^3
Pr-142		6×10^5	Dy-159		7×10^4
Pr-143		4×10^4	Dy-165		7×10^7
Nd-147		6×10^4	Dy-166	+	6×10^4
Nd-149		8×10^7	Ho-166		5×10^5
Pm-143		3×10^4	Ho-166m		2×10^3
Pm-144		6×10^3	Er-169		2×10^5
Pm-145		3×10^4	Er-171		6×10^6
Pm-147		1×10^4	Tm-167		1×10^5
Pm-148m	+	1×10^4	Tm-170		5×10^3
Pm-149		3×10^5	Tm-171		3×10^4
Pm-151		8×10^5	Yb-169		3×10^4
Sm-145		2×10^4	Yb-175		4×10^5
Sm-147		1×10^2	Lu-172		1×10^5
Sm-151		3×10^4	Lu-173		2×10^4
Sm-153		5×10^5	Lu-174		1×10^4
Eu-147		8×10^4	Lu-174m		1×10^4
Eu-148		2×10^4	Lu-177		2×10^5
Eu-149		9×10^4	Hf-172	+	2×10^3
Eu-150b		3×10^6	Hf-175		3×10^4

TABLE 10. DEFAULT RADIONUCLIDE SPECIFIC OILs FOR FOOD, MILK AND WATER CONCENTRATIONS FROM LABORATORY ANALYSIS (cont.)

Radionuclide		OIL6 (Bq/kg)	Radionuclide		OIL6 (Bq/kg)
Eu-150a		4×10^3	Hf-181		2×10^4
Eu-152		3×10^3	Hf-182	+	1×10^3
Eu-152m		4×10^6	Ta-178a		1×10^8
Eu-154		2×10^3	Ta-179		6×10^4
Eu-155		1×10^4	Ta-182		5×10^3
W-178	+	2×10^5	Hg-194	+	2×10^2
W-181		1×10^5	Hg-195		2×10^7
W-185		2×10^4	Hg-195m		8×10^5
W-187		1×10^6	Hg-197		1×10^6
W-188	+	3×10^3	Hg-197m		2×10^6
Re-184		2×10^4	Hg-203		1×10^4
Re-184m	+	3×10^3	Tl-200		5×10^6
Re-186		1×10^5	Tl-201		3×10^6
Re-187		5×10^5	Tl-202		2×10^5
Re-188		7×10^5	Tl-204		3×10^3
Re-189		8×10^5	Pb-201		2×10^7
Os-185		2×10^4	Pb-202	+	1×10^3
Os-191		8×10^4	Pb-203		2×10^6
Os-191m		1×10^7	Pb-205		2×10^4
Os-193		7×10^5	Pb-210	+	2.0
Os-194	+	8×10^2	Pb-212	+	2×10^5
Ir-189		2×10^5	Bi-205		7×10^4
Ir-190		6×10^4	Bi-206		8×10^4
Ir-192		8×10^3	Bi-207		3×10^3
Ir-194		6×10^5	Bi-210		1×10^5
Pt-188	+	6×10^4	Bi-210m		2×10^2
Pt-191		9×10^5	Bi-212	+	7×10^7
Pt-193		8×10^4	Po-210		5.0
Pt-193m		3×10^5	At-211	+	2×10^5
Pt-195m		3×10^5	Ra-223	+	4×10^2
Pt-197		2×10^6	Ra-224	+	2×10^3
Pt-197m		1×10^8	Ra-225	+	2×10^2

TABLE 10. DEFAULT RADIONUCLIDE SPECIFIC OILs FOR FOOD, MILK AND WATER CONCENTRATIONS FROM LABORATORY ANALYSIS (cont.)

Radionuclide		OIL6 (Bq/kg)	Radionuclide		OIL6 (Bq/kg)
Au-193		8×10^6	Ra-226	+	2×10^1
Au-194		1×10^6	Ra-228		3.0
Au-195		2×10^4	Ac-225		3×10^3
Au-198		3×10^5	Ac-227	+	5.0
Au-199		5×10^5	Ac-228		7×10^6
Th-227	+	9×10^1	Pu-242		5×10^1
Th-228	+	2×10^1	Pu-244	+	5×10^1
Th-229	+	8.0	Am-241		5×10^1
Th-230		5×10^1	Am-242m	+	5×10^1
Th-231		2×10^6	Am-243	+	5×10^1
Th-232		4.0	Am-244		4×10^6
Th-234	+	8×10^3	Am-241/Be-9		5×10^1
Pa-230		5×10^4	Cm-240		4×10^3
Pa-231		2×10^1	Cm-241		3×10^4
Pa-233		3×10^4	Cm-242		5×10^2
U-230	+	8×10^2	Cm-243		6×10^1
U-232		2×10^1	Cm-244		7×10^1
U-233		1×10^2	Cm-245		5×10^1
U-234		2×10^2	Cm-246		5×10^1
U-235	+	2×10^2	Cm-247		6×10^1
U-236		2×10^2	Cm-248		1×10^1
U-238	+	1×10^2	Bk-247		2×10^1
Np-235		7×10^4	Bk-249		1×10^4
Np-236l	+	8×10^2	Cf-248		2×10^2
Np-236s		4×10^6	Cf-249		2×10^1
Np-237	+	9×10^1	Cf-250		4×10^1
Np-239		4×10^5	Cf-251		2×10^1
Pu-236		1×10^2	Cf-252		4×10^1
Pu-237		2×10^5	Cf-253		3×10^4
Pu-238		5×10^1	Cf-254		3×10^1
Pu-239		5×10^1	Es-253		5×10^3
Pu-240		5×10^1	Pu-239/Be-9		5×10^1
Pu-241		4×10^3			

TABLE 11. EQUILIBRIUM RADIOACTIVE CHAINS

Parent radionuclide	Progeny radionuclides considered in OIL6 assessment as being in equilibrium with the parent
Mg-28	Al-28
Si-32	P-32
Ca-47	Sc-47 (3.8)[a]
Ti-44	Sc-44
Fe-52	Mn-52m
Zn-69m	Zn-69 (1.1)
Ge-68	Ga-68
Sr-90	Y-90
Y-87	Sr-87m
Zr-95	Nb-95 (2.2)
Zr-97	Nb-97m (0.95), Nb-97
Tc-95m	Tc-95 (0.041)
Mo-99	Tc-99m (0.96)
Ru-103	Rh-103m
Ru-106	Rh-106
Pd-103	Rh-103m
Pd-109	Ag-109m
Ag-108m	Ag-108 (0.09)
Ag-110m	Ag-110 (0.013)
Cd-109	Ag-109m
Cd-115	In-115m (1.1)
In-114m	In-114 (0.96)
Sn-113	In-113m
Sn-121m	Sn-121 (0.78)
Sn-126	Sb-126m, Sb-126 (0.14)
Sb-125	Te-125m (0.24)
Te-121m	Te-121
Te-127m	Te-127
Te-129m	Te-129 (0.65)
Te-132	I-132

[a] The value inside the parentheses is the activity of the daughter radionuclide, per unit of the parent, assumed to be present.

TABLE 11. EQUILIBRIUM RADIOACTIVE CHAINS (cont.)

Parent radionuclide	Progeny radionuclides considered in OIL6 assessment as being in equilibrium with the parent
Cs-137	Ba-137m
Ba-131	Cs-131 (5.6)
Ba-140	La-140 (1.2)
Ce-144	Pr-144m (0.018), Pr-144
Pm-148m	Pm-148 (0.053)
Gd-146	Eu-146
Dy-166	Ho-166 (1.5)
Hf-172	Lu-172
Hf-182	Ta-182
W-178	Ta-178a
W-188	Re-188
Re-184m	Re-184 (0.97)
Os-194	Ir-194
Pt-188	Ir-188 (1.2)
Hg-194	Au-194
Pb-202	Tl-202
Pb-210	Bi-210, Po-210
Pb-212	Bi-212 , Tl-208 (0.40), Po-212 (0.71)
Bi-210m	Ti-206
Bi-212	Tl-208 (0.36), Po-212 (0.65)
At-211	Po-211 (0.58)
Rn-222	Po-218, Pb-214, Bi-214, Po-214
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Tl-207
Ra-224	Rn-220, Po-216, Pb-212 , Bi-212, Tl-208 (0.36), Po-212 (0.65)
Ra-225	Ac-225 (3.0), Fr-221 (3.0), At-217 (3.0), Bi-213 (3.0), Po-213 (2.9), Pb-209 (2.9), Tl-209 (0.067), Pb-209 (0.067)
Ra-226	Rn-222, Po-218, Pb-214, Bi-214, Po-214
Ac-225	Fr-221, At-217, Bi-213, Po-213 (0.98), Pb-209, Tl-209 (0.022)
Ac-227	Th-227 (0.99), Ra-223 (0.99), Rn-219 (0.99), Po-215 (0.99), Pb-211 (0.99), Bi-211 (0.99), Tl-207 (0.99), Fr-223 (0.014), Ra-223 (0.014), Rn-219 (0.014), Po-215 (0.014), Pb-211 (0.014), Bi-211 (0.014), Tl-207 (0.014)

TABLE 11. EQUILIBRIUM RADIOACTIVE CHAINS (cont.)

Parent radionuclide	Progeny radionuclides considered in OIL6 assessment as being in equilibrium with the parent
Th-227	Ra-223 (2.6), Rn-219 (2.6), Po-215 (2.6), Pb-211 (2.6), Bi-211 (2.6), Tl-207 (2.6)
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Th-229	Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213 (0.98), Pb-209 (0.98), Tl-209 (0.02), Pb-209 (0.02)
Th-234	Pa-234m
U-232	Th-226, Ra-222, Rn-218, Po-214
U-235	Th-231
U-238	Th-234, Pa-234m
Np-237	Pa-233
Pu-244	U-240, Np-240m
Am-242m	Am-242, Cm-242 (0.83)
Am-243	Np-239

II.24. OIL6 is exceeded if the following condition is satisfied:

$$\sum_i \frac{C_{f,i}}{\mathrm{OIL6}_i} > 1 \qquad (6)$$

where

$C_{f,i}$ is the concentration of radionuclide i in the food, milk or water (Bq/kg);
$\mathrm{OIL6}_i$ is the concentration of radionuclide i from Table 10 (Bq/kg).

II.25. If OIL6 is exceeded, the following actions should be taken:

— Stop consumption of non-essential[15] food, milk or water and conduct an assessment on the basis of realistic consumption rates. Replace essential

[15] Restriction of the consumption of essential food could result in severe health effects (e.g. severe malnutrition).

food, milk and water promptly, or relocate people if replacement of essential food, milk and water is not possible.
— For fission products (e.g. containing iodine) and iodine contamination, consider providing iodine thyroid blocking if replacement of essential food, milk or water is not immediately possible.
— Estimate the dose to those who may have consumed food, milk or rainwater from the area where restrictions were implemented to determine if medical screening is warranted.

PLAIN LANGUAGE EXPLANATION

II.26. Experience has shown that decision makers take actions and the public follow instructions best when they understand how the actions provide for the safety of the public [32]. The default OILs are therefore supported by a plain language explanation of how criteria and associated actions provide for the safety of all members of the public. In addition, experience shows that use of overly conservative criteria can result in the public taking actions that do more harm than good. The default OILs are developed using realistically conservative assumptions that provide reasonable assurance that all members of the public are safe.

II.27. The development of plain language explanations for the default OILs should be based on the assumption that members of the public living under normal conditions, including those who are more vulnerable to radiation exposure such as children and pregnant women, will achieve a level of protection that meets international standards, provided that during the emergency phase they:

— Do not receive a dose to any organ approaching that resulting in severe deterministic effects. The thresholds for the onset of severe deterministic effects are listed in Table 2.
— Do not receive a dose above which the risk of health effects (e.g. cancers) is sufficiently high to justify taking protective actions during an emergency (generic criterion of 100 mSv per annum, as presented in Table 3). Below this generic criterion, protective actions are not always justified and will be taken (if at all) on the basis of justified criteria developed, with interested parties, after careful consideration of the conditions, including the impact of any protective action.

II.28. The plain language communications below provide text that may be given directly to those members of the public to whom the criterion applies.

OIL1 plain language explanation

II.29. Remaining in the area where OIL1 is exceeded may not be safe. Those living in the area should *[insert appropriate recommended actions for OIL1]* to reduce the risk of health effects due to radiation.

OIL2 plain language explanation

II.30. Remaining in the area where OIL2 is exceeded for a short time is possible if the following recommended actions are taken, but staying for longer periods may not be safe. Move out of the area (relocate) within a week and *[insert appropriated recommended actions for OIL2]*.

II.31. The recommended actions for OIL2 take into account those members of the public most vulnerable to radiation exposure (e.g. infants and pregnant women). They also consider all the ways a person can be exposed to radiation from radioactive material deposited on the ground, including inhalation of dust and inadvertent ingestion of dirt (e.g. from dirty hands). For some types of radioactive material this advice may be overly cautious, but it is considered prudent until further analysis is performed. The relocation is likely to be temporary.

OIL3 plain language explanation

II.32. If other food is available in the territories where OIL3 is exceeded, stop consuming local produce (e.g. vegetables), milk from grazing animals and rainwater until they have been screened and declared safe. However, if restriction of consumption is likely to result in severe malnutrition or dehydration because replacement food, milk or water is not available, these items may be consumed for a short time until replacements are available.

II.33. The recommended actions for OIL3 take into account the most vulnerable members of the public (e.g. infants and pregnant women). The actions assume that all the locally produced food and milk is contaminated with radioactive material and that little is done (e.g. washing) to reduce the levels of contamination in the food before consumption. Exceeding OIL3 does not mean that the food or milk produced in the area is not safe; however, it is prudent not to consume local non-essential food until further analysis has been performed.