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FUNCTIONAL REQUIREMENTS IN EMERGENCY PREPAREDNESS AND RESPONSE

PRACTICE

Saint-Petersburg
2023

Practice 1. Public Communication Plan

Task: Development of a Public Communication Plan

based on

- GSR Part 7
- ARRANGEMENTS FOR PUBLIC COMMUNICATION IN PREPAREDNESS AND RESPONSE FOR A NUCLEAR OR RADIOLOGICAL EMERGENCY, General Safety Guide No. GSG-14
- Communication with the Public in a Nuclear or Radiological Emergency, EPR Public Communication 2012
- Additional info see below (from EPR_Method 2003)

Threat category

THREAT DESCRIPTION

Legend:

(1) operator (O);

(2) local officials (L); and

(3) national officials (N).

Providing information, and issuing instructions and warnings to the public (A5 elements)

Response objective: To warn the public promptly of an emergency and inform them of the immediate action that they should take

Keeping the public informed (A9 elements)

Response objective: To provide the public with useful, timely, truthful, consistent and appropriate information throughout a radiation emergency

A9 - KEEPING THE PUBLIC INFORMED	**Threat category**					**Responsibility**		
Elements	**I**	**II**	**III**	**IV**	**V**	**O**	**L**	**N**
A9.1 Arrange to provide useful, timely, truthful, consistent and appropriate information to the public in a radiation emergency, responding to incorrect information and rumours, and to requests for information from the public and from news and information media (4.83).	✓	✓	✓	✓		✓	✓	✓
Upon declaration of an emergency or receipt of significant inquiries from the media concerning a possible emergency, arrange to immediately co-ordinate all information from sources viewed by the public as official (governmental agencies and the facility). This should include arrangements: 1) to issue a press release identifying the agency that will be the official source of information; 2) to establish as soon as possible, a single official source and 3) to remind other agencies to refer requests by the media for information to the designated agency. For significant events, a PIC (see Appendix 14) should be established near the location of the emergency that will be the only location disseminating official information. Security should be provided for the PIC along with a system for confirming the credentials of media personnel.	✓	✓	✓	✓		✓	✓	✓

Arrange to provide the public promptly with information on the risk and protective actions following warning of an emergency (see Element A5.2) and again following issuance of protective action recommendations. Identify sources of additional information in the instructions provided to the public (see Element A5.1). Arrange to provide information to the public outside the emergency zones (outside the area where protective actions are being recommended) on what actions they should or should not take and why (see Element A5.2).	✓	✓		✓		✓	✓	✓
Arrange to monitor media information and to promptly respond to misleading, inaccurate or confusing information. Arrange to identify inappropriate reactions (see Element A11.2) by the public during an emergency and to provide information to the media to help alleviate the situation. Address incorrect or misleading information in the international media through the IAEA (see Element A2.15).			✓	✓		✓	✓	✓
Prepare material in advance to be used to provide advice to the public and address likely questions and concerns during an emergency. Arrangements should be made to revise this material before release during an emergency. Ref. [37]provides examples of such material.	✓	✓	✓	✓		✓	✓	✓
Have arrangements to dispatch a public information officer/team to assist local officials responding to a radiological emergency. (see Appendix 7 for typical responsibilities)								✓
Arrange, after the declaration of an emergency, to brief trusted members of the local community, including doctors, teachers, religious leaders and action groups.	✓	✓	✓	✓		✓	✓	✓
Arrange, in advance, a location to serve as the PIC (see Appendix 14), where facility, local and national officials provide media briefings. The PIC should be near the facility but outside the UPZ.	✓					✓	✓	
Arrange to provide information to the members of the media at the scene on risks, restrictions, and precautions they should take for their protection. Members of the media could be considered emergency workers (because they are needed to provide trusted information to the public) and should be included in the arrangements for providing radiation protection and long term medical monitoring (see Element A8.5).	✓	✓		✓		✓	✓	✓
Arrange to provide responders who will have direct contact with the public (e.g. monitoring teams) with instructions on how to interact with the public and media.	✓	✓		✓	✓	✓	✓	✓

Arrange to promptly provide the public with the results of medical examinations, monitoring, sampling or other activities directly involving them, their homes, community or workplaces.	✓	✓		✓		✓	✓	✓
A9.2 Ensure that the operator, the response organizations, other States and the IAEA co-ordinate the provision of information to the public and to the news and information media in the event of a radiation emergency (4.84).	✓	✓	✓	✓	✓	✓	✓	✓
Arrange for all response organizations, States within the emergency zones and the IAEA to co-ordinate the information provided to the public and the news media.	✓	✓		✓		✓	✓	✓

Practice 2

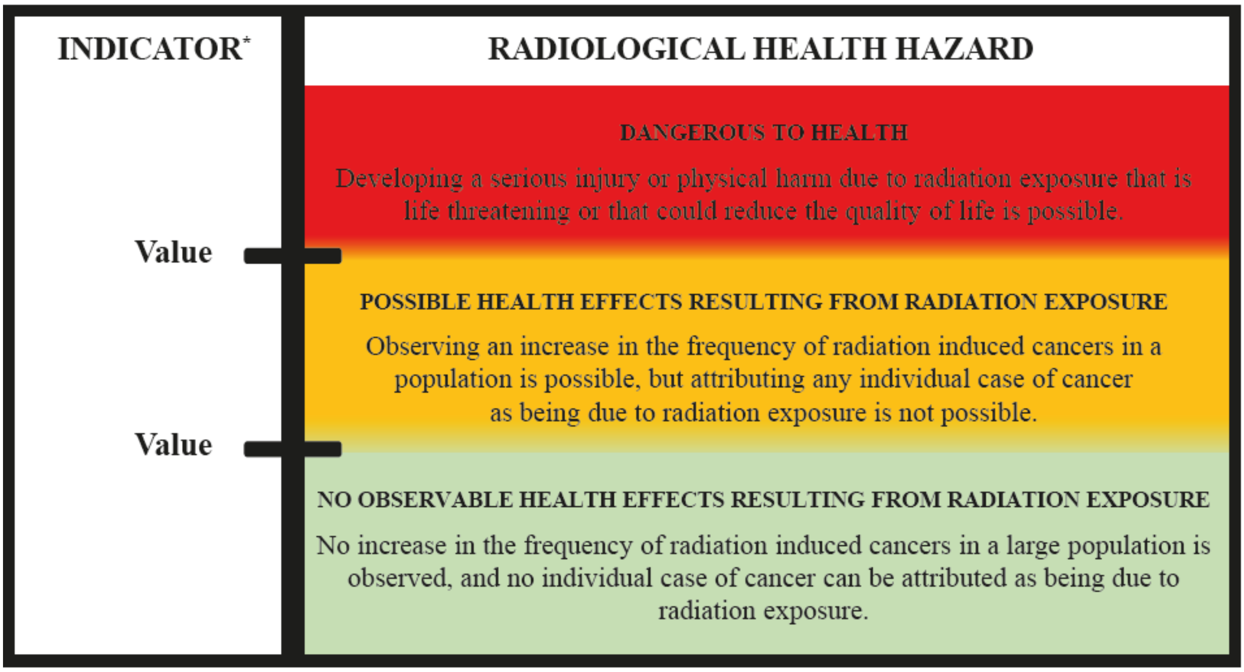
Task: Familiarization with
EXAMPLE SYSTEM FOR PUTTING RADIOLOGICAL HEALTH HAZARDS IN PERSPECTIVE IN A NUCLEAR OR RADIOLOGICAL EMERGENCY

A.1. The system for putting radiological health hazards in perspective has been derived on the basis of the findings of the UNSCEAR 2012 Report and the generic criteria established in GSR Part 7 and GSG-2 for taking protective actions and other response actions in a nuclear or radiological emergency.

A.2. The system should be considered by the relevant authorities when developing a national system for putting radiological hazards in perspective, as required by paras 5.72, 5.83 and 5.96 of GSR Part 7. In considering this system, the national context should also be taken into account.

A.3. The system comprises three levels as follows:

- Dangerous to health;
- Possible health effects resulting from radiation exposure;
- No observable health effects resulting from radiation exposure.



*System for putting radiological health hazards in perspective. *Examples include dose, dose rate or any other indicator.*

Each level is explained in detail in paras A.4–A.15 and is colour coded (see Fig. above).

DANGEROUS TO HEALTH

A.4. ‘Dangerous to health’ corresponds to situations in which there is a possibility to develop in an individual a serious injury or physical harm that is life threatening or that could reduce the quality of life as being due to radiation exposure.

A.5. ‘Dangerous to health’ corresponds to doses exceeding the generic criteria in table II.1 of GSR Part 7, at which health effects in an individual could be scientifically attributed to radiation exposure. If such doses are projected, protective actions and other response actions should be taken under any circumstances to protect individuals.

A.6. If such doses are received, medical examination and screening should be provided and should be followed by medical treatment, as necessary

EXPOSURE

A.7. ‘Possible health effects resulting from radiation exposure’ corresponds to situations in which there is a small possibility that epidemiological studies would reveal an increase due to radiation exposure in the frequency of occurrence of specific cancers in a large population. However, attributing any individual case of cancer as being due to radiation exposure will not be possible.

A.8. ‘Possible health effects resulting from radiation exposure’ corresponds to doses exceeding the generic criteria in table II.2 of GSR Part 7, at which an increase in the frequency of occurrence of specific cancers in a population could be scientifically attributed to radiation exposure by means of epidemiological analysis.

A.9. If such doses are projected, protective actions and other response actions should be taken as a precaution to protect individuals.

A.10. If such doses are received, longer term medical follow-up should be provided for the early detection and effective treatment of specific radiation induced health effects.

A.11. Care should be taken in public communication when projections of numbers of health effects among a population are provided in such cases. The meaning of the numbers should be clearly explained and should be clearly related to the objective of the longer term medical follow-up.

POSSIBLE HEALTH EFFECTS RESULTING FROM RADIATION EXPOSURE

Observing an increase in the frequency of radiation induced cancers in a population is possible, but attributing any individual case of canceras being due to radiation exposure is not possible.

DANGEROUS TO HEALTH.

Developing a serious injury or physical harm due to radiation exposure that is life threatening or that could reduce the quality of life is possible.

NO OBSERVABLE HEALTH EFFECTS RESULTING FROM RADIATION EXPOSURE.

No increase in the frequency of radiation induced cancers in a large population is observed, and no individual case of cancer can be attributed as being due to radiation exposure.

RADIOLOGICAL HEALTH HAZARDINDICATOR*ValueValue

System for putting radiological health hazards in perspective. *Examples include dose, dose rate or any other indicator.

NO OBSERVABLE HEALTH EFFECTS RESULTING FROM RADIATION EXPOSURE

A.12. ‘No observable health effects resulting from radiation exposure’ corresponds to situations in which there is no possibility that current epidemiological studies would reveal an increase due to radiation exposure in the frequency of occurrence of specific cancers in a large population. Attributing any individual case of cancer as being due to radiation exposure will also not be possible.

A.13. ‘No observable health effects resulting from radiation exposure’ corresponds to doses of the order of magnitude of doses due to global average background levels of radiation and below the generic criteria provided in tables II.1 and II.2 of GSR Part 7. If such doses are projected, protective actions and other response actions for protecting individuals against radiological health hazards are not warranted. Taking such actions might be considered, as a precaution, to reduce doses to be as low as reasonably achievable, but only if the actions are justified and optimized.

A.14. If such doses are received, no medical attention in relation to radiation induced health effects is warranted.

A.15. Projections of hypothetical numbers of health effects among a population in such cases, made for whatever reason, should not be used in public communication on radiological health hazards.

Practice 3

Task: Familiarization with

International Nuclear and Radiological Event Scale (INES)

GENERAL DESCRIPTION OF THE SCALE

Events are classified on the scale at seven levels: Levels 4–7 are termed "accidents" and Levels 1–3 "incidents". Events without safety significance are classified as "Below Scale/Level 0". Events that have no safety relevance with respect to radiation or nuclear safety are not classified on the scale (see Section 1.3).

For communication of events to the public, a distinct phrase has been attributed to each level of INES. In order of increasing severity, these are: 'anomaly', 'incident', 'serious incident', 'accident with local consequences', 'accident with wider consequences'1, 'serious accident' and 'major accident'.

The aim in designing the scale was that the severity of an event would increase by about an order of magnitude for each increase in level on the scale (i.e. the scale is logarithmic). The 1986 accident at the Chernobyl nuclear power plant is rated at Level 7 on INES. It had widespread impact on people and the environment. One of the key considerations in developing INES rating criteria was to ensure that the significance level of less severe and more localized events were clearly separated from this very severe accident. Thus the 1979 accident at the Three Mile Island nuclear power plant is rated at Level 5 on INES, and an event resulting in a single death from radiation is rated at Level 4.

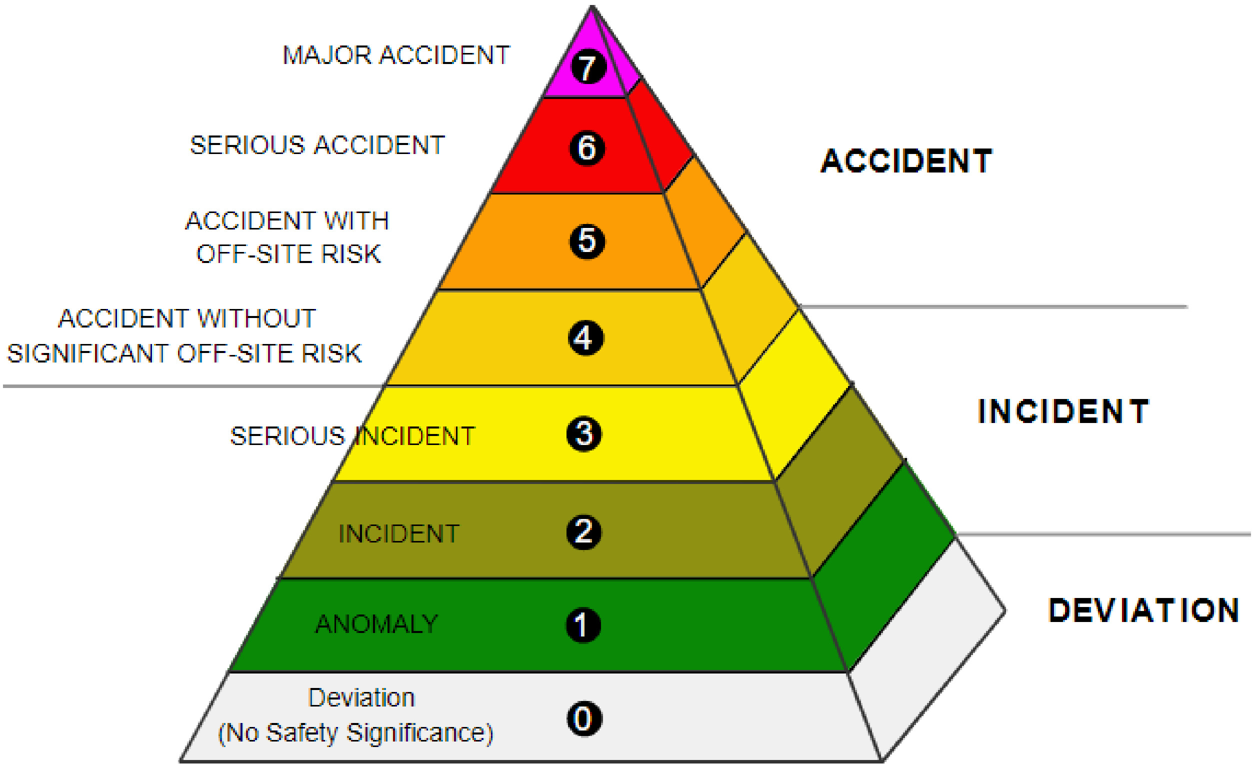
The structure of the scale is shown in Table 1. Events are considered in terms of their impact on three different areas: impact on people and the environment; impact on radiological barriers and controls at facilities; and impact on defence in depth. Detailed definitions of the levels are provided in the later sections of this manual.

The impact on people and the environment can be localized (i.e. radiation doses to one or a few people close to the location of the event or widespread as in the release of radioactive material from an installation). The impact on radiological barriers and controls at facilities is only relevant to facilities handling major quantities of radioactive material such as power reactors, reprocessing facilities, large research reactors or large source production facilities. It covers events such as reactor core melt and the spillage of significant quantities of radioactive material resulting from failures of radio-logical barriers, thereby threatening the safety of people and the environment. Those events rated using these two areas (people and environment, and radio-logical barriers and controls) are described in this manual as events with "actual consequences." Reduction in defence in depth principally covers those events with no actual consequences, but where the measures put in place to prevent or cope with accidents did not operate as intended.

Level 1 covers only degradation of defence in depth. Levels 2 and 3 cover more serious degradations of defence in depth or lower levels of actual consequence to people or facilities. Levels 4 to 7 cover increasing levels of actual consequence to people, the environment or facilities.

GENERAL DESCRIPTION OF INES LEVELS

INES Level	People and Environment	Radiological Barriers and Control	Defence-in-Depth
Major Accident Level 7	• Major release of radioactive material with widespread health and environmental effects requiring implementation of planned and extended countermeasures.		
Serious Accident Level 6	• Significant release of radioactive material likely to require implementation of planned countermeasures.		
Accident with Wider Consequences Level 5	• Limited release of radioactive material likely to require implementation of some planned countermeasures. • Several deaths from radiation.	• Severe damage to reactor core. • Release of large quantities of radioactive material within an installation with a high probability of significant public exposure. This could arise from a major criticality accident or fire.	
Accident with Local Consequences Level 4	• Minor release of radioactive material unlikely to result in implementation of planned countermeasures other than local food controls. • At least one death from radiation.	• Fuel melt or damage to fuel resulting in more than 0.1% release of core inventory. • Release of significant quantities of radioactive material within an installation with a high probability of significant public exposure.	
Serious Incident Level 3	• Exposure in excess of ten times the statutory annual limit for workers. • Non-lethal deterministic health effect (e.g., burns) from radiation.	• Exposure rates of more than 1 Sv/h in an operating area. • Severe contamination in an area not expected by design, with a low probability of significant public exposure.	• Near accident at a nuclear power plant with no safety provisions remaining. • Lost or stolen highly radioactive sealed source. • Misdelivered highly radioactive sealed source without adequate procedures in place to handle it.
Incident Level 2	• Exposure of a member of the public in excess of 10 mSv. • Exposure of a worker in excess of the statutory annual limits.	• Radiation levels in an operating area of more than 50 mSv/h. • Significant contamination within the facility into an area not expected by design.	• Significant failures in safety provisions but with no actual consequences. • Found highly radioactive sealed orphan source, device or transport package with safety provisions intact. • Inadequate packaging of a highly radioactive sealed source.
Anomaly Level 1			• Overexposure of a member of the public in excess of statutory annual limits. • Minor problems with safety components with significant defence-in-depth remaining. • Low activity lost or stolen radioactive source, device or transport package.
NO SAFETY SIGNIFICANCE *(Below Scale/Level 0)*			



Although INES covers a wide range of practices, it is not credible for events associated with some practices to reach the upper levels of the scale. For example, events associated with the transport of sources used in industrial radiography could never exceed Level 4, even if the source was taken and handled incorrectly.

SCOPE OF THE SCALE

The scale can be applied to any event associated with the transport, storage and use of radioactive material and radiation sources. It applies whether or not the event occurs at a facility. It includes the loss or theft of radioactive sources or packages and the discovery of orphan sources, such as sources inadvertently transferred into the scrap metal trade. The scale can also be used for events involving the unplanned exposure of individuals in other regulated practices (e.g. processing of minerals).

The scale is only intended for use in civil (non-military) applications and only relates to the safety aspects of an event. The scale is not intended for use in rating security-related events or malicious acts to deliberately expose people to radiation.

When a device is used for medical purposes (e.g. radiodiagnosis and radiotherapy), the guidance in this manual can be used for the rating of events resulting in actual exposure of workers and the public, or involving degradation of the device or deficiencies in the safety provisions. Currently, the scale does not cover the actual or potential consequences on patients exposed as part of a medical procedure. The need for guidance on such exposures during medical procedures is recognized and will be addressed at a later date.

The scale does not apply to every event at a nuclear or radiation facility. The scale is not relevant for events solely associated with industrial safety or other events which have no safety relevance with respect to radiation or nuclear safety. For example, events resulting in only a chemical hazard, such as a gaseous release of non-radioactive material, or an event such as a fall or an electrical shock resulting in the injury or death of a worker at a nuclear facility would not be classified using this scale. Similarly, events affecting the availability of a turbine or generator, if they did not affect the reactor at power, would not be classified on the scale nor would fires if they did not involve any possible radiological hazard and did not affect any equipment associated with radiological or nuclear safety.

PRINCIPLES OF INES CRITERIA

Each event needs to be considered against each of the relevant areas described in Section 1.2, namely: people and the environment; radiological barriers and controls; and defence in depth. The event rating is then the highest level from consideration of each of the three areas. The following sections briefly describe the principles associated with assessing the impact on each area.

People and the environment

The simplest approach to rating actual consequences to people would be to base the rating on the doses received. However, for accidents, this may not be an appropriate measure to address the full range of consequences. For example, the efficient application of emergency arrangements for evacuation of members of the public may result in relatively small doses, despite a significant accident at an installation. To rate such an event purely on the doses received does not communicate the true significance of what happened at the installation, nor does it take account of the potential widespread contamination. Thus, for the accident levels of INES (4-7), criteria have been developed based on the quantity of radioactive material released, rather than the dose received. Clearly these criteria only apply to practices where there is the potential to disperse a significant quantity of radioactive material.

In order to allow for the wide range of radioactive material that could potentially be released, the scale uses the concept of "radiological equivalence." Thus, the quantity is defined in terms of terabecquerels ^{131}I, and conversion factors are defined to identify the equivalent level for other isotopes that would result in the same level of effective dose.

For events with a lower level of impact on people and the environment, the rating is based on the doses received and the number of people exposed.

(The criteria for releases were previously referred to as "off-site" criteria)

Radiological barriers and controls

In major facilities with the potential (however unlikely) for a large release of activity, where a site boundary is clearly defined as part of their licensing, it is possible to have an event where there are significant failures in radiological barriers but no significant consequences for people and the environment (e.g. reactor core melt with radioactive material kept within the containment). It is also possible to have an event at such facilities where there is significant contamination spread or increased radiation, but where there is still considerable defence in depth remaining that would prevent significant consequences to people and the environment. In both cases, there are no significant consequences to individuals outside the site boundary, but in the first case, there is an increased likelihood of such consequences to individuals, and in the second case, such failures represent a major failure in the management of radiological controls. It is important that the rating of such events on INES takes appropriate account of these issues.

The criteria addressing these issues only apply at authorized facilities handling major quantities of radioactive materials. (These criteria, together with the criteria for worker doses, were previously referred to as "on-site" criteria). For events involving radiation sources and the transport of radioactive material, only the criteria for people and the environment, and for defence in depth need to be considered.

Defence in depth

INES is intended to be applicable to all radiological events and all nuclear or radiation safety events, the vast majority of which relate to failures in equipment or procedures. While many such events do not result in any actual consequences, it is recognized that some are of greater safety significance than others. If these types of events were only rated based on actual consequences, all such events would be rated at “Below scale/Level 0”, and the scale would be of no real value in putting them into perspective. Thus, it was agreed at its original inception, that INES needed to cover not only actual consequences but also the potential consequences of events.

A set of criteria was developed to cover what has become known as “degradation of defence in depth.” These criteria recognize that all applications involving the transport, storage and use of radioactive material and radiation sources incorporate a number of safety provisions. The number and reliability of these provisions depends on their design and the magnitude of the hazard. Events may occur where some of these safety provisions fail but others prevent any actual consequences. In order to communicate the significance of such events, criteria are defined which depend on the amount of radioactive material and the severity of the failure of the safety provisions.

Since these events only involve an increased likelihood of an accident, with no actual consequences, the maximum rating for such events is set at Level 3 (i.e. a serious incident). Furthermore, this maximum level is only applied to practices where there is the potential, if all safety provisions failed, for a significant accident (i.e. one rated at Levels 5, 6 or 7 in INES). For events associated with practices that have a much smaller hazard potential (e.g. transport of small medical or industrial radioactive sources), the maximum rating under defence in depth is correspondingly lower.

One final issue that is addressed under defence in depth is what is described in this document as additional factors, covering as appropriate, common cause failure, issues with procedures and safety culture. To address these additional factors, the criteria allow the rating to be increased by one level from the rating derived solely by considering the significance of the actual equipment or administrative failures. (It should be noted that for events related to radiation sources and transport of radioactive material, the possibility of increasing the level due to additional factors is included as part of the rating tables rather than as a separate consideration.)

The detailed criteria developed to implement these principles are defined in this document. Three specific but consistent approaches are used; one for transport and radiation source events, one specific to events at power reactors in operation and one for events at other authorized facilities (including events at reactors during cold shutdown, research reactors and decommissioning of nuclear facilities). It is for this reason that there are three separate sections for defence in depth, one for each of these approaches. Each section is self- contained, allowing users to focus on the guidance relevant to events of interest.

The criteria for transport and radiation source events are contained in a set of tables that combine all three elements of defence in depth mentioned earlier (i.e. the amount of radioactive material, the extent of any failure of safety provisions and additional factors).

The criteria for power reactors in operation give a basic rating from two tables and allow additional factors to increase the rating by one level. The basic rating from the tables depends on whether the safety provisions were actually challenged, the extent of any degradation of the safety provisions and the likelihood of an event that would challenge such provisions.

The criteria for events at reactors in cold shutdown, research reactors and other authorized facilities give a basic rating from a table, depending on the maximum consequences, were all the safety provisions to fail, and the extent of the remaining safety provisions. This latter factor is accounted for by grouping safety provisions into what are called independent safety layers and counting the number of such safety layers. Additional factors are then considered by allowing a potential increase in the basic rating by one level.

The final rating

The final rating of an event needs to take account of all the relevant criteria described above. Each event should be considered against each of the appropriate criteria and the highest derived rating is the one to be applied to the event. A final check for consistency with the general description of the levels of INES ensures the appropriateness of the rating. The overall approach to rating is summarized in the flow charts of Section 7.

USING THE SCALE

INES is a communication tool. Its primary purpose is to facilitate communication and understanding between the technical community, the media and the public on the safety significance of events. Some more specific guidance on the use of INES as part of communicating event information is given in Section 1.6.

It is not the purpose of INES or the international communication system associated with it to define the practices or installations that have to be included within the scope of the regulatory control system, nor to establish requirements for events to be reported by the users to the regulatory authority or to the public. The communication of events and their INES ratings is not a formal reporting system. Equally, the criteria of the scale are not intended to replace existing well-established criteria used for formal emergency arrangements in any country. It is for each country to define its own regulations and arrangements for such matters. The purpose of INES is simply to help to put into perspective the safety significance of those events that are to be communicated.

It is important that communications happen promptly; otherwise a confused understanding of the event will occur from media and public speculation. In some situations, where not all the details of the event are known early on, it is recommended that a provisional rating is issued based on the information that is available and the judgment of those understanding the nature of the event. Later on, a final rating should be communicated and any differences explained.

For the vast majority of events, such communications will only be of interest in the region or country where the event occurs, and participating countries will have to set up mechanisms for such communications. However, in order to facilitate international communications for events attracting, or possibly attracting, wider interest, the IAEA and OECD/NEA have developed a communications network that allows details of the event to be input on an event rating form (ERF), which is then immediately disseminated to all INES member States. Since 2001, this web-based INES information service has been used by the INES members to communicate events to the technical community as well as to the media and public.

It is not appropriate to use INES to compare safety performance between facilities, organizations or countries. Arrangements for reporting minor events to the public may be different, and it is difficult to ensure precise consistency in rating events at the boundary between Below scale/Level 0 and Level 1. Although information will be available on events at Level 2 and above, the statistically small number of such events, which also varies from year to year, makes it difficult to put forth meaningful international comparisons.

COMMUNICATING EVENT INFORMATION

General principles

INES should be used as part of a communications strategy, locally, nationally and internationally. While it is not appropriate for an international document to define exactly how national communications should be carried out, there are some general principles that can be applied. These are provided in this section. Guidance on international communications is provided in Section 1.6.2.

When communicating events using the INES rating, it needs to be remembered that the target audience is primarily the media and the public. Therefore:

— Use plain language and avoid technical jargon in the summary description of the event;

— Avoid abbreviations, especially if equipment or systems are mentioned (e.g. main coolant pump instead of MCP);

— Mention the actual confirmed consequences such as deterministic health effects to workers and/or members of the public;
— Provide an estimate of the number of workers and/or members of the public exposed as well as their actual exposure;
— Affirm clearly when there are no consequences to people and the environment;
— Mention any protective action taken.

The following elements are relevant when communicating events at nuclear facilities:
— Date and time of the event;
— Facility name and location;
— Type of facility;
— Main systems involved, if relevant;
— A general statement saying that there is/is not release of radioactivity to the environment or there are/are not any consequences for people and the environment.

In addition, the following elements are relevant parts of the event description for an event related to radiation sources or the transport of radioactive material:
— The radionuclides involved in the events;
— The practice for which the source was used and its IAEA Category [1];
— The condition of the source and associated device; and if it is lost, any information that will be helpful in identifying the source or device, such as the registration serial number(s).

International communications

As explained in Section 1.5, the IAEA maintains a system to facilitate international communication of events. It is important to recognize that this service is not a formal reporting system, and the system operates on a voluntary basis. Its purpose is to facilitate communication and understanding between the technical community (industry and regulators), the media and the public on the safety significance of events that have attracted or are likely to attract international media interest. There are also benefits in using the system to communicate transboundary transport events.

Many countries have agreed to participate in the INES system because they clearly recognize the importance of open communication of events in a way that clearly explains their significance.

All countries are strongly encouraged to communicate events internationally (within 24 hours if possible) according to the agreed criteria which are:
— Events rated at Level 2 and above; or
— Events attracting international public interest.

It is recognized that there will be occasions when a longer time scale is required to know or estimate the actual consequences of the event. In these circumstances, a provisional rating should be given with a final rating provided at a later date.

Events are posted in the system by the INES national officers, who are officially designated by the Member States. The system includes event descriptions, ratings in INES, press releases (in the national language and in English), and technical documentation for experts. Event descriptions, ratings and press releases are available to the general public without registration. Access to the technical documentation is limited to nominated and registered experts.

The main items to be provided for a specific event are summarized in the ERF. The information being made available to the public should follow the principles listed in Section 1.6.1. When the scale is applied to transport of radioactive material, the multinational nature of some transport events complicates the issue; however, the ERF for each event should only be provided by one country. The ERF, which itself is not available to the public, is posted by the country where the event occurs. The principles to be applied are as follows:
— It is expected that the country in which the event is discovered would initiate the discussion about which country will provide the event rating form.
— As general guidance, if the event involves actual consequences, the country in which the consequences occur is likely to be best placed to provide the event rating form. If the event only

involves failures in administrative controls or packaging, the country consigning the package is likely to be best placed to provide the event rating form. In the case of a lost package, the country where the consignment originated is likely to be the most appropriate one to deal with rating and communicating the event.

— Where information is required from other countries, the information may be obtained via the appropriate competent authority and should be taken into account when preparing the event rating form.

— For events related to nuclear facilities, it is essential to identify the facility, its location and type.

— For events related to radiation sources, it may be helpful to include some technical details about the source/device or to include device registration numbers, as the INES system provides a rapid means for disseminating such information internationally.

— For events involving transport of radioactive material, it may be helpful to include the identification of the type of package (e.g. excepted, industrial, Type A, B).

— For nuclear facilities, the basic information to be provided includes the facility name, type and location, and the impact on people and the environment. Although other mechanisms already exist for international exchange of operational feedback, the INES system provides for the initial communication of the event to the media, the public and the technical community.

— The event rating form also includes the basis of the rating. Although this is not part of the material communicated to the public, it is helpful for other national officers to understand the basis of the rating and to respond to any questions. The rating explanation should clearly show how the event rating has been determined referring to the appropriate parts of the rating procedure.

Practice 4. Preparing the hospital to receive patients in a radiation accident

Task: Develop recommendations for medical and administrative personnel on compiling checklists for receiving, accommodating victims and providing them with qualified medical care.

See: -EPR Pocket Guide for Medical Physicists

- GSR Part 7 Appendix II GENERIC CRITERIA FOR USE IN EMERGENCY PREPAREDNESS, Table II.I

Before the emergency (preparation phase)

Once there is notification of a radiation emergency, patients may start arriving at the hospital in large numbers. The Medical Physicists (MP) should help implement the hospital emergency response plan and ensure that the facility is protected. Specific steps include the following:

(a) Hospitals should be prepared for three groups of people arriving from a radiation emergency with mass casualties. Note that all three groups could contain individuals who have not been monitored or decontaminated prior to arriving at the hospital:

- The 'worried-well', who are not injured, but who are worried about how they may have been affected, and who arrive at the hospital quickly on their own initiative. If the staff does not know how to deal with this group, these individuals may take up the hospital's resources and interfere with the treatment of the injured arriving later.
- The injured who are rescued by the public or bystanders. Though clearly injured, these individuals may not be the most severely injured.
- The injured who are rescued by emergency response personnel. These individuals will typically be the most severely injured.

(b) Individuals who are only externally contaminated, but not sick or injured, will be decontaminated at another facility (i.e. a reception centre), so that hospital resources are conserved for the truly sick and injured.

(c) In cases where a large number of people have potentially been contaminated, it is necessary to establish a reception centre — separate from the hospital — to perform contamination monitoring. The reception centre needs trained personnel, radiation monitoring equipment, decontamination facilities and supplies, and manual or digital record keeping supplies. Access to the reception centre should not interfere with access to the hospitals accepting casualties. Athletic fields, stadiums and community centres could be used as reception centres.

ACTIONS TO PREPARE THE HOSPITAL AND STAFF

TO ACCEPT AFFECTED INDIVIDUALS

(a) Brief health care staff that the risk from a contaminated person is negligible if they follow the personnel protection guidelines.

(b) Check and prepare radiation survey meters for use:

a. Perform operational checks of the instruments.

b. Document background radiation levels.

c. Unless the contaminant is an alpha emitter, cover the detector with a plastic sheet or surgical glove to protect the detector from becoming contaminated.

d. If possible, maintain at least one instrument in the clean area for monitoring.

(c) Collect enough instruments and supplies (e.g. outer gloves, dressings) to allow replacement when they become contaminated.

(d) Follow the personnel protection guidelines.

(e) Follow proposed operational intervention levels (OILs) for decontamination, as shown in Table 27 (Appendix III)

TABLE 8. MATERIALS NEEDED DURING THE FACILITY PREPARATION PHASE (*p.18)*

(a) Rolls of plastic sheeting to cover floors and unneeded equipment.

(b) Tape for securing the plastic floor coverings in place.

(c) Tape for marking the floor.

(d) Rope or caution tape and warning signs for marking controlled areas clearly.

(e) Large plastic bags for trash.

(f) Large waste containers.

(g) Plastic trash bags for contaminated clothing, tags and marking pens.

(h) Small bags for contaminated personal items, with tags or marking pens.

(i) Charts for tracking patient contamination/exposure (see Appendices I–III)

During the emergency (response phase)
Setting up radiological control areas

TABLE 9. SETTING UP RADIOLOGICAL CONTROL AREAS (FIGS 10, 11)
(a) Include law enforcement to support redirection of the 'worried-well' persons (i.e. those who are concerned, but not injured), to the secondary location (i.e. reception centre) for monitoring/reassurance, as established by the resource coordinator.
(b) Prepare and designate an **ambulance reception area** and **treatment area** for receiving casualties according to the hospital plan for medical response to radiation emergencies.
(c) Each hospital has to consider its individual situation and respective facility design. See Fig. 17 in Appendix I for sample set-ups of hospital reception areas for emergencies resulting in several casualties or mass casualties.

(d) Make a path from the ambulance entrance to the hospital entrance using rolls of plastic sheeting about 1 m wide.

Cover the floor.

- Ordinary cloth sheets or square absorbent pads can be used if paper is unavailable.
- Tape the floor covering securely to the floor.
- Plastic sheets may often be slippery (especially if wet).

Remember that placing floor covering should not delay any urgent or emergent medical care.

(e) Rope off and mark the route to prevent unauthorized entry.

(f) Re-route the traffic of other (non-radiation emergency) patients (e.g. direct other medical emergencies to another hospital entrance).

(g) Select a controlled treatment area near an outside entrance (if possible):

- Set up an area large enough to handle the anticipated number of patients.
- Clear this area of visitors and non-radiation emergency patients.
- Remove or cover equipment that will not be needed.

(h) Restrict access to the controlled treatment area.

(i) Designate a buffer zone or secondary control line for added security.

(j) Make provisions to monitor anyone or anything leaving the controlled area.

(k) Prepare several large, plastic-lined waste containers; stock plastic bags of varying sizes, as well as labels, for personal effects; and stock warning labels and signs.

(l) Prepare the decontamination room of the treatment area if one has been previously designated. Otherwise, designate a decontamination room near the treatment area entrance.

(m) Establish a control line at the entrance to the decontamination room. Use wide tape to clearly mark the floor at the entrance to the room to differentiate the controlled (contaminated) side from the non-controlled (uncontaminated) side.

(n) As the patients arrive:

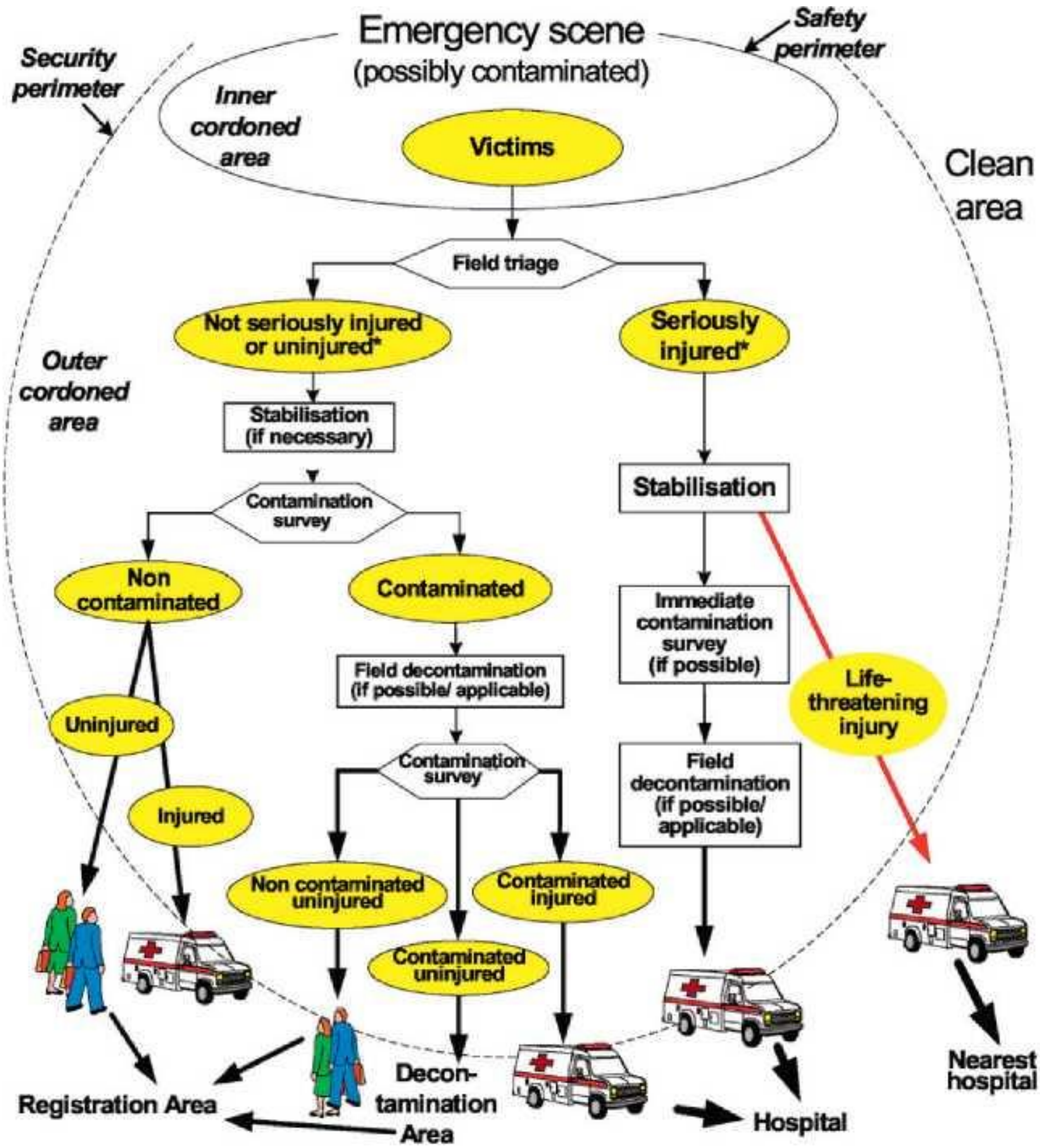
- Meet the patients at the established ambulance reception area and direct them to the contamination screening area, unless they need immediate medical attention.
- Exposed patients require no special handling, while contaminated victims are handled and transported using contamination control procedures. If there is any doubt, assume all victims are contaminated untilproven otherwise.
- Ambulance personnel should be surveyed and decontaminated (if necessary), unless the ambulance personnel need to return to the scene immediately for life saving response actions (see Section 5 for more information on decontamination of patients).
- Surveying the ambulance may be delayed until the end of the shift or until all the patients have been transported.
- Use specified charts for tracking patient contamination/exposure (see Appendices I–III).

(o) Control the spread of contamination:

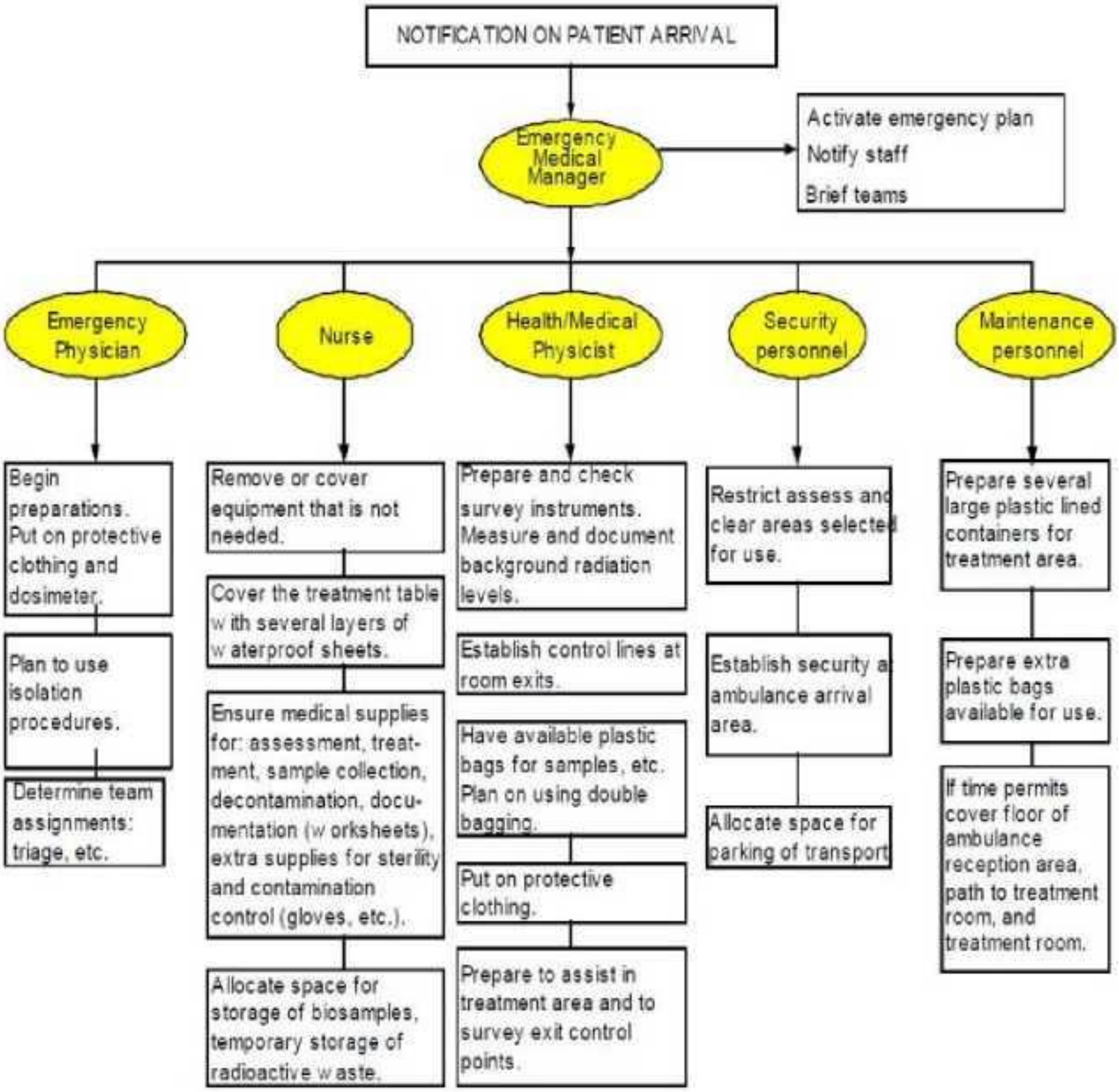
- Periodically survey staff for possible contamination.
- Ensure that staff are properly surveyed for contamination and decontaminate them, when necessary, prior to exiting the contaminated area.
- Survey medical equipment for contamination before removing it from the contaminated area.

NOTE: In principle, it may be desirable that rooms in the contamination control area have either a separate ventilation system from the rest of the hospital, or a means of preventing the unfiltered exhaust air from the radiation emergency area from mixing with air that is distributed to the rest of the hospital. However, there is very little likelihood that contaminants will become suspended in the air and enter the ventilation system; hence, no special precautions are advised.

Workflow and prioritization at the emergency



Duties of team members during response to radiation emergencies



After the emergency (recovery phase)

The MP can lead the radiological survey of the hospital areas and the decontamination of those areas, if needed; work with relevant national or local authorities to dispose of any radioactive waste stored at the hospital; and brief hospital management and hospital staff before the facility returns to normal and routine operations (see Table 10)

Waste management

(a) Establish a waste storage area where potentially contaminated items such as clothing can be stored. Preferably, this area will be indoors and secured to prevent the spread of contamination (e.g. by wind or rain).

(b) Clearly mark the waste storage area to control access and prevent inadvertent disposal and/or mixing with regular waste.
(c) Collect the following in plastic bags, label them accordingly, and take them to the secure designated waste storage area:

- Clothes collected from potentially contaminated patients or staff;
- Waste from the decontamination area (gloves, paper towels, used floor covering, etc.);
- Sheets, blankets and medical supplies used for patient transfer.

(d) Segregate presumptive or confirmed radiological waste.
(e) Make reasonable efforts to minimize the spread of contamination. However, these efforts should not be allowed to delay other response actions.
(f) Collect wastewater in containers for later analysis and disposal, but only if doing so will not delay decontamination efforts and will not interfere with or delay patient treatment.

(g) Ensure that the final disposal by the hospital of waste from a radiation emergency is consistent with the national policy and strategy for management of radioactive waste.

(h) If applicable, coordinate handling and processing of this waste with law enforcement officials and forensic experts

Termination (facility)

At the end of the emergency phase:

- Perform a radiological survey of hospital areas and clean any contaminated areas following established procedures. Do not return the area to normal use until approved by the radiation control authority.
- Make sure all emergency equipment is restored and inventories are restocked and prepared for use in the event of another radiation emergency

Practice 5. The classification of radioactive waste

Task: Open discussion in form of seminar/webinar/round table

Based on Standards Classification of Radioactive Waste for protecting people and the environment No. GSG-1General Safety Guide IAEA

A.1. Schemes for the classification of radioactive waste may be developed from different bases, such as operational or long term safety, the demands of process engineering, the availability of management or disposal facilities or the source of generation of the waste. A discussion of different purposes of and approaches to classification schemes for radioactive waste is provided in Annex II. In this Safety Guide, consideration is given primarily to the long term safety of waste management, since this is overriding in most cases involving its extended storage and disposal. This approach does not preclude the consideration of other aspects, such as occupational safety, that are pertinent in operational waste management.
A.2. Classification of radioactive waste may be helpful in planning a disposal facility and at any stage between the generation of raw waste and its disposal. It will help:
—At the conceptual level:
•In devising waste management strategies;
•In planning and designing waste management facilities;
•In assigning radioactive waste to a particular conditioning technique or disposal facility.
—At the legal and regulatory level:
•In the development of legislation;
•In the establishment of regulatory requirements and criteria.
—At the operational level:
•By defining operational activities and in organizing the work to be undertaken with the waste;
•By providing a broad indication of the potential hazards associated with the various types of radioactive waste;
•By facilitating record keeping.
—For communication:
•By providing terms or acronyms that are widely understood in order to improve communication among all parties with an interest in radioactive waste management, including generators and managers of radioactive waste, regulators and the public.
A.3. To satisfy all these purposes, an ideal radioactive waste classification scheme should meet a number of objectives, namely:
—Cover the full range of radioactive waste types;
—Be of use at all steps of radioactive waste management and be able to address the interdependences between them;
—Relate radioactive waste classes to the associated potential hazards for both present and future generations;
—Be sufficiently flexible to serve specific needs;
—Be straightforward and easy to understand;
—Be accepted as a common basis for characterizing waste by all parties, including regulators, operators and other interested parties;
—Be as widely applicable as possible.
A.4. It is clearly not possible to develop a unique classification scheme satisfying fully all these objectives simultaneously. For instance, a classification scheme cannot at the same time be universally applicable and still reflect the finer details of all the steps of radioactive waste management. Compromise will be needed to ensure simplicity, flexibility and broad applicability of the scheme. In developing a classification scheme:

—The definition of waste classes should be developed on a sound technical basis, should be clear and should be easily understandable;
—The general nature and applicability of the classification scheme should be clearly understandable;
—The number of classes should be such as to achieve a balance between the desired differentiation among waste types and the ease of handling of the classification scheme.

A.5. The classification scheme developed in this publication is intended to provide a framework for defining waste classes within national waste management strategies and to serve as a tool for facilitating communication on radioactive waste safety. The boundaries between the classes are not intended to be seen as hard lines, but rather as transition zones whose precise determination will depend on the particular situation in each State (Ref. [12] provides an example). The classification scheme is intended to cover all types of radioactive waste. Consequently, waste classes cannot be defined in terms of all the specific properties of the waste at this generic level. Rather, general concepts for defining waste classes are provided, from which specific criteria should be derived for different types of waste. Also of relevance is when and how material is declared to be waste, that is, material for which no further use is foreseen, and arrangements and procedures related to such a declaration should be subject to approval by the regulatory body.

A.6. The classification scheme developed in this publication is mainly based on long term safety considerations and can be applied for all waste management activities. The assignment of waste to a particular waste class does not depend on the actual activities being performed, except when disposal is being considered. However, for certain waste management steps (e.g. processing, transport and storage), more detailed classification may be required. This could be expressed in terms of subclasses of the general waste classes set down in this publication. Aspects that could be considered in the development of a more detailed classification scheme for specific waste management activities are discussed in Annex II.

A.7. The classification scheme is not intended to — and cannot — replace the specific safety assessment required for a waste management facility or activity. A waste management option that varies from that indicated by the generic waste classification scheme may also be determined as safe and viable on the basis of a specific safety assessment.

A.8. The main consideration for defining waste classes in this publication is long term safety. Waste is classified according to the degree of containment and isolation required to ensure its safety in the long term, with consideration given to the hazard potential of different types of waste. This reflects a graded approach towards the achievement of safety, as the classification of waste is made on the basis of the characteristics of the practice or source, with account taken of the magnitude and likelihood of exposures.

A.9. The parameters used in the classification scheme are the levels of activity content of the waste and the half-lives of the radionuclides contained in the waste, with account taken of the hazards posed by different radionuclides and the types of radiation emitted. Activity levels may be expressed in terms of total activity of the waste, activity concentration or specific activity, depending on the type of waste considered. These parameters are not used to present precise quantitative boundaries between waste classes. Rather, they are used to provide an indication of the severity of the hazard posed by specific types of waste.

A.10. The specification of criteria for the different waste classes will need to take account of the type of waste. For example, criteria specified in terms of total activity or level of activity concentration that would be suitable for bulkcontent of the waste and the half-lives of the radionuclides contained in the waste, with account taken of the hazards posed by different radionuclides and the types of radiation emitted. Activity levels may be expressed in terms of total activity of the waste, activity concentration or specific activity, depending on the type of waste considered. These parameters are not used to present precise quantitative boundaries between waste classes. Rather, they are used to provide an indication of the severity of the hazard posed by specific types of waste.

A.10. The specification of criteria for the different waste classes will need to take account of the type of waste. For example, criteria specified in terms of total activity or level of activity concentration that would be suitable for bulk amounts of waste will, in general, not be adequate to classify disused sealed sources. The implementation of the classification scheme will, therefore, have to take account of the specific characteristics of the potential hazard posed by the waste.

A.11. Dose criteria used for the management of waste containing naturally occurring radionuclides may be different from those used for the management of waste arising in nuclear installations and may be developed on the basis of considerations of optimization of protection. Such differences may influence the disposal option selected for large volumes of waste containing naturally occurring radionuclides such as tailings from mining and minerals processing.

A.12. The classification scheme presented in this publication is based on the safety aspects of waste management, in particular the safety aspects of disposal. However, the importance of security aspects of the management of radioactive waste is recognized. Although security is not explicitly addressed in the determination of the waste classes, safety and security aspects of waste management are in general compatible inasmuch as waste with higher activity concentrations and longer lived radionuclides is subjected to disposal options providing a greater degree of containment and isolation. However, a substantial difference in safety and security aspects of waste management could arise for waste containing mainly short lived radionuclides. On the basis of security considerations, the degree of containment and isolation necessary in the short term will most likely be greater than the degree of containment and isolation necessary in the long term to ensure safety.

A.13. The degree of containment and isolation provided in the long term varies according to the disposal option selected. The classification scheme set out in this publication is based on the consideration of long term safety provided by the different disposal options currently adopted or envisaged for radioactive waste. In the classification scheme, the following options for management of radioactive waste are considered, with an increasing degree of containment and isolation in the long term:

—Exemption or clearance;

—Storage for decay;

—Disposal in engineered surface landfill type facilities;

—Disposal in engineered facilities such as trenches, vaults or shallow boreholes, at the surface or at depths down to a few tens of metres;

METHODS OF CLASSIFICATION

II—1. Classification schemes for radioactive waste may be developed from different bases, such as safety or regulatory related aspects or process engineering demands. This annex provides a discussion of the various purposes of and approaches to classification schemes for radioactive waste.

II—2. Radioactive waste classification schemes can be set up at different levels and for various purposes. A classification scheme may be defined at the international level, at the national level or at the operator level. Its perspective and purpose will differ accordingly, addressing, for example, safety related aspects, the origin and characteristics of the waste, engineering demands or regulatory control.

II—3. The approach to classification will depend on the purpose of the radioactive waste classification scheme. One basic approach to classification is a straightforward qualitative description of the individual classes, whereby the general characteristics of the radioactive waste are used as the main criteria for the classification. Nevertheless, even for this qualitative approach to classifying, numerical values to characterize broad bands or orders of magnitude may also be helpful. Another basic approach to classification is by the use of quantitative criteria, whereby numerical values are specified for the definition of waste classes.

II-4. The approach described in Section 2 of Safety Guide is based mainly on the long term safety aspects of waste disposal, but can be used in the various stages of waste management. It is reasonable to use disposal as a basis for a classification scheme in order to maintain compatibility and coherence through the different stages of waste management.

II-5. A clear distinction has to be made between a classification scheme and a set of regulatory limits. The purpose of classification is to ensure that waste is managed in a safe and economic manner within the framework of a national strategy and to facilitate communication, while the purpose of regulatory limitation is to ensure the safety of each licensed facility and activity. Therefore, the development of precise limits has to be carried out within the regulatory framework of licensing or authorizing specific radioactive waste management activities and facilities. The regulatory body of a State will establish actual limits on quantities or concentrations for the classification of radioactive waste.

While a waste classification scheme may be useful for generic safety considerations, it is not a substitute for specific safety assessments performed for an actual facility and involving good characterization of radioactive waste.

QUALITATIVE CLASSIFICATION

II—6. There exist ‘natural’ classification schemes, for example, classification of waste according to its origin. An example of such a qualitative classification scheme is given in Annex III. While such a scheme is convenient for record keeping and notification to the regulatory body, it fails to meet many of the objectives listed in para. A.3 of the Appendix. Moreover, the characteristics relating to safety of the waste in a given class may vary widely, and waste within the same class may require different types of processing.

II—7. Another ‘natural’ classification scheme is the differentiation of radioactive waste according to its physical state, that is, solid, liquid or gaseous. This scheme stems from the process engineering needs for the processing of different waste streams, and the scheme is often refined to correspond to individual waste processing systems. A classification scheme of this type follows technical needs and possibilities and will therefore generally be specific to the individual facility. It may, however, incorporate safety considerations such as the radiation protection measures necessary for radioactive waste classes with higher radiological hazard potential.

II-8. The classification scheme proposed in 1994 had three principal waste classes: exempt waste, low and intermediate level waste (subdivided into short lived waste and long lived waste), and high level waste. The boundaries between waste classes were presented in terms of orders of magnitude of activity levels.

II-9. Different States use different classification schemes. In the United States of America, for example, the low and intermediate level class of waste is divided into four subclasses [II—1]. Some States have a class of very low level radioactive waste [II-2, II-3]. In many States, further distinction is made on the basis of half-lives of radionuclides in the waste, the physical state of the waste and other factors [II-4].

QUANTITATIVE CLASSIFICATION

II—10. Frequently, classification of radioactive waste is related to the safety aspects of the management of the waste in question. Such a classification scheme therefore provides a link between the characteristics of the waste and safety objectives that have been established by a regulatory body or the operator of a waste management facility. As safety criteria are generally formulated in terms of numerical values, a quantitative approach to classification will be necessary. Quantitative criteria for a radioactive waste classification scheme may be presented in terms of levels of activity concentration, half-lives of the radionuclides in the waste, heat generated by the waste and/or dose or dose rate. To derive a quantitative classification scheme, a procedure such as that outlined in paras II-11 to II-17 should be used.

II—11. The first step in developing a quantitative classification scheme is a definition of the purpose of the classification scheme, since a given classification scheme can only address a particular aspect of radioactive waste management. The decision as to the purpose of the classification scheme will be based on such aspects as:

— Type of radioactive waste;
— Facility or activity under consideration;
— Processing options available;
— Safety objectives to be met;
— Related social and economic factors;
— Need for communication.

II-12. The second step is the definition of the aspects to be considered in the scheme, for example:

— Exposure of personnel;
— Exposure of members of the public;
— Contamination of the environment;
— Safety from criticality;
— Normal conditions or accidents;
— Heat generated by the waste;
— Process engineering aspects.

II—13. For some of the aspects listed in para. II—12, regulatory or technical constraints may exist that have to be taken into account. Examples of such constraints are:

— Limits and requirements set by the regulatory body;
— The characteristics of the waste itself, that is, the annual amount arising, the total volume of generation, and the spectrum of radionuclides and their concentrations;
— Facility specific conditions (e.g. waste forms or waste packages accepted, engineering design);
— Operational limits;
— Pathways or scenarios prescribed for safety assessments;
— Site specific conditions (e.g. for waste disposal, the geological, hydrogeological and climatic characteristics of a site may restrict the choice of a disposal site or of the type of waste that can be disposed of at the site);
— Social or political aspects;
— Legal definitions and requirements.

These factors may place restrictions on the choice and the development of a classification scheme and therefore their effect has to be evaluated before the classification scheme can be derived.

II—14. Once the framework for classification has been set, the third step involves selection of the parameters to be used for classifying the waste. Important characteristics of waste that may be used as parameters for classification are given in Table II—I.

II-15. Possible scenarios, design options for the facility and site specific options then have to be evaluated in a fourth step to assess their suitability as classification parameters. For the case of LLW, a discussion of possible scenarios is provided in Ref. [II—4].

II-16. When a set of classification parameters has been chosen, intervals for numerical values or, alternatively, qualitative characteristics are specified as limits for different classes. Assignment of the waste to these classes will indicate whether the classification scheme that has been established is adequate.

II-17. Normally, the steps described in paras II-11 to II-16 are repeated in an iterative manner until a satisfactory result is reached.

TABLE II-I. IMPORTANT CHARACTERISTICS OF RADIOACTIVE WASTE THAT MAY BE USED AS PARAMETERS FOR CLASSIFICATION

Origin
Criticality
Radiological properties:
— Half-lives of radionuclides
— Heat generation
— Intensity of penetrating radiation
— Activity concentration of radionuclides
— Surface contamination
— Dose factors of relevant radionuclides
— Decay products
Physical properties:
— Physical state (solid, liquid or gaseous)
— Size and weight
— Compatibility
— Dispersibility
— Volatility
— Miscibility
— Free liquid content
Chemical properties:
— Chemical composition
— Solubility and chelating agents
— Potential chemical hazard
— Corrosion resistance/corrosiveness
— Organic content
— Combustibility and flammability
— Chemical reactivity and swelling potential
— Gas generation
— Sorption of radionuclides
Biological properties:
— Potential biological hazards
— Bio-accumulation
Other factors:
— Volume
— Amount arising per unit of time
— Physical distribution

ORIGIN AND TYPES OF RADIOACTIVE WASTE

III-1. Many activities involving the use of radionuclides and the production of nuclear energy, including all the steps in the nuclear fuel cycle, result in the generation of radioactive waste. Radioactive waste may also be generated by other activities such as the medical or industrial use of radioisotopes and sealed radiation sources, by defence and weapons programmes, and by the (mostly large scale) processing of mineral ores or other materials containing naturally occurring radionuclides, which in some cases have to be managed as radioactive waste. Examples of the last include the processing of phosphate ore and oil or gas exploration. Radioactive waste also arises from intervention activities, which are necessary after accidents or to remediate areas affected by past practices.

III-2. The radioactive waste that is generated is as varied in form, activity concentration and type of contamination as it is in type of generating activity. It may be solid, liquid or gaseous. Levels of activity concentration range from extremely high levels associated with spent fuel and residues from fuel reprocessing to very low levels associated with radioisotope applications in laboratories, hospitals, etc. Equally broad is the spectrum of half-lives of the radionuclides contained in the radioactive waste.

III—3. This annex briefly and qualitatively describes the major waste generating activities and the types of radioactive waste generated by each. The descriptions and the numerical values given are based on Ref. [III—1]. This annex also illustrates the application of the classification scheme developed in this Safety Guide to some of the types of radioactive waste described.

WASTE FROM MINING AND MINERALS PROCESSING THAT CONTAINS ELEVATED LEVELS OF NATURALLY OCCURRING RADIONUCLIDES

III-4. The initial step in the nuclear fuel cycle is the mining of uranium or thorium ores that are then used to produce nuclear fuel. However, other radioactive products, such as radium, may also be separated from the ores for a variety of applications. Mining activities lead to the extraction of ore that is sufficiently rich to justify processing, and also of relatively large amounts of materials that contain uranium or thorium in such small quantities that further processing is not economically justified. The mined materials not subjected to further processing constitute the mine tailings generally accumulated as waste piles, usually in proximity to the mines. Mine tailings resulting from the mining of uranium and thorium ores generally contain elevated levels of naturally occurring radionuclides and are required to be managed as radioactive waste for radiation protection purposes and safety reasons.

III-5. The richer ores from which uranium or thorium are to be separated are sent to mills for processing, which generally entails crushing and chemical processing. After removal of the uranium, the residues (the mill tailings) contain little of the parent nuclide of the decay chain of the mined element, but they still contain most of its decay products. Some of the daughter products may be more susceptible to leaching and emanation from the tailings than from the original ore. In addition, tailings from processing contain significant amounts of hazardous chemicals, including heavy metals such as copper, arsenic, molybdenum and vanadium; these need to be considered in assessing the safety of planned management options.

III-6. Similar types and quantities of radioactive waste containing naturally occurring radionuclides also arise from the extraction and/or processing of other materials that happen to be rich in naturally occurring radioactive materials; these materials include phosphate minerals, mineral sands, some gold-bearing rocks, coal and hydrocarbons, and contain long lived radionuclides at relatively low concentrations. The concentration of the radionuclides in these waste streams may exceed the levels for exempt waste as recommended in Section 2 of this Safety Guide. In recent years an increasing awareness has arisen that action is required to reduce doses due to exposure to such waste (often referred to as NORM and TENORM) and that regulatory control is necessary to ensure safety. The characteristics of such waste, however, are sufficiently different from those of other waste that specific regulatory considerations may be required. Of particular relevance are the long half-lives of radionuclides present and the usually large volumes of materials arising.

III—7. The classification scheme described in Section 2 of this Safety Guide covers such waste from mining and processing, but specific consideration needs to be given to its special properties and the regulatory approach applied. Some waste, such as some scales arising in the oil and gas industry, may have high levels of activity concentrations. These may necessitate the management of waste such as LLW or, in some cases, ILW. Volumes of such waste, however, are generally very limited.

WASTE FROM NUCLEAR POWER PRODUCTION

III-8. Nuclear power production gives rise to the generation of several kinds of radioactive waste, including spent fuel (if it is declared waste), other high level waste (HLW) that is generated mainly from the chemical reprocessing of spent fuel, and very low level waste (VLLW), low level waste (LLW) and intermediate level waste (ILW) that is generated as a result of reactor operations, reprocessing, decontamination, decommissioning and other activities in the nuclear fuel cycle.

High level waste (HLW)

III—9. Spent nuclear fuel contains significant amounts of fissile materials, other actinides and fission products. It generates significant heat when freshly removed from the reactor, and is usually placed in storage pools, generally located within the reactor building. Eventually the spent fuel will be removed and subjected to a management option chosen from among a few possibilities:

— Reprocessing: In this case the fuel is dissolved and treated to separate the remaining fissile components from the fission products and activation products. Reprocessing operations generate solid, liquid and gaseous radioactive waste streams. Solid waste such as fuel element cladding hulls, hardware and other insoluble residues is generated during fuel dissolution. This waste may contain activation products, as well as some undissolved fission products, uranium and plutonium. The principal liquid waste stream is the nitric acid solution, which contains both high levels of activity concentration of fission products and actinides in high concentrations. The principal gaseous waste stream is the off-gas, which contains rare gases and volatile fission products that are released from the spent fuel during the dissolution process. After solidification, HLW arising from reprocessing of spent fuel requires disposal in geological disposal facilities providing sufficient isolation and containment over long time periods.

— Disposal: A number of States have decided that spent fuel should not be reprocessed and consider it to be waste, therefore requiring disposal. The disposal option generally under consideration is emplacement in geological disposal facilities.

— Long term storage: If reprocessing is not carried out, and as long as geological disposal facilities are not operational, storage of spent fuel is obviously unavoidable. Most States that do not reprocess spent fuel are making plans for its extended storage. Long term storage may take place at reactor sites or in storage facilities remote from the reactor.

III—10. Liquid HLW is generally stored in tanks prior to its eventual solidification (vitrification is the approach currently used). While there is general agreement that liquid HLW needs to be transformed into a solid, there are a number of sites where liquid HLW has been stored in tanks for time periods now extending to several decades. Most liquid HLW subjected to such long term storage has been generated by activities in defence programmes (see para. III-21).

Low level waste and intermediate level waste from operations

III—11. The manufacture of reactor fuel generates waste from purification, conversion and enrichment of uranium and the fabrication of fuel elements. This waste includes contaminated filter materials from off-gas systems, lightly contaminated trash, and residues from recycling or recovery operations. This waste generally contains uranium and, in the case of waste from the manufacture of mixed oxide fuel, also plutonium.

III—12. In the operation of nuclear power plants, waste arises from the processing of cooling water and storage pond water, from equipment decontamination and from routine facility maintenance. Waste from the operation of nuclear power plants is normally contaminated with fission products and activation products. Waste generated from routine operations includes contaminated clothing, floor sweepings, paper and plastic. Waste from processing of primary coolant water and the off-gas system includes spent resins and filters as well as some contaminated equipment. Waste may also be generated from the replacement of activated core components such as control rods or neutron sources.

Waste from decommissioning of nuclear installations

III-14. At the end of the useful life of a nuclear installation, administrative and technical actions are taken to allow the removal of some or all of the regulatory requirements from the facility. The activities involved in decontamination and dismantling of a nuclear facility and the cleanup of the site will lead to the generation of radioactive waste that may vary greatly in type, level of activity concentration, size and volume, and may be activated or contaminated. This waste may consist of solid materials such as process equipment, construction materials, tools and soils. The largest volumes of waste from the dismantling of nuclear installations will mainly be VLLW and LLW. To reduce the amount of radioactive waste, decontamination of materials is widely

WASTE FROM INSTITUTIONAL ACTIVITIES

III-15. Institutional uses of radioactive materials include activities in the fields of research, industry and medicine. Such activities, particularly in the field of research, are very varied and result in the generation of waste of different classes. As in the nuclear sector, institutional waste can be generated in gaseous, liquid or solid form. Most institutional waste is in solid form and is generally handled in a comparable way to waste generated within the nuclear fuel cycle.

Waste from research reactors

III—16. The waste generated by research reactors and from some disused radioactive sources is particularly significant because, owing to its level of activity concentration and to the half-lives of the radionuclides, it does not meet the waste acceptance criteria of near surface disposal facilities.

Waste from research facilities

III-17. Research facilities (e.g. hot cell chains, glovebox chains) or pilot plants for checking fuel fabrication processes (particularly the fabrication of mixed uranium plutonium oxides, known as MOX), for fuel reprocessing (particularly advanced schemes), and for post-irradiation examinations, as well as their analytical laboratories, generate types of waste that, often, are different from the typical waste generated by industrial plants. Owing to the presence of non-negligible amounts of long lived alpha emitters, waste from research facilities generally belongs to the ILW class and even, in some circumstances, to the HLW class. Research activities take place at facilities such as research reactors and accelerators, and include laboratory activities. The type and volume of waste generated by research activities is dependent on the research conducted.

Waste from the production and use of radioisotopes

III-18. The production and use of radioisotopes generate smaller quantities of waste than fuel cycle activities:

— Production of radioisotopes: The type and volume of waste generated depends on the radioisotope and its production method. Generally, the volume of radioactive waste generated from these activities is small but the levels of activity concentration may be significant.

— Applications of radioisotopes: The use of radioisotopes may generate small volumes of waste. The type and volume of waste generated will depend on the application.

Waste from decommissioning of other nuclear facilities

III—19. Nuclear facilities within the institutional sector will also require decommissioning. The waste generated will be similar to that arising from the decommissioning of nuclear installations (in particular in the case of decommissioning of research reactors); however, the volumes of waste generated will be substantially smaller.

Disused sealed sources

III-20. A particular type of waste is disused sealed radioactive sources. Sealed sources are characterized by the concentrated nature of their radioactive contents and are widely used in medical or industrial applications. They may still be hazardous at the end of their useful lives and will require appropriate management, as they contain large and highly concentrated amounts of a single radionuclide and in many cases may not meet the waste acceptance criteria for near surface disposal facilities even when the source radionuclide is not particularly long lived. Radioactive sources unsuitable for near surface disposal require emplacement at greater depths and therefore fall within the ILW class or, in some cases, even the HLW class.

III-21. Sources may be described according to the activity and half-life of the radionuclide they contain. Sources containing radionuclides with half-lives of less than 100 days (e.g. 90Y, 192Ir, or 198Au used in brachytherapy) may be stored for decay and eventually disposed of as exempt waste. Other sources such as those containing 137Cs, 60Co or 238Pu have longer half-lives and other management options will be required. A breakdown of different types of sources is given in Table III-1 (from Ref. [III-2]).

WASTE FROM DEFENCE PROGRAMMES AND WEAPONS PRODUCTION RELATED WASTE

III-22. Large quantities of waste from defence programmes and waste relating to the production of nuclear weapons were generated in the early days of the development and testing of nuclear weapons. The most mobile HLW in this context is that in storage while awaiting solidification. Decommissioning of nuclear weapons typically involves blending the highly enriched uranium and/ or plutonium with natural uranium to produce UO2 and/or mixed uranium- plutonium fuel for commercial power reactors or storing this material for future disposal in geological disposal facilities with HLW or spent fuel.

RADIOACTIVE MATERIAL IN THE ENVIRONMENT

III-23. Radioactive residues have been deposited on the Earth’s surface as a result of a variety of activities. These include residues from nuclear weapon testing, accidents at nuclear facilities and past practices such as uranium mining that were subject to less stringent regulatory control than that required by present-day safety standards. The waste arising from remediation operations will have to be managed as radioactive waste and be either stabilized in situ or disposed of in appropriate disposal facilities [III-3].

EXAMPLE OF THE USE OF THE WASTE CLASSIFICATION SCHEME

III-24. An example of the use of the classification scheme described in this Safety Guide to waste not deriving from nuclear activities is given in Fig. III-1. It shows the waste classes into which different types of sealed sources as defined in Table III-1 and waste containing naturally occurring radionuclides typically will fall. Waste containing naturally occurring radionuclides can vary considerably in its characteristics and could hence fall into a number of classes for disposal. As indicated, some waste could have very low levels of activity concentration and not require disposal as radioactive waste. Other waste with higher, but limited concentrations could be appropriate for near surface disposal, and such waste with higher concentrations, where specific radionuclides may have been concentrated, may require disposal at greater depth than is typical for near surface disposal. This example illustrates that the waste classification scheme is able to accommodate a variety of different types of waste. Similar diagrams can be developed for other types of waste.

TABLE III-1.

DISUSED SEALED RADIOACTIVE SOURCES

Example in Fig. III-1	Half-life	Activity	Volume	Example
i	<100 d	100 MBq	Small	Y-90, Au-198 (brachytherapy)
ii	<100 d	5 TBq	Small	Ir-192 (brachytherapy)
iii	<15 a	<10 MBq	Small	Co-60, H-3 (tritium targets), Kr-85
iv	<15 a	<100 TBq	Small	Co-60 (irradiators)
v	<30 a	<1 MBq	Small	Cs-137 (brachytherapy, moisture density detectors)
vi	<30 a	<1 PBq	Small	Cs-137 (irradiators)
				Sr-90 (thickness gauges, radioisotope thermoelectric generators (RTGs))
vii	>30 a	<40 MBq	Small, but may be	Pu, Am, Ra (static eliminators)
viii	>30 a	<10 GBq	large numbers of sources (up to tens of thousands)	Am-241, Ra-226 (gauges)

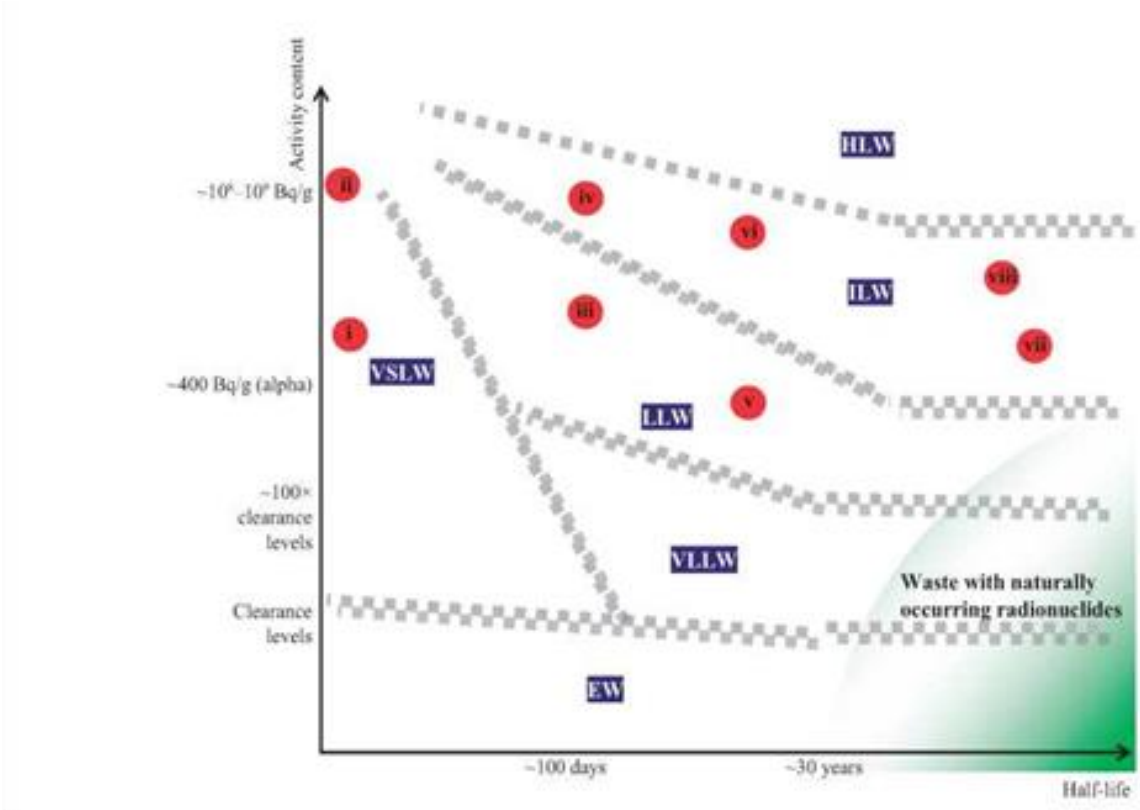


FIG. III-1. Illustrative example of the application of the waste classification scheme. The numbers refer to examples of disused sealed sources set out in Table III-1.

Practice 6. Emergency preparedness categories

Task: Open discussion in form of seminar/webinar/round table

Abstracts for discussion

Source: EPR-Method2003

THREAT CATEGORIES

Before any planning can begin, the practices and activities for which emergency response planning is necessary must be identified. Emergency planning could be different for each practice. However, this can be simplified by grouping practices into five threat categories, defined in Table I, each presenting common features in terms of the magnitude and timing of the hazard.

Information in the remainder of this publication is organized according to these "threat categories". Threat categories I through III represent decreasing levels of threats at facilities and therefore decreasing emergency preparedness and response requirements. Threat category IV applies to threats and practices that can exist virtually anywhere and thus is the minimum level of threat assumed to exist everywhere. Threat category IV always applies to all jurisdictions, possibly along with other categories. Threat category V applies to the off-site areas where emergency preparations are warranted to address contamination resulting from a release from a facility in threat category I or II. These threat categories apply both to facilities or uses and to governmental jurisdictions for which various levels of preparedness are warranted. Section 2.2.5 provides help in determining the threat categories and Appendix 4 gives examples of the threat categories for different practices.

Emergency preparedness categories

For the purposes of these safety requirements, assessed hazards are grouped in accordance with the emergency preparedness categories shown in Table 1. The five emergency preparedness categories (hereinafter referred to as 'categories') in Table 1 establish the basis for a graded approach to the application of these requirements and for developing generically justified and optimized arrangements for preparedness and response for a nuclear or radiological emergency

TABLE …….. EMERGENCY PREPAREDNESS CATEGORIES

Keeping the public informed (A9 elements)

Response objective: To provide the public with useful, timely, truthful, consistent and appropriate information throughout a radiation emergency

Legend:

(4) operator (O); local officials (L); and national officials (N).

A9 - KEEPING THE PUBLIC INFORMED	Threat category					Responsibility		
Elements	**I**	**II**	**III**	**IV**	**V**	**O**	**L**	**N**
A9.1 Arrange to provide useful, timely, truthful, consistent and appropriate information to the public in a radiation emergency, responding to incorrect information and rumours, and to requests for information from the public and from news and information media (4.83).	✓	✓	✓	✓		✓	✓	✓
Upon declaration of an emergency or receipt of significant inquiries from the media concerning a possible emergency, arrange to immediately co-ordinate all information from sources viewed by the public as official (governmental agencies and the facility). This should include arrangements: 1) to issue a press release identifying the agency that will be the official source of information; 2) to establish as soon as possible, a single official source and 3) to remind other agencies to refer requests by the media for information to the designated agency. For significant events, a PIC (see Appendix 14) should be established near the location of the emergency that will be the only location disseminating official information. Security should be provided for the PIC along with a system for confirming the credentials of media personnel.	✓	✓	✓	✓		✓	✓	✓
Arrange to provide the public promptly with information on the risk and protective actions following warning of an emergency (see Element A5.2) and again following issuance of protective action recommendations. Identify sources of additional information in the instructions provided to the public (see Element A5.1). Arrange to provide information to the public outside the emergency zones (outside the area where protective actions are being recommended) on what actions they should or should not take and why (see Element A5.2).	✓	✓		✓		✓	✓	✓
Arrange to monitor media information and to promptly respond to misleading, inaccurate or confusing information. Arrange to identify inappropriate reactions (see Element A11.2) by the public during an emergency and to provide information to the media to help alleviate the situation. Address incorrect or misleading information in the international media through the IAEA (see Element A2.15).			✓	✓		✓	✓	✓
Prepare material in advance to be used to provide advice to the public and address likely questions and concerns during an emergency. Arrangements should be made to revise this material before release during an emergency. Ref. [37]provides examples of such material.	✓	✓	✓	✓		✓	✓	✓
Have arrangements to dispatch a public information officer/team to assist local officials responding to a radiological emergency. (see Appendix 7 for typical responsibilities)								✓
Arrange, after the declaration of an emergency, to brief trusted members of the local community, including doctors, teachers, religious leaders and action groups.	У	y	✓	✓		✓	✓	✓

Arrange, in advance, a location to serve as the PIC (see Appendix 14), where facility, local and national officials provide media briefings. The PIC should be near the facility but outside the UPZ.	У					✓	✓	
Arrange to provide information to the members of the media at the scene on risks, restrictions, and precautions they should take for their protection. Members of the media could be considered emergency workers (because they are needed to provide trusted information to the public) and should be included in the arrangements for providing radiation protection and long term medical monitoring (see Element A8.5).	У	y		✓		✓	✓	✓
Arrange to provide responders who will have direct contact with the public (e.g. monitoring teams) with instructions on how to interact with the public and media.	У	y		✓	/	✓	✓	✓
Arrange to promptly provide the public with the results of medical examinations, monitoring, sampling or other activities directly involving them, their homes, community or workplaces.	y	y		✓		✓	✓	✓
A9.2 Ensure that the operator, the response organizations, other States and the IAEA co-ordinate the provision of information to the public and to the news and information media in the event of a radiation emergency (4.84).	У	y	✓	✓	/	✓	✓	✓
Arrange for all response organizations, States within the emergency zones and the IAEA to co-ordinate the information provided to the public and the news media.	У	y		✓		✓	✓	✓

Category description

I

Facilities, such as nuclear power plants, for which on-site events, (including those not considered in the design[c]) are postulated that could give rise to severe deterministic effects[d] off the site that would warrant precautionary urgent protective actions, urgent protective actions or early protective actions, and other response actions to achieve the goals of emergency response in accordance with international standards[e], or for which such events have occurred in similar facilities.

II

Facilities, such as some types of research reactor and nuclear reactors used to provide power for the propulsion of vessels (e.g. ships and submarines), for which on-site events[a,b] are postulated that could give rise to doses to people off the site that would warrant urgent protective actions or early protective actions and other response actions to achieve the goals of emergency response in accordance with international standards[e], or for which such events have occurred in similar facilities. Category II (as opposed to category I) does not include facilities for which on-site events (including those not considered in the design) are postulated that could give rise to severe deterministic effects off the site, or for which such events have occurred in similar facilities.

III

Facilities, such as industrial irradiation facilities or some hospitals, for which on-site events[b] are postulated that could warrant protective actions and other response actions on the site to achieve the goals of emergency response in accordance with international standards[e], or for which such events have occurred in similar facilities. Category III (as opposed to category II) does not include facilities for which events are postulated that could warrant urgent protective actions or early protective actions off the site, or for which such events have occurred in similar facilities.

IV

Activities and acts that could give rise to a nuclear or radiological emergency that could warrant protective actions and other response actions to achieve the goals of emergency response in accordance with international standards[e] in an unforeseen location. These activities and acts include: (a) transport of nuclear or radioactive material and other authorized activities involving mobile dangerous sources such as industrial radiography sources, nuclear powered satellites or radioisotope thermoelectric generators; and (b) theft of a dangerous source and use of a radiological dispersal device or radiological exposure device[f]. This category also includes: (i) detection of elevated radiation levels of unknown origin or of commodities with contamination; (ii) identification of clinical symptoms due to exposure to radiation; and (iii) a transnational emergency that is not in category V arising from a nuclear or radiological emergency in another State. Category IV represents a level of hazard that applies for all States and jurisdictions.

V

Areas within emergency planning zones and emergency planning distances[g] in a State for a facility in category I or II located in another State.

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a That is, on-site events involving an atmospheric or aquatic release of radioactive material, or external exposure (due, for example, to a loss of shielding or a criticality event), that originates from a location on the site.

b Such events include nuclear security events.

c This includes events that are beyond the design basis accidents and, as appropriate, conditions that are beyond design extension conditions.

d See ‘deterministic effect’ under Definitions.

e See the goals of emergency response in para. 3.2 and the generic criteria in Appendix II.

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

g See para. 5.38.

In the context of a radiation emergency, ***the practical goals of emergency response*** are:

(1) to regain control of the situation;

(2) prevent or mitigate consequences at the scene;

(3) to prevent the occurrence of deterministic health effects in workers and the public;

(4) to render first aid and manage the treatment of radiation injuries;

(5) to prevent, to the extent practicable, the occurrence of stochastic health effects in the population;

(6) to prevent, to the extent practicable, the occurrence of adverse non-radiological effects on individuals and among the population;

(7) to protect, to the extent practicable, the environment and property; and

(8) to prepare, to the extent practicable, for the resumption of normal social and economic activity.

The sixth goal addresses what many feel is the most important consequence of many radiation emergencies. In these emergencies the psychological, sociological and economic consequences were far greater than the radiological consequences. Many of these nonradiological effects were caused by inappropriate actions taken to address radiological concerns. These in turn resulted from unrealistic fears of radiation due to a lack of information early in the emergency followed by conflicting and non-informative information from official sources and the technical community.

Source: United Nations. Sources and Effects of Ionizing Radiation. Report to the General Assembly with Scientific Annexes; Volume II: Annex D. United Nations Scientific Committee on the Effects of Atomic Radiation, UNSCEAR 2008. United Nations, New York.

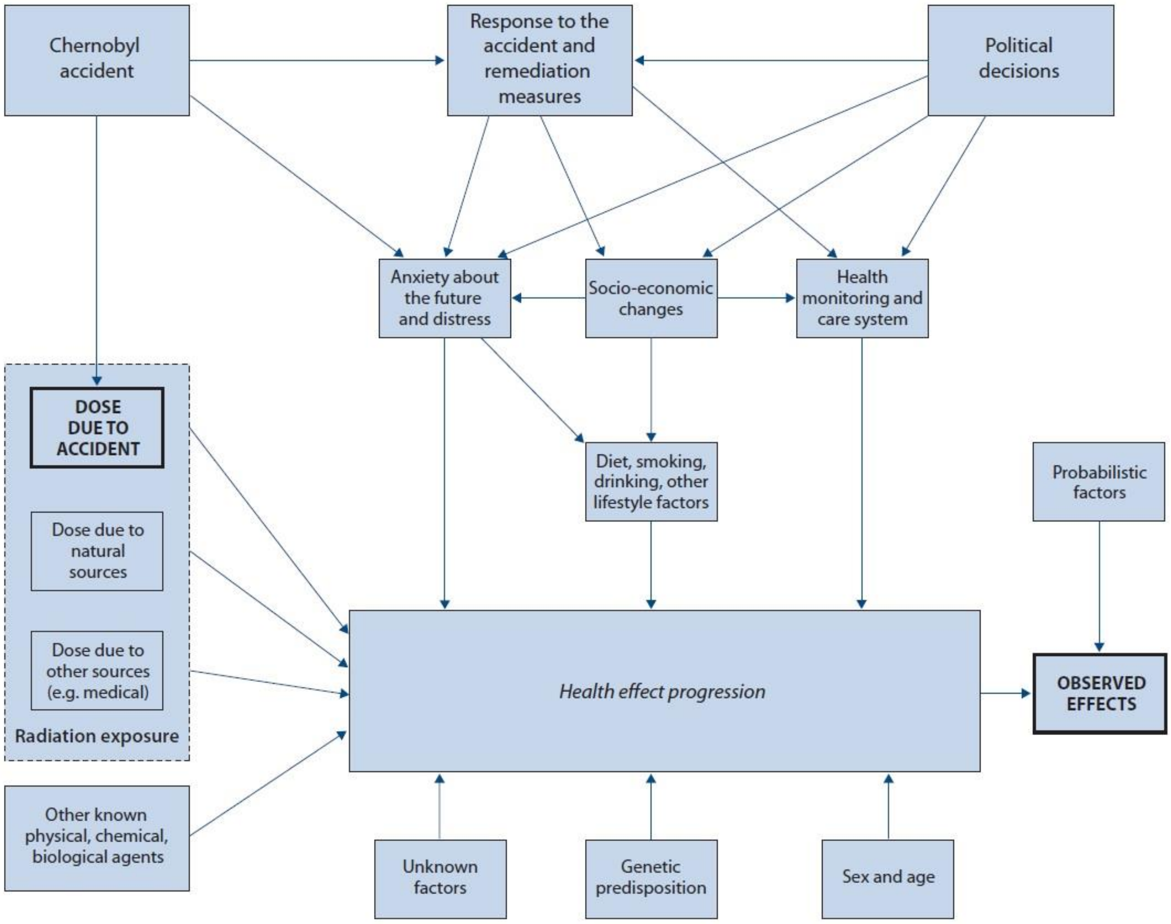
The effects of radiation exposure fall into two main classes: deterministic effects, where the effect is certain to occur under given conditions (e.g. individuals exposed to several grays over a short period of time will definitely suffer ARS); and stochastic effects, where the effect may or may not occur (e.g. an increase in radiation exposure may or may not induce a cancer in a particular individual but if a sufficiently large population receive a radiation exposure above a certain level, an increase in the incidence of cancer may become detectable in that population).

39. Attribution is the process of ascribing an effect to a particular cause. If radiation exposure is not the only known cause of a particular effect, then it is only possible to ascribe a probability that that effect was caused by radiation exposure. In practice, attributing, either wholly or partly, a specific effect to radiation exposure involves considering whether the effect could have occurred by other means, and analysing factors such as the nature of the exposure, the surrounding circumstances, and the clinical evolution of the observed effect. Even though a vast scientific literature can be used to support attribution, each effect must be examined on its own merits; and varying degrees of confidence will be associated with any judgment.

Psychological trauma and other related effects

Deterministic and stochastic effects both have a biological basis traceable to radiation dose, i.e. to ionizing radiation depositing energy in tissue. However, the Chernobyl accident is known to have had major effects that are not related to the radiation dose. They include effects brought on by anxiety about the future and distress, and any resulting changes in diet, smoking habits, alcohol consumption and other lifestyle factors, and are essentially unrelated to any actual radiation exposure. Figure VI illustrates schematically some of the factors that might possibly influence the observation of health effects after the accident.

Figure VI. Schematic illustration of some of the factors possibly influencing the observed health effects.



The Chernobyl Forum concluded that stress symptoms, increased levels of depression, anxiety (including post‐traumatic stress symptoms), and medically unexplained physical symptoms, have been found in the exposed populations compared to control groups. Mostly, these conditions were subclinical and did not meet the criteria for classification as psychiatric disorders. Nevertheless, these subclinical symptoms had important consequences for behaviour, such as diet, smoking habits, drinking and other lifestyle factors. The Chernobyl Forum Expert Group "Health" concluded that they were unable to partition the attribution of these effects among radiation fears, issues with distrust of government, inadequate communications, the break‐up of the Soviet Union, economic issues and other factors. Nevertheless, it is clear that a significant fraction of the effects is attributable to the Chernobyl accident, if not directly to radiation exposure.

In summary, the effects of the Chernobyl accident are many and varied. Early deterministic effects can be attributed to radiation with a high degree of certainty, while for other medical conditions, radiation almost certainly was not the cause. In between, there was a wide spectrum of conditions. It is necessary to evaluate carefully each specific condition and the surrounding circumstances before attributing a cause.

Source: - United Nations. Sources and Effects of Ionizing Radiation. Volume I: Sources; Volume II: Effects. United Nations Scientific Committee on the Effects of Atomic Radiation, 2000 Report to the General Assembly, with scientific annexes. Annex J. Exposures and effects of the Chernobyl accident. United Nations, New York, 2000. 384

Psychological and other accident-related effects

Many aspects of the Chernobyl accident have been suggested to cause psychological disorders, stress and anxiety in the population. The accident caused long-term changes in the lives of people living in the contaminated districts, since measures intended to limit radiation doses included resettlement, changes in food supplies and restrictions on the activities of individuals and families. These changes were accompanied by important economic, social and political changes in the affected countries, brought about by the disintegration of the former Soviet Union. These psychological reactions are not caused by ionizing radiation but are probably wholly related to the social factors surrounding the accident.

The decisions of individuals and families to relocate were often highly complex and difficult. The people felt insecure, and their lack of trust in the scientific, medical and political authorities made them think they had lost control. Experts who tried to explain the risks and mollify people were perceived as denying the risk, thus reinforcing mistrust and anxiety.

The environmental contamination created widespread anxiety that should be referred to not as radiophobia, as it initially was, but as a real, invisible threat, difficult to measure and localize. The key to how people perceive risk is the degree of control they exert over it. Once measures are taken to improve the quality of life for those still living in contaminated areas, the climate of social trust improves, probably because of the better cooperation between inhabitants and local authorities.

Psychological effects related to the Chernobyl accident have been studied extensively. Symptoms such as headache, depression, sleep disturbance, inability to concentrate, and emotional imbalance have been reported and seem to be related to the difficult conditions and stressful events that followed the accident.

The psychological development of 138 Belarusian children who were exposed to radiation from the Chernobyl accident in utero was compared with that of 12 age-matched children from uncontaminated areas. The children were followed for several years and the study included neurological, psychiatric and intellectual assessments of children and parents. The exposed group was found to have a slightly lower intellectual capability and more emotional disorders. A correlation was found between anxiety among parents and emotional stress in children. It was concluded that unfavorable psychosocial factors, such as broken social contacts, adaptation difficulties, and relocation, explained the differences between the exposed and non-exposed groups. No differences could be related to ionizing radiation.

Many individuals affected by the Chernobyl accident are convinced that radiation is the most likely cause of their poor health. This belief may cause or amplify psychosomatic distress in these individuals. When studying the impact of the accident in exposed areas of Belarus found that depression, general anxiety and adjustment disorders were more prevalent among those evacuated and in mothers with children under 18 years of age. It was concluded that the Chernobyl accident had had a significant long-term impact on psychological well-being, health-related quality of life, and illness in the exposed populations. However, none of the findings could be directly attributed to ionizing radiation.

Post-traumatic stress is an established psychiatric diagnostic category involving severe nightmares and obsessive reliving of the traumatic event. Although it is widely perceived by victims of disasters, such stress is supposed to occur only in those persons who were directly and immediately involved. The uncertainty, threat and social disruption felt by the wider public has been termed chronic environmental stress disorder by Lee, who compared the consequences of the Chernobyl accident with the consequences of other destructive events and accidents.

Among recovery operation workers, those without occupational radiation experience suffered a higher rate of neurotic disturbances than the general population. Clinically expressed disturbances with significant psychosomatic symptoms were predominant in this group, but the increased medical attention, which leads to the diagnosis of chronic somatic diseases and subclinical changes that persistently attract the attention of the patient, complicates the situation. The possibility of rehabilitation decreased correspondingly, while unsatisfactory and unclear legislation exacerbated the conflicts and tended to prolong the psychoneurotic reactions of the patients. The health status of recovery operation workers who were nuclear industry professionals did not seem to be different from that of the rest of the cohort.

Social and economic suffering among individuals living in contaminated areas has exacerbated the reactions to stressful factors. Although the incidence of psychosomatic symptoms in the population of highly contaminated areas is higher than that in populations of less contaminated areas, no direct correlation with radiation dose levels has been observed. The self-appraisal of this group is low, as is their general physical health, as observed in systematic screening programmes, including the International Chernobyl Project. This makes the individuals functionally unable to solve complicated social and economic problems and aggravates their psychological maladaptation. The tendency to attribute all problems to the accident leads to escapism, "learned helplessness", unwillingness to cooperate, overdependence, and a belief that the welfare system and government authorities should solve all problems. It also contributes to alcohol and drug abuse. There is evidence of an increased incidence of accidents (trauma, traffic incidents, suicides, alcohol intoxication and sudden death with unidentified cause) in this population, as well as in recovery operation workers, compared with the populations of unaffected regions.

Source: - Mental Health and Social Issues Following a Nuclear Accident. The case of Fukushima. Jun Shigemura & Rethy Kieth Chhem. Springer Japan 2016. 146 p. DOI 10.1007/978-4-431-55699-2

A Brief History of Nuclear Fear in Japan

Radiation research had begun as a hopeful and publically welcomed enterprise, with experiments over the early twentieth century meeting widespread public admiration—for instance, Marie Curie's groundbreaking work with radioactivity. However, the bodily disfiguration and fatalities of those exposed to high doses of radiation within this formative era, including Curie herself, began to curtail the universal support for this research. The remedial radiological technologies developed by way of this initial research (e.g., X-ray technology) have not lessened this initial motion towards negative perception.

The Second World War was critical to this perception of nuclear technologies in Japan. In the decades preceding Gojira, the citizens of Japan witnessed a series of events which would cast radiation, artificial or otherwise, in an entirely negative light. The firebombing of Tokyo in early 1945 was only eclipsed in its disparaging effect on the Japanese psyche by the detonation of nuclear weapons over the Japanese cities of Nagasaki and Hiroshima later that year. Although significant loss of life had already been inflicted upon the Japanese over the previous years of war, the impact of the atomic bombings resulted in physical and psychological damage of unprecedented immensity, irreparably distorting the Japanese psyche over the next decades towards the present. As Palferman discusses, human beings tend to fear technologies that are "unbounded or that have catastrophic potential, imposed on a community, or managed by organizations or individuals that are seen as untrustworthy or incompetent". In the context of Japan, this list of factors reads as if written specifically for nuclear weapons: catastrophically imposed, as they were, during wartime by an enemy combatant. Thus, the latent accumulation of apprehension towards nuclear technology instantly ascended to the forefront of public concern.

The era that followed would be considerably less forgiving to experimentation within the emergent nuclear sciences. The Japanese would view radiation and its antecedent materials as mysterious and harmful, scientists as persons meddling beyond the proper limits of human control, and the entire enterprise of scientific investigation as morally dubious. These beliefs were particularly accentuated by the accounts of mutation suffered through radiation exposure, where seared, fireless wounds fed into ancient beliefs of transmutation to human flesh, elevating alchemist narratives, having long been internalized within the population and cultural ethos, into modernity.

In 1954, the public interest in nuclear technologies peaked once more with the aforementioned Lucky Dragon incident. That same year, Russia introduced the AM-1, the world's first nuclear reactor capable of feeding into an energy grid. The former event had a particular effect on the Japanese, being the first instance of irradiation inflicted upon civilians following the atrocities of wartime. Thus, the mentality of the Japanese public as victim of circumstance, having initially formed with unwanted inclusion in the Second World War at the behest of the presiding government, was further emboldened by this accidental irradiation upon the Japanese population. This mentality was visible in two regards: The first by which the Japanese perceived themselves as victims of American military aggression—both during the war and through the cultural influence and media censorship immediately following—and as previously mentioned, as persons involuntarily bound to domestic policy and most directly affected by the disasters originating from government directives. The citizens of Japan, having endured this imperious era, would later seek to produce cultural vessels that encapsulated the anxieties of falling victim to political and technological device. Arguably, the most impactful of these was the motion picture.

Prior to our explication of the film itself, a brief section on nuclear fear and perception as presently understood is required, within which we will shortly illustrate the potency of cinema as a medium of transporting these fears to the audience

Nuclear Fear and Perception

In discussing the fears associated with radiation, Weart posits that "the fact is, emotions came first, and the powerful devices themselves came later". Scholarly concerns regarding the fear of radiation, or radiophobia, often adjoins with studies of afflictions caused by real or perceived risk, most apparently posttraumatic stress disorder (PTSD) and depression. Once inscribed in genetics through traumatic or repeated exposure, fear necessitates a host of expressions at the physiological (micro) level, eventually manifesting itself in the societal (macro) level. From the approximate locus of fear in the brain's amygdala, the following are characteristic of fear response: human perception of threat of danger, pain, or harm; conditioned response paired to an unconditioned stimulus4; organization and coordination of the defensive behavior system to environmental threats; and interpretation of emotional stimuli or people's emotional state. To the latter, "macro" cultural terms, the impressions of fear are held within group dynamics or what scholars have recognized as collectivism: a counterbalance to individualism that includes norms, history, and geography, as variables in considering the strength of relationships between individuals in various communal groups.

Observations of collectivism traverse the spectrum of collective groupings from families to, in the case of Japan, prefectures and the population en masse. Thus, the complexity of nuclear fear in Japan is such that the individual within the collective must be regarded as a vessel of cultural influence, simultaneously containing and promulgating, through their interactions (and intensity of these reactions) with others.

In probabilistic terms, the fear of radiation relative to other possible dangers can be usefully analogized with the fear inspired by the probability of a plane crash when compared with automobile accidents. Often the former (i.e., plane) inspires a degree of fear which far outweighs statistical dangers and yet is often regarded with relatively higher degrees of fear, despite the enormous imbalance of frequency when compared with the latter. This unique convergence of fear can be attributed, above all, to the fact that these fears are far more easily sensationalized by media and pop culture.

As the public understands science mainly through “the filter of journalistic language and imagery”, this example illustrates that our focus cannot simply localize on the human carrier, but must encompass the social environment as well.

Not unlike most Westernized cultures, the exploitations of fear are rife throughout Japan. Nuclear fear is simply a categorical division of cultural production — albeit one which carries considerable psychological, historical, and societal weight. In the body of cultural artifacts, it is cinema that is most often neglected by scholarly concern, a medium that plainly showcases human misgivings about technological productions, particularly those with destructive capacities.

Practice 7. International assistance

Task 1: Develop full sample of Assistance Action Plan (AAP) in Word, PPT or PDF format
APPENDIX B: RANET ASSISTANCE ACTION PLAN

An Assistance Action Plan (AAP) for the requested assistance will be developed by the IEC in coordination with the requesting State, State(s) providing assistance and relevant international organization(s), as appropriate.
An AAP is required for all Assistance Missions, regardless of whether they are in the form of:

- Assistance Missions;
- Joint Assistance Teams (JAT);
- External Based Support (EBS).

An AAP is not required for the provision of information or advice, except in the case of detailed assessment and advice.
A sample plan is provided below. The sample plan is an example of a case where assistance is provided under the Assistance Convention. However, in some instances, whether under the Assistance Convention or not, some parts may not be applicable. All names used in this example are fictitious and do not denote actual States, places or persons.

INTERNATIONAL ASSISTANCE TO STATE E
ASSISTANCE ACTION PLAN (Sample)

Radioactive Contamination and Public Exposure in Township
Date effective: 31 March 2017
Version No.: Final Date prepared: 30 March 2017
INTERNATIONAL ATOMIC ENERGY AGENCY
Incident and Emergency Centre
State E hereby agrees to receive the international assistance as detailed in this Assistance Action Plan. Members of the Assistance Mission hereby agree to provide assistance to State E as detailed in this Assistance Action Plan, including the special conditions specified in Annex I. The agreement to the terms contained herein is without prejudice to the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency to which State E, State A, State B, State C and State D are Parties.

Background
On 29 March 2017, the IAEA's Incident and Emergency Centre (IEC) received a request for assistance from the Atomic Authority of State E in regard to radioactive contamination and public overexposure in Township, State E.
State E (Requesting State) is a State Party to the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (Assistance Convention), and it made the request for assistance to the IAEA pursuant to the Assistance Convention.

Objective and Scope
The overall objective of the Assistance Mission is to assist the Government of State E in response to its request for assistance in relation to a radiological emergency in State E.
Taking into account the information on the event available at present and the type of assistance requested from the Government of State E, an IAEA Assistance Mission (Assistance Mission) will be conducted in the form of a Joint Assessment Team (JAT). ANNEX I of this Assistance Action Plan (AAP) includes details of the Assisting State Team(s) and the capabilities being utilized during the Assistance Mission.

Agreed by:		
Head–IEC	Name: F. Weston Signature:	Date: 29-03-2017
Assisting State officials	Name: H. Smith Organization: National Regulatory Authority State: State A Signature:	Date: 29-03-2017
	Name: J. Elton Organization: Atomic Energy Commission State: State B Signature:	Date: 29-03-2017
	Name: C. Woodhouse Organization: Nuclear Safety Administration State: State C Signature:	Date: 29-03-2017
	Name: P. Okafor Organization: Ministry of Foreign Affairs State State D Signature:	Date: 29-03-2017
Requesting State (State E) official	Name: G. Knightley Organization: Atomic Authority of State E (AAE) Signature:	Date: 30-03-2017

The following activities to be performed have been identified:

1. Assess the current situation;
2. Assess the radiological impact in terms of doses and levels of contamination;
3. Assess the threat to public health and safety;
4. Predict the possible evolution of the radiological conditions;
5. Advise the Government of State E on immediate steps to be taken in responding to the event and provide technical advice on countermeasures and source recovery;
6. Provide medical advice, undertake a medical evaluation of overexposed persons and collect blood samples;
7. Provide laboratory analysis of samples;
8. Perform biodosimetry on blood samples;
9. Recommend additional actions to be taken by the IAEA in assisting State E in responding to the event; and
10. Review the accident history to identify lessons to be learned; gather, record and evaluate information on the event and compile appropriate records for a formal accident report.

Responsibilities

Requesting State

State E will maintain overall direction, control, coordination and supervision of any assistance within its territory.

The Government of State E will observe the terms of the Assistance Convention and in particular will:

— Provide, to the extent of its capabilities, local facilities and services for the proper and effective administration of the assistance;

— Ensure the protection and security of personnel, equipment and materials brought into its territory by or on behalf of the assistance teams;

— Facilitate the entry into, stay in and departure from its national territory of personnel, equipment and property involved in the assistance; and

— Facilitate the transit through its territory of duly notified personnel, equipment and property involved in the assistance.

During the Assistance Mission, the National Competent Authority of State E will, where applicable, provide or arrange (free of charge) for:

— Hotel arrangements;

— Transportation within the country;

— English speaking counterpart or translator;

— Access to required facilities/premises;

— External power supplies/generators;

— Interviews with workers, first responders and patients;

— Workroom for Assistance Mission team members; and

— Access to international telephone lines, internet and e-mail, PC projector, printer and copier. Assistance Mission Team

The Assistance Mission team, as described in Annex I, should accomplish the objectives and activities set by this Assistance Action Plan; and

The Assistance Mission team will provide the IAEA Secretariat with an authoritative and factual overview of the radiological emergency and make recommendations for any further action(s) to be taken by the State E authorities and the IAEA.

Assistance Mission Leader The Assistance Mission Leader:

— Is in charge of and retains operational supervision over the Assistance Mission team and the equipment provided by or on behalf of the Assistance Mission team.

— Is responsible to ensure that all activities are performed in a safe manner by following procedures, which at a minimum shall meet applicable IAEA safety standards.

— Will prepare an After Action Assistance Report (in English) for submission to the IAEA's IEC for distribution to the requesting State and its Permanent Mission to the IAEA and to assisting parties within one week after completion of assistance. The After Action Assistance Report will contain background information, actions taken, actions recommended and conclusions.

Assisting State(s)

State A, State B, State C and State D (Assisting States) will provide assistance through the IAEA to State E in response the radioactive contamination and public overexposure in Township. The specific details and conditions of the assistance to be provided by the Assisting State(s) are detailed in Annex I.

IAEA's Incident and Emergency Centre

The IAEA's IEC will be the focal point for the provision of this international assistance, providing necessary coordination and/or administration and support to all parties.

The IAEA's IEC will produce a final Assistance Report (in English) in coordination with all involved parties to fully describe the event history, response actions taken, collected data, measurement results, resolution of the situation, recommendations for future actions (if any) and lessons identified.

The IAEA's IEC will provide:

— An After Action Assistance Report (in English) to the Government of State E and its Permanent Mission to the IAEA within one week after completion of the mission; and

— A Final Assistance Report (in English) to the Government of State E, its Permanent Mission to the IAEA, all assisting parties and all members of the Assistance Mission within 60 days after completion of the mission.

Confidentiality

All involved parties will treat all acquired information and assistance reports as classified and keep them for their respective internal use only until such time as deemed appropriate by all parties to release them. Confidential information provided under the terms of the Assistance Convention will not be made available to any party other than the Government of State E and will not be included in the assistance reports.

Notwithstanding the above, the involved parties avail themselves of the right to use elements from the assistance reports as deemed relevant for the sole purpose of describing their respective roles in the respective assistance mission and for sharing experiences and lessons identified. This excludes any sensitive medical data, personnel information and/or any information from classified annexes of the assistance reports, which will be treated as confidential until such time as deemed appropriate by all parties. The involved parties will make every effort to coordinate the release of such information.

Public Information

Members of the Assistance Mission team will not give any public interviews or information to the media before, during or after the mission without prior agreement of the State E authorities and without prior consultation with the IAEA's Office of Public Information and Communication (through the IEC).

Field Operational Safety and Security

The activities defined in this AAP will not be conducted in conditions that are unsafe/not secure or possibly unsafe/not secure.

Where any such situations are identified, the Assistance Mission Leader shall coordinate with the appropriate authorities and entities to identify an acceptable, safe/secure solution for the conduct of the identified activities.

Financial Arrangements

The IAEA will cover the expenses for the mobilization and deployment of the Assistance Mission.

All other financial arrangements relating to the assistance shall be in accordance with Article 7 of the Assistance Convention.

— In accordance with the Assistance Convention, State A, State B and State C will offer the assistance as detailed in Annex I without cost.

— In accordance with the Assistance Convention, State D will require to be wholly or partly reimbursed for any specialized hospital treatment to be provided.

Privileges and Immunities

The Government of State E will afford the necessary privileges, immunities and facilities to the IAEA, its officials and experts, as well as the property, funds and assets of the IAEA, for the performance of the assistance functions in accordance with the Agreement on the Privileges and Immunities of the International Atomic Energy Agency, which was approved by the Board of Governors on 1 July 1959 (see INFCIRC/9/Rev.2).

Claims and Compensation

All claims and compensation relating to the assistance provided under this Assistance Action plan shall be governed by Article 10 of the Assistance Convention.

Assistance Termination

The IAEA will declare the official termination of assistance when all AAP objectives and activities are declared completed by the Assistance Mission Leader.

State E or any of the assisting parties may at any time, after appropriate consultations and by notification in writing, request termination of assistance received or provided (including partial withdrawal of assistance capabilities). Once such a request has been made, the involved parties consult to make arrangements for the proper conclusion of the assistance.

The IAEA may declare at any time, after appropriate consultations and by notification in writing, the end of the Assistance Mission due to failure to resolve conditions or practices that are unsafe or not secure, or the failure of the requesting State to comply with the AAP.

Upon termination of the assistance, the resources of the assisting States will be demobilized. Partial demobilization of resources may occur as the individual AAP tasks are completed.

Overall Work Plan

The following is a provisional overall Assistance Mission Work Plan:

#	Activity	Date
1.	Arrival at Township	03 April
2.	Assistance Mission team meeting	04 April
3.	Introductory meeting with the AAE	04 April
4.	Start of mission activities	04 April
5.	Detect, locate and demarcate contaminated area(s)	04 - 05 April
6.	Measure ground contamination	05 April
7.	Measure dose rates	05 April
8.	Monitor personnel, equipment and other objects for external contamination	08 April
9.	Obtain blood samples for biodosimetry	06 April
10.	Obtain environmental samples	07 April
11.	Manage the collection of samples	07 April
12.	Measure concentration of radionuclide in samples	12 April
13.	Conduct cytogenetic-based biodosimetry	12 April
14.	Collect all information needed for analysis of consequences	08 April
15.	Collect information needed for dose reconstruction	08 April
16.	Assess the threat to the public	05 April
17.	Assess possible evolution of an emergency/situation	04 April
18.	Assess and evaluate radiological consequences of an emergency/situation	06 April
19.	Assess the doses to victims/emergency workers/public	06 April
20.	Undertake medical evaluation of patient(s)	08 April
21.	Assess the level of internal contamination	07 April

#	Activity	Date
22.	Plan source recovery operations	08 April
23.	Plan the transfer of the patient(s) to a specialized centre(s) (if required)	08 April
24.	Provide medical treatment (if required)	04 April
25.	Deal with public concerns and media attention	08 April
26.	Provide advice on collection of adequate samples	04 April
27.	Provide advice on source transportation and secure/safe storage	06 April
28.	Provide medical advice/consultation	08 April
29.	Provide advice on public health	08 April
30.	Provide advice on protective actions	05 April
31.	End of mission's activities	08 April
32.	Drafting Assistance Mission's conclusions and recommendations	09 April
33.	Exit meeting with the AAE	10 April
34.	Departure from Township	11 April

The Assistance Mission Leader, JAT Command and/or individual FAT Leaders shall develop more detailed work plans, as appropriate, for tasks to be performed to meet the mission objectives.

Task 2: Familiarization with IRMIS

EPR–IEComm (2018) Attachment 2. INTERNATIONAL RADIATION MONITORING INFORMATION SYSTEM USER MANUAL, IRMIS VERSION 3.0.0

This manual describes IRMIS version 3.0.0, a web based tool for sharing, aggregating and visualizing large quantities of radiation monitoring data during a nuclear or radiological incident or emergency, to aid in decision making. The manual does not describe routine file sharing or file formatting procedures.
IRMIS is a web application that is continuously improved. For more information about its latest enhancements and features, please contact: IRMIS.Contact-Point@iaea.org

Abbreviations

CA Competent Authority
EURDEP European Radiological Data Exchange Platform
IAEA International Atomic Energy Agency
IEC IAEA's Incident and Emergency Centre
EPR—IEComm IAEA Operations Manual for Incident and Emergency Communication (Emergency Preparedness and Response series)
IRMIS International Radiation Monitoring Information System
NPP Nuclear power plant
NWP National Warning Point
OILs Operational intervention levels
PPA Public protective action
USIE Unified System for Information Exchange in Incidents and Emergencies

IRMIS — CONCEPT AND SCOPE

Background

In the event of a nuclear or radiological emergency, the Convention on Early Notification of a Nuclear Accident (Early Notification Convention) requires the accident State to provide relevant information about the emergency situation (Article 5). This should include information about the results of environmental monitoring relevant to the transboundary release of radioactive materials, and information about the off-site protective actions that have been taken or that are planned.
IRMIS has been developed to support the implementation of the Early Notification Convention, facilitating the reporting and visualization of large quantities of radiation monitoring data during nuclear or radiological incidents or emergencies. In addition, IRMIS supports and enhances some of the features of the Unified System for Information Exchange in Incidents and Emergencies (USIE). USIE is a protected and secure web site that provides Competent Authorities (CAs) and points of contact designated under the Early Notification Convention with a unified communication tool through which they can share relevant information and data in a nuclear or radiological incident or emergency with the IAEA Secretariat, Member States and relevant international organizations.

Objectives of IRMIS

IRMIS assists IAEA Member States in meeting the requirements of the Early Notification Convention. It complements USIE when a large quantity of radiation monitoring data needs to be shared and visualized. Thus, IRMIS enables near real time monitoring of the evolving radiological situation worldwide as a consequence of a nuclear or radiological emergency. IRMIS also aims to facilitate the assessment of radiological hazards caused by the release of radioactive materials, decisions on protective actions and provision of credible public information on the developing situation.

Concept of IRMIS

Radiation monitoring during a nuclear or radiological incident or emergency needs to be integrated into decision making systems in such a way that its use will not impede the effective implementation of response actions. Conceptually, IRMIS is a collaborative Decision Support Tool shared between the IAEA, the Accident State(s) and neighbouring States. In an emergency situation, through the aggregation and display of routine monitoring data, IRMIS can quickly be expanded into a powerful emergency communications tool that aids the assessment and prognosis conducted by the Accident State, the IAEA and supporting States. As a Decision Support Tool, IRMIS is fully capable of integrating fixed point monitoring data with the data collected by deployed emergency monitoring systems and comparing these to pre-established operational intervention levels (OILs) as well as planned or executed public protective actions (PPAs).

Scope of IRMIS

IRMIS is primarily a data sharing platform that provides CAs 24/7 access to data collected and collated by routine monitoring in the participating states.

IRMIS is not an early warning system. However, IRMIS analysis tools may be used to determine where elevated levels of radiation observed in monitoring data suggest that PPAs may be warranted. The detection of time correlated elevation of gamma dose rate in nearby fixed radiation monitoring stations can signify a release of radioactivity into the atmosphere. The time series analysis can also provide the duration of the release. Thus, IRMIS routine monitoring data can seamlessly transition into nuclear or radiological emergency data.

IRMIS does not replace other emergency communication channels, but when used jointly with USIE, it will collectively provide the necessary quantitative technical information required to support a comprehensive assessment and prognosis of the situation.

Early in an emergency, the results obtained by monitoring may be limited and confusing. By providing gamma dose rates from routine monitoring, IRMIS establishes a foundation upon which data can be quickly shared during an emergency. The ambient dose equivalent rate is shared and visualized in IRMIS. The ambient dose equivalent rate Hp (10) is an appropriate and effective indicator under emergency conditions. All ambient gamma dose rate data are visualized on a map with reference to the OIL, an ambient dose equivalent rate that corresponds to a generic criterion for taking protective actions. An OIL is used immediately and directly (without further assessment) to determine the appropriate protective actions on the basis of an environmental monitoring measurement (a measurement by instruments in the field or determined by laboratory analysis). In its current configuration, IRMIS data are compatible with OIL 1, 2 and 3 for the gamma dose rates. To support decision making and inform PPAs beyond those supported by OIL 1, 2 and 3 for gamma dose rates, it is planned that IRMIS will incorporate other data types that will be supported by and used in conjunction with additional OILs.

IRMIS — OVERVIEW AND FEATURES

Technical requirements

The application is fully functional in Internet Explorer 11 and Google Chrome on the Windows operating systems. The data visualization works best at screen resolutions of 1280 x 1024 pixels or more, assuming the browser window is displayed in full screen mode. The data visualization screens have been optimized for use with a scroll wheel mouse (map zoom).

Radiological monitoring data

The radiological monitoring data in IRMIS are reported in either of two categories:

1. Routine Data, in the form of radiation dose rates from fixed monitoring stations voluntarily reported by participating Member States. The maximum or latest values reported per fixed station are displayed over the previous 24, 48 or 72 hours; or over user defined dates and times.
2. Emergency Data, collected during a nuclear or radiological emergency or on other occasions where the Member States deem it necessary to share radiation monitoring data with the IAEA and other Member States.

Routine Data

The routine provision, on a voluntary basis, of the radiation dose rate data from fixed monitoring stations in non-emergency situations is intended to ensure that the data can be reported effectively during an emergency. IRMIS provides a time series analysis tool which enables users to observe the systematic time correlated rise of dose rate data indicating a pre-release condition at a nuclear power plant. Thus, IRMIS provides a mechanism through which measurements recorded at the fixed monitoring stations can be reported in a timely manner during the early phase of an emergency. Routine Data are normally reported through an agreed arrangement where the organizations authorized to report these data will make them available in the International Radiological Information Exchange (IRIX) format on a secure data server hosted within their country, or via a regional hub (e.g. the European Radiological Data Exchange Platform (EURDEP)). IRMIS routinely retrieves radiation monitoring data from the servers: the web application gathers large amounts of data continuously with a periodicity of one hour. The maximum aggregated value of dose rate data over a number of spatially-close fixed monitoring stations is presented. The aggregated data correspond to either the maximum dose rate readings or the latest dose rate readings.

The type(s) of data, and the frequency and volume of Routine Data (as defined above) reported by Member States to IRMIS are at the discretion of the Member State, the CAs and the IRMIS Data Provider(s).

Emergency Data

During an emergency, Member States may wish to provide additional data, for example: dose rate data collected through monitoring networks that do not routinely provide IRMIS with data, data from temporary fixed stations, and data from hand held measurements or data from mobile monitoring systems (e.g. backpack, vehicle or aerial systems). Normally, these systems record dose rate measurements automatically, along with the location and time. Member States may, in certain circumstances, want to report event data that may not be of any safety significance, but nevertheless will provide situational awareness to neighbouring States. A web interface has been designed in IRMIS through which authorized users may upload the Emergency Data onto IRMIS, either in IRIX format or using a pre-formatted spreadsheet template. These Data Reports are subsequently reviewed and published on IRMIS by the IAEA's Incident and Emergency Centre (IEC).

IRMIS Data Providers

All CAs officially designated under the Early Notification Convention and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency ('Assistance Convention') and in accordance with the operational arrangements defined in the Operations Manual for Incident and Emergency Communication (EPR-IEComm), are authorized to report Routine Data and Emergency Data in IRMIS. The USIE and IRMIS roles of a national user can be found in the USIE Settings area.

In addition, technical organizations that operate national systems of fixed monitoring stations, or that have a role in collecting and reporting radiation monitoring data during an emergency, may

be authorized to be IRMIS Data Providers. The authorization of these organizations needs to be provided by the relevant CA or the Permanent Missions of the Member States to the IAEA (States' PMs) to the IAEA.
The level of permissions that IRMIS Data Providers have for reporting Routine Data and/or Emergency Data in IRMIS is determined by the relevant CA or the States' PMs.

Data ownership and retention

All data reported in IRMIS remain the property of the reporting Member State. The IAEA does not claim any ownership over the data reported by Member States.
The type(s) of data and the frequency and volume of Routine Data reported by Member States to IRMIS during an emergency is dependent on the nature and status of the emergency. Emergency Data from the IRMIS Data Providers and Routine Data from secure FTP servers maintained by globally distributed radiation monitoring networks are uploaded to a database. A query database then delivers those data via a web interface to the client users, on request by the user.
The IAEA retains Routine Data for 30 days, unless it is associated with an actual event, in which case it is retained for longer. The 30 day period allows sufficient time to capture some baseline data prior to an actual or suspected event, or to retain data relevant to an actual or suspected event that occurred or may have occurred within the past 30 days.
When an event is notified to the IEC through a proper channel and after discussing the details with the 'Accident State', the IEC creates a USIE event under the following classification:1
Based on sets of emergency conditions or event types defined in EPR—IEComm that warrant immediate response actions.

(a) Nuclear emergencies (events specific to nuclear installations):

i. General emergency;
ii. Site area emergency;
iii. Facility emergency;
iv. Alert;
v. Other event in the facility that may trigger public concerns and/or media interest.

(b) Radiological emergencies (events not specific to nuclear installations):

i. Release from a facility;
ii. Missing dangerous source;
iii. Severe overexposure;
iv. Space object re-entry;
v. Elevated radiation levels;
vi. Other radiological event.

If the event is considered to have a radiation monitoring component, the IEC will create an event on IRMIS based on the created USIE Event (i.e. importing all the details of the event from the USIE created event). In consultation with the 'Accident State' or reporting State, the IEC will determine the amount of time the Routine Data should be retained for this event. In such a situation, the Routine Data retained is then considered part of the overall data reported for the event, together with any additional Emergency Data reported. The overall retention of data associated with an event will be determined by the IEC, as is pertinent to the nature and scale of the event.

Access to IRMIS and IRMIS users

All USIE users from CAs, National Warning Points (NWPs) and States' PMs are automatically granted read-only access to IRMIS. In addition, IRMIS Data Providers endorsed by their relevant CA and/or Permanent Mission to the IAEA may have read-only users registered in both USIE and IRMIS.
Authorized users from CAs and IRMIS Data Providers may be given additional permissions on IRMIS through which they can upload radiological monitoring data through the web site interface.

The public has no access to IRMIS. However, a public version of IRMIS is planned for a later stage of development.

Currently there are two access modes for IRMIS:

1. Reader: Users with this access mode can access the web site and can visualize and analyse data.
2. Uploader: Users with this access can read/view data and upload data to IRMIS database.

3.6. Data confidentiality

Member States determine the level of confidentiality to be applied to Routine and Emergency Data reported to IRMIS by selecting one of the three confidentiality levels described below, in the same approach that is applied to reports submitted on USIE. In addition, the level of confidentiality that is applied to an event in USIE is automatically applied in IRMIS:

1. For Authority use only: The information/data reported are provided for official use only and are not for public disclosure. The data reported will be available on IRMIS to official counterparts authorized to access IRMIS.
2. For IAEA Secretariat use only: The information/data reported are provided ‘in confidence’ to the IAEA Secretariat. Note: The data reported will not be seen by any Member States, including the reporting State.
3. Free for public use: The information/data reported are provided without restrictions on their use.

In addition, in situations in which an event is created in USIE for a restricted number of Member States or international organizations, this restriction is also applied within IRMIS, and any Emergency Data reported and published as part of that USIE Event will be available only to the Member States and international organizations that have access to the USIE Event.

Task 3: Familiarization with several IAEA documents

Operations manual for incident and emergency communication EPR-IEComm2019

The international emergency preparedness and response (EPR) framework consists of:
(a) international legal instruments;
(b) IAEA safety standards; and
(c) operational arrangements.

The main international legal instruments regarding EPR are the Early Notification Convention and the Assistance Convention. These conventions are supplemented by bilateral or multilateral agreements between and among States and relevant international organizations. In addition, the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention) address some aspects of EPR in relation to nuclear facilities and to management of spent fuel and radioactive waste, respectively. The Convention on the Physical Protection of Nuclear Material (CPPNM) and its Amendment (A/CPPNM) include provisions for States Parties to voluntarily exchange information, as and where appropriate, with the IAEA and other relevant international organizations in the case of nuclear security events within the scope of the CPPNM and A/CPPNM.

The IAEA Response and Assistance Network (RANET) is a network of States within the framework of the Assistance Convention that are capable and willing to provide, in a nuclear or radiological emergency and upon request by the affected State, specialized assistance in a timely and effective manner to help mitigate the consequences of the event.

The IAEA RANET manual was developed and first issued in 20001. It has been updated periodically, with the latest version, EPR—RANET 2018, published in 2018.

The IAEA's General Conference of 2017, in resolution GC(61)/RES/8, requested the "Secretariat to work with Member States to improve the IAEA Response and Assistance Network (RANET) to ensure that, if and when requested, timely and effective assistance can be provided". The resolution further requested the Secretariat "to work with Member States to facilitate, as appropriate, bilateral and multilateral arrangements, and to enhance efforts to establish technical compatibility for international assistance". It encouraged "Member States to register national capabilities in as many fields as possible in RANET". Information on assistance utilizing the IAEA RANET can be found in Section 4.5.

During a nuclear or radiological emergency, the factors and actions determining an effective response can change rapidly. An assessment of the situation and a prognosis of how the emergency might evolve support an effective emergency response. Through the adoption of the Action Plan on Nuclear Safety, the IAEA's role in an emergency was expanded to include the prognosis of the potential evolution of an accident and an assessment of the possible consequences. The IAEA shares the results of its assessment and prognosis with Member States and international organizations to assist them in their own analysis of the situation. Overviews containing the results of the IAEA's assessment and the likely development of the situation are also shared with the public. More information on assessment and prognosis can be found in Section 4.4.

The details of the IAEA assessment and prognosis process are described in a companion publication to this manual, entitled Operations Manual for IAEA Assessment and Prognosis during a Nuclear or Radiological Emergency (EPR—A&P 2019).

Objective

The overall objective of the IEComm manual is to improve international information exchange in nuclear or radiological emergencies between the IAEA's Secretariat, the IAEA's Member States, Parties to the Early Notification Convention and the Assistance Convention, relevant international organizations and other States by:

- providing necessary information to States and relevant international organizations for the development of operational arrangements for interacting with each other and with the IAEA's Secretariat;
- defining clear operational arrangements for international exchange of information in nuclear or radiological incidents or emergencies3

Framework

To meet its responsibilities under the Early Notification Convention and the Assistance Convention, the IAEA Secretariat needs to be prepared to respond appropriately and efficiently to any incident or emergency, irrespective of its origin, that may have actual, potential or perceived radiological consequences to health, property or the environment, and which requires the IAEA Secretariat's involvement, including responding to requests for assistance.

The prime roles of the IAEA Secretariat in response to nuclear or radiological emergencies are:

- Provision of notification and exchanging and sharing of official information with States and international organizations;
- Performing an assessment of potential consequences and a prognosis of the likely emergency progression;
- Timely coordination and provision of assistance or advice, upon request, to States/international organizations;
- Provision of timely, clear, factually correct, objective, consistent and easily understandable public information;
- Coordination of the inter-agency response.

The IAEA fulfils these roles through its Incident and Emergency System (IES) and the Incident and Emergency Centre (IEC). The IEC is the IAEA's focal point with regard to preparedness for and response to a nuclear or radiological incident or emergency, irrespective of its origin. It is also the custodian of the IES.

The IAEA emergency response is organized through:

(1) a 24/7 warning point;

(2) an on-call system;

(3) an on-duty system; and

(4) an IES Steering Group.

The Security Control Centre (SCC), which is located in the Vienna International Centre, serves as an integrated 24/7 warning point and telecommunications backup for the IEC.

Media and public requests for information, received by the Secretariat's staff, are dealt with by the IAEA's Office of Public Information and Communication (OPIC): www.iaea.org/press

The on-call system ensures that the initial response to any incoming message is timely and adequate. The following on-call officers are available 24/7 to facilitate and coordinate the initial response: an emergency response manager (ERM); a nuclear installation specialist; a radiation safety specialist; a nuclear security specialist; an external event specialist; a public information officer; and a logistics support officer.

The on-duty system ensures that the Secretariat's response is effective and commensurate with the nature and magnitude of the emergency.

The IES Steering Group oversees the Secretariat's response and guides the response on matters of policy.

To ensure a coordinated response, all response actions, including the provision of assistance, are performed within the IES.

The IAEA emergency response arrangements are documented in the IES documentation system. This system includes prescriptive and descriptive documents, tools and records. Prescriptive documents cover policy issues, objectives, emergency response authorities, as well all emergency preparedness and response requirements. Descriptive documents, such as the internal emergency response plan, its appendices (explaining the setup of the IES) and annexes (describing what actions are carried out), contain basic arrangements of the IES. Tools are documents (e.g. response checklists, task and equipment instructions, forms) that deal with actions for staff during an emergency response and their day to day activities.

The IES contains a training and exercise programme for IAEA staff members who participate in the system. They need to go through initial training, which is specialized for every response position, and take part in an emergency response exercise. Both the training and the exercise have to be attended before an IAEA staff member is qualified to participate in the IES. The exercise programme consists of drills and full response exercises. A drill is a small scale exercise, normally involving small groups in a learning process designed to ensure that essential skills and specific knowledge are available for the accomplishment of certain tasks. A full response exercise is a large scale exercise involving most of the organizations, facilities, resources and personnel that would be utilized in an actual emergency. The purpose of the full scale exercise is to test, verify and evaluate the overall performance of the IES — including its organization, concept of operations and coordination — against established objectives.

Concept of operations

The IES operates in three modes: Normal/Ready[13] mode, Basic response[14] mode and Full response[15] mode. Response actions and the urgency of the response may vary according to the actual or perceived magnitude and potential consequences of an event.

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[13] *In Normal/Ready mode, the IEC's operational area is not staffed continuously, but on-call officers are available, 24 hours per day, 7 days per week, to immediately respond to incoming messages. This mode includes all of the IEC's day to day activities that ensure readiness; it is the default condition under which the IEC operates. The Normal/Ready mode is maintained while an incoming message that describes a situation with apparent, actual, potential or perceived radiological consequences is being confirmed. Assistance missions may then be deployed in response to a request for assistance.*

[14] *In Basic response mode, once again, the IEC is not staffed continuously, but on-call officers are immediately available to respond to incoming messages (e.g. the IEC staffed during the day 12/7, the on-call officers ready to respond during the night 12/7). In this mode, extra assessments are made during office hours by IEC staff. Additional staff may have been activated or placed on standby, and preparations may be underway to move rapidly to Full response mode. Assistance missions may now be deployed in response to a request for assistance.*

[15] *In Full response mode, the IEC is staffed continuously — 24 hours per day, with shift changes of personnel — and actively manages the IAEA's response ac*

Exchange of information

States Parties to the Early Notification Convention are obliged, in an emergency involving facilities or activities from which a release of radioactive material occurred or is likely to occur and which has resulted or may result in an international transboundary release that could be of radiological safety significance for another State, to send notification of an emergency immediately to other States that may be affected, either directly to those States or through the IAEA.

Article 3 of the Early Notification Convention states: "With a view to minimizing the radiological consequences, States Parties may notify in the event of nuclear accidents other than those specified in article 1". Hence, in accordance with article 3, States Parties may voluntarily

notify about any type of nuclear emergency with a view to minimizing its radiological consequences.
Additionally, in the event of a transnational emergency, States Parties are expected, on a voluntary basis, to send a notification promptly to the IAEA, in order to meet the requirements of GSR Part 7.
Similarly, other States that are not Parties to the Early Notification Convention are strongly encouraged to send advisory messages about events to other States that may be affected, either directly or through the IAEA.
All States are encouraged to inform the IAEA of any kinds of an actual, potential or perceived nuclear or radiological events, especially when they may attract or have attracted wide media attention or caused public concerns.
For events, such as a General Emergency, at facilities close to a State's national borders (when emergency planning zones and emergency planning distances extend beyond national borders), a notification is expected to be sent by the Accident State directly to the relevant neighbouring countries within 1 hour after the declaration of a nuclear or radiological emergency — at the same time that this declaration is being sent to the off-site authorities. A notification to the IAEA is expected to be sent within 2 hours after the declaration of a nuclear or radiological emergency.
Even when facilities are located far from national borders, notifications to the relevant CAs are expected to be sent within 2 hours — either directly or through the IAEA — after the declaration of a nuclear or radiological emergency, or when changes of the emergency class occur (see appendix VI). The IEC expects to receive initial information from a CA(D).
The IEC receives information from its CPs on a wide range of events. For example, it receives information from INES National Officers on INES rated events and from CA(D)s or CA(A)s on events that have attracted the interest of the media. The IEC may follow up with the relevant CA(D) regarding information received from other CPs about an event in their country.
When a message is received at the IEC, the IEC authenticates the message and verifies the content with the CA of the State that issued it. If the information is confirmed, the IEC activates the relevant IES processes. The IEC informs its CPs, in line with the response procedures (see Section 4), and distributes the message through USIE. It does this no later than 2 hours after receiving the message, while aiming to achieve a much shorter response time.
If information is received in a language other than English, and if English translations are not readily available from the notifying/reporting State, the IEC produces an unofficial translation of the information to understand the situation. It makes this unofficial translation available to other relevant States and international organizations, but only with the consent of the State that provided the original information.
The notifying/reporting State needs to send follow-up information promptly (i.e. not later than 4 hours) after the notification of a nuclear or radiological emergency to the IAEA. For facilities close to national borders, it is expected that follow-up information is sent directly to neighbouring countries at the same time as it is made available to offsite authorities. The IEC rapidly screens this additional follow-up information from the notifying/reporting State. Depending on its urgency, the IEC informs its CPs, according to the response procedures (see Section 4), and distributes the message through USIE. Follow-up information needs to contain all the information necessary to enable States to take actions aimed at minimizing transboundary or transnational radiological consequences; this information ought to include the results of environmental radiation monitoring.
The relevant CPs of States or international organizations may request information about an ongoing event in another State or about an event of international concern. The IEC, after authenticating the request, forwards it to the CA(D) of the relevant State, which is expected to respond promptly to the IEC. The IEC rapidly screens the reply for consistency, plausibility, legibility and comprehensibility and communicates the response to the requesting CP.
If there are reports in the media, inquiries from the media (via OPIC) or other unconfirmed accounts of a transnational emergency or an event of international concern, the IEC may contact

the CA(D) of the relevant State for provision of information and/or verification. Once the situation, as reported, has been either confirmed or proven to be false, the IEC requests the CA(D) concerned to send relevant information to the IEC through one of its primary emergency communication channels (fax or email) on EMERCON SRF or to submit this form to USIE. This information will be used by the IEC, in cooperation with the IAEA's OPIC, to address media inquiries. For details, see Section 4.2.

Provision of assistance

In support of the implementation of the Assistance Convention, the IAEA has developed and maintains the IAEA Response and Assistance Network (EPR—RANET).

In the event of an actual or perceived nuclear or radiological emergency, the relevant CA or the State's PM to the IAEA may request assistance. The IAEA facilitates the provision of the requested assistance through its RANET mechanisms.

RANET is a network for providing international assistance in a nuclear or radiological emergency, upon request from a State. States Parties to the Assistance Convention are obliged, within the limits of their capabilities and resources, to identify National Assistance Capabilities (NACs) that could be made available to assist another State. The IEC facilitates provision of the requested assistance by calling upon these NACs, which include a wide range of capabilities. To be able to provide assistance in an efficient and timely manner, the IAEA encourages Member States to register their NACs in RANET.

Assistance may also be requested by and provided to non-Member States within the scope of the IAEA's Board of Governors' decision, as detailed in GOV/2810 Error! Reference source not found.

Assistance during a nuclear or radiological emergency could be provided/offered via other existing international or bilateral mechanisms applicable for a State. Therefore, there is a need to coordinate the process of requesting/ offering assistance at the national level. For details on requesting IAEA emergency assistance, see Section 4.5.

Assessment of consequences and prognosis of emergency progression The IAEA Action Plan on Nuclear Safety [9] expanded IAEA's role19 in responding to an emergency at an NPP. This requested the IAEA Secretariat to provide Member States, international organizations and the general public with timely, clear, factually correct, objective and easily understandable information during a nuclear emergency on its potential consequences, including the analysis of available information and the prognosis of possible scenarios based on evidence, scientific knowledge and the capabilities of Member States.

To fulfill this role, the IAEA has developed an assessment and prognosis process that is described in the companion publication to this manual, entitled Operations.

Manual for IAEA Assessment and Prognosis during a Nuclear or Radiological Emergency (EPR—A&P 2019). This manual is supported by the IAEA's IEC Assessment and Prognosis Tools website, which contains specialized tools and procedures and explains the technical details of the process.

Note that all USIE Users are automatically granted access to the IEC Assessment and Prognosis Tools website (https://iec.iaea.org/iecat).20

The IEC requests from the Accident State and other Member States technical information to conduct assessment and prognosis. In parallel, the IEC may contact Member States which have pre-identified advanced assessment capabilities registered in RANET with a request to perform an assessment of a situation based on the input data received from the Accident State and other Member States.

The results of the assessment and prognosis are discussed with the Accident State and are shared with CPs in a timely manner, via fax and USIE distribution channels, and are classified as being "For Authority use only". At the same time, the IAEA produces easily understandable information in plain language for release to the media and the general public. For details on the assessment and prognosis process, see Section 4.4.

The IAEA email for matters concerned with assessment and prognosis is: IEC-Assessment-Tools.Contact-Point@iaea.org

Provision of public information

The IAEA extracts and summarizes any unrestricted and authenticated information received from CPs in relevant States about the situation and posts it in the form of public statements on the IAEA's public website and/or uses it to answer questions from the media. Prior to posting information on the IAEA's public website and/or issuing information to the media in response to their requests, the Secretariat contacts each relevant State to obtain its consent and to coordinate their respective efforts.

The IAEA makes all reasonable efforts to coordinate the release of information with the notifying/reporting State, other relevant States and international organizations, with due regard to their respective areas of responsibility. The IAEA monitors the international media to identify inconsistencies in authoritative information and ascertain any rumours, and it requests clarification as appropriate from the relevant CA. Timely, clear, factually correct, objective, consistent and easily understandable information (including analysis of available official information, assessment of possible consequences and prognosis of possible emergency progression) may be issued on the IAEA's public website and/or made available to the media. CPs are consulted to obtain clarity on the information provided, and they are requested to provide additional information as needed.

Coordination of the inter-agency response

The objective of the coordinated emergency response of the participating international organizations, in the context of the JPLAN, is to provide an appropriate and timely response to a nuclear or radiological emergency at the international level. Detailed practical arrangements are developed on a bilateral basis within the JPLAN between the IAEA and the participating international organizations.

To maximize the effectiveness of the inter-agency response, the participating international organizations coordinate their response arrangements and actions among themselves and with the relevant CA, making sure that there are clear lines of responsibility and authority in accordance with their respective mandates and obligations.

After confirming to the notifying/reporting State that the notification/report has been received, the IEC sends a notification/report to all relevant international organizations that have registered their CPs. During the Full Response mode of the IEC's activation, a designated liaison officer is available for any communication between the IAEA and the international organizations. The IEC may set up video/telephone conferences to exchange information and to coordinate common issues between the international organizations, such as the release of joint press statements. In addition, the IAEA has arrangements in place with the World Health Organization (WHO), the World Meteorological Organization (WMO) and the Food and Agriculture Organization of the United Nations (FAO) that allow these organizations, in response to emergencies, to send their liaison officers to the IEC to speed up the coordination process.

The framework for inter-agency response coordination is described in EPR— JPLAN.

Termination and follow-up actions

A State may send to the IEC information on the termination of a nuclear or radiological emergency and the subsequent transition to an existing or planned exposure situation, if applicable, using the General Emergency at Nuclear Facility Form (EMERCON GENF) or the Standard Report Form (EMERCON SRF). This decision needs to be taken at the national level and needs to consider both radiological and non-radiological consequences, as required in paras 5.97 and 5.98 of GSR Part 7. The IEC announces the termination of a response based on a

State's termination announcement. A termination announcement by the IEC is issued when the emergency situation is contained, is stable and does not present any further immediate risk to persons and the environment, or when the IEC does not anticipate any further urgent requests for advice or assistance.

If a State wishes to share information about follow-up actions and/or relevant implementation plans, this also may be shared through the established communication channels with the parties concerned.

Suggested response time objectives

Table 1 gives suggested response times for the key response actions described in Section 4.6 of this manual. This table complements the information found in Appendix VI of GS-G-2.1. States may use this table as a basis for establishing the response time objectives in their response procedures. The IAEA's IES response procedures are developed on the expectation that the States implement the suggested response time objectives.

TABLE 1.

Suggested response times for the key response actions*

Suggested response time objectives	
For the CPs	**For the IAEA**
Sent to the IEC within 2 hours** after receiving the information on a General Emergency.	Acknowledges receipt of the notification to the CP within 15 minutes after receiving it.
Calls the IEC if notification is not acknowledged within 30 minutes after sending the notification.	Authenticates and verifies the content within 30 minutes after receiving the notification. Informs all States within 2 hours after receiving the notification.
Sent to the IEC within 2 hours after sending the notification to the IAEA.	Verifies the information and informs all States within 1 hour after receiving further information.
Within 2 hours after sending the notification to the IAEA, respond to possible questions from the IAEA related to the assessment and prognosis.	As applicable, formulates questions related to the assessment and prognosis within 2 hours after receiving the notification.
Within 1 hour after receiving questions from the IAEA related to the assessment and prognosis, respond to those questions.	As applicable, formulates questions related to the assessment and prognosis within 1 hour after receiving further information.
Assisting States respond to the request for assistance within 6 hours after receiving the request from the IAEA.	Deploys assistance assets within 48 hours after receiving the request.
Within 2 hours after declaration of a General Emergency, prepares a press statement.	Prepares a press statement within 2 hours after receiving the notification message.
	Activates the JPLAN within 4 hours after receiving the notification message.
Announced to the IEC within several weeks after the prerequisites for termination of the emergency have been fulfilled.	Declares the termination on USIE within the working day after receiving the confirmation of the termination of the emergency.

* See Section 4.6 for additional details.

** The CA(D) is encouraged to send the notification to the neighbouring countries, immediately after receiving it from the operator

Use of provided information

The IAEA makes all reasonable efforts to keep States and relevant international organizations informed during a nuclear or radiological emergency. In order to facilitate the information exchange between States and international organizations and to enable them to further communicate with the public based on official information shared between CPs on USIE, three options to categorize the use of the provided information exist. CPs need to choose one specific option, as available in the emergency communication forms (see Section 3.3.4), to indicate how the provided information may be used, when posting information on USIE. These three options are:

• "For IAEA Secretariat use only" — the information is provided to the IAEA Secretariat. The information may not be shared with other CPs or with the public. Upon receiving such a message, the IEC will assess the information to determine potential implications to other States. The IEC will consult with the relevant CP to determine further actions, as appropriate and in accordance with the relevant procedures.

• "For Authority use only" — the information, as submitted, is provided to the IAEA Secretariat and the CPs for official use only, not for public disclosure; that is, the IAEA Secretariat and the CPs do not disclose the information, as submitted, to third parties. However, the IAEA Secretariat and the CPs may extract information from emergency communications forms to prepare, for example, information for their public websites, a press release or a brief note for public use, taking into account the need to protect sensitive information and to clearly explain technical information. CPs within the same country need to coordinate with each other to provide consistent information to the public, as per Requirement 13 of GSR Part 7 [6].

• "Free for public use" — the information is provided without restriction on its use as it is presented on USIE. The IAEA Secretariat and the CPs may share this information also with members of the public.

If a CP decides to request the change of the status of a message or messages published on USIE by another CP (or other CPs), from "For Authority use only" to "Free for public use", a request needs to be sent by email to the IEC routine email iec- routine@,iaea.org. The IEC will ask the CP of the Member State which initially submitted the message(s) (or the CPs of all Member States that contributed to the information exchange concerning the event in question) to approve such a request. With the approval of the Member State's CP which originally submitted the message(s) (or the CPs of all Member States which contributed to the information exchange concerning the respective event), the IEC will change the status of the message or messages on USIE. This would allow the requesting CP to use the information contained in the message(s) without restriction, as described above.

Designation of IAEA Points of Contact

Designations by States and international organizations

States, IAEA Member States and international organizations Parties to the Early Notification Convention and to the Assistance Convention must designate and make known to the IAEA their respective NWPs and CAs (referred to as CAs and CPs in the Early Notification Convention and the Assistance Convention).

The IAEA Secretariat strongly encourages all other IAEA Member States to designate their particular NWPs and CAs and make them known to the IAEA in order to meet the requirements stipulated in GSR Part 7.

The IAEA Secretariat also strongly encourages all relevant international organizations to designate their CPs and to make them known to the IAEA. International organizations that are not yet co-sponsors of the JPLAN and that wish to be considered relevant for the purposes of the Early Notification Convention and the Assistance Convention may address the IAEA making such a request.

The IAEA Secretariat also strongly encourages all non-Member States of the IAEA to designate their respective NWPs and CAs and to make them known to the IAEA.

States may designate INES National Officers23 and IRMIS Data Providers and send their contact

details to the IAEA.
The functions of IAEA CPs and USIE Users are described in Section 3.2.

Designation of IAEA CPs
Each State, through either its Ministry of Foreign Affairs or the State's PM to the IAEA, makes known in a written communication to the IAEA the designation of its NWP, its CAs and its INES National Officers, as applicable.

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

National Warning Point — NWP
The NWP is designated by the Government of a State. The NWP role in a nuclear or radiological emergency is assigned to a single institution in a State that is authorized by its Government to receive a notification/initial advisory/follow-up message, a request for/offer of assistance and a request for information or verification and to act upon it immediately, on a 24/7 basis. The NWP's functions are independent of those of the CA. Nevertheless, a CA could also have the functions of an NWP, i.e. they may be a single entity.
The NWP is expected to be part of a national emergency response system and possesses both the authority and the means to activate the system. The NWP, under the terms of the Early Notification Convention and the Assistance Convention, has to be available continuously. It must be staffed and able to be alerted 24 hours per day, 7 days per week. Additionally, requirements regarding their functions and availability are described in GSR Part 7.
The NWP is able to rapidly forward to the relevant CA any received notification/initial advisory/follow up message, request for/offer of assistance and request for information or verification from another State or the IAEA. The NWP has staff on duty who understand and speak English, or there must be speedy access to such staff. The NWP has the capability, and is available, at all times to receive fax messages and to establish direct telephone communications with the IEC. The NWP also has Internet capability for sending and receiving electronic mail, and it registers its staff as Liaison Officers on the USIE website for accessing and acknowledging receipt of posted messages. The NWP registers its USIE Users and at least one staff member as a USIE Administrator.

Competent Authority for a Domestic Emergency — CA(D)
The CA(D) is designated by the Government of a State. The CA(D) role in a nuclear or radiological emergency is assigned to one or more institutions within a State that are authorized by the Government to issue, as appropriate, a notification/initial advisory/follow-up message, a request for/offer of assistance and a request for information or verification, and to reply to a request for information or verification regarding a nuclear or radiological emergency originating at a facility or activity on the territory of, or under the jurisdiction of, the State. Each assigned CA(D) in a State is competent to verify relevant information provided during a nuclear or radiological emergency at a facility and activity under its authority. If the State designates only one CA(D), this CA(D) needs to be in a position to verify relevant information during a nuclear or radiological emergency at all facilities and during all activities on the territory of, or under the jurisdiction of, the State. If the CA(D) sends a request for assistance to the IAEA, the CA(D) coordinates this request with all other CAs in the State.

Competent Authority for an Emergency Abroad — CA(A)

The CA(A) is designated by the Government of a State. The CA(A) role is assigned to the single institution within a State that is authorized by its Government to receive a notification/initial advisory/follow-up message, a request for/offer of assistance and a request for information or verification and to issue follow-up messages, a request for/offer of assistance and a request for information or verification during a nuclear or radiological emergency originating in another State. If the CA(A) sends a request for assistance to the IAEA, it coordinates this request with all other CAs in the State.

Sensitive information related to a nuclear or radiological emergency may be received, as appropriate, by the authorized staff of the CA(A) using the EMERCON SRF (specifically, its field for provision of encrypted information) and the encryption feature of USIE. This encryption feature is available only to authorized USIE Users (Encrypted Information Readers/Editors/Publishers) of the CA(A).

The CA(A) does not normally need to be continuously staffed, but, in a nuclear or radiological emergency in another State, the CA(A) has arrangements in place so that it can activate rapidly and coordinate with other relevant organizations in the State after receiving notification from the NWP.

The CA(A) has the capability and availability at all times to receive fax messages and to establish direct telephone communications with the IEC. It has an nternet connection for sending and receiving electronic mail and for utilizing USIE. The CA(A) needs to register at least one staff member as USIE Administrator, who, in turn, registers staff as Publishers to publish messages on USIE. It is recommended that staff who are responsible for acknowledging USIE alert messages (the 'Liaison Officer' role) and who compose reporting forms (the 'Editor' role) are registered on USIE with their appropriate roles.

Competent Authority for Other Conventions — CAOC

In a nuclear or radiological emergency, there may be a need for an organization designated as a contact point under other relevant conventions [2]-[5] to send to the IAEA information relevant to the emergency for events within the scope24 of these conventions. While these conventions do not necessarily specify the method by which a State would communicate with the IAEA in such cases, the Parties to these instruments may choose to exchange information via the 24/7 secured emergency communication channel established through USIE. In this context, the IAEA has further enhanced USIE to enable encryption of information in transfer and storage, with due regard to the principle of protection of sensitive information, in order to facilitate the exchange of such information.

For this purpose, at the preparedness stage, States may decide to designate such organization(s) as Competent Authorities for Other Conventions (CAOC). If and as decided by the States Parties, the responsibilities related to exchanging relevant information in a nuclear or radiological emergency with States, the IAEA and other international organizations can be assigned to the CAOCs. The CAOC role may be delegated to one or more institutions within a State that have been authorized by the Government to implement this role.

In order to fulfill these responsibilities, the CAOC has the capability, and is available, to receive fax messages and to establish direct telephone communications with the IEC at all times. The CAOC also has Internet connections for sending and receiving electronic mail and for utilizing USIE. The CAOC needs to register at least one staff member as USIE Administrator. The USIE Administrator, in turn, registers staff as Publishers to publish messages on USIE. It is recommended that staff who are responsible for acknowledging USIE alert messages (the 'Liaison Officer' role) and who compose reporting forms (the 'Editor' role) are registered on USIE with their appropriate roles.

Relevant information is provided on a voluntary basis, as appropriate, by the CAOC through the EMERCON SRF, using the encrypted area that is only available to the authorized USIE Users. The CAOC may submit EMERCON forms in coordination with relevant CAs.

INES National Officers

INES National Officers are officially designated by their respective States. They ensure that — once a decision has been taken, on a voluntary basis, to rate an event on INES — the proper INES rating is performed in accordance with the INES methodology [13], and the event rating is posted on USIE25 by using the Event Rating Form (ERF).

INES National Officers have Publisher and Administrator rights on USIE. They have read access to all information posted on USIE (except the encrypted information), and they have write access and Publisher rights only for the ERF. INES National Officers can manage national users affiliated with INES.

TABLE 2.

Key functions of IAEA CPs as described in this manual

IAEA CPs	Key Function
IEC IAEA Incident and Emergency Centre	The IEC is the IAEA's focal point for preparedness for and response to a nuclear and radiological incident or emergency, irrespective of its origin. It is also the custodian of the IES.
NWP National Warning Point	A single institution in a State that is designated by its Government and authorized to receive a notification/initial advisory/follow-up messages, a request for/offer of assistance and a request for information or verification. It is available 24/7 to act immediately upon receiving the message.
CA(D) Competent Authority for a Domestic Emergency	One or more institutions within a State that are designated by their Governments and are authorized to issue, as appropriate, a notification/initial advisory/follow-up message, a request for/offer of assistance and request for information or verification; they are also authorized to reply to request for information or verification regarding a nuclear or radiological emergency originating at a facility or activity under the jurisdiction of that State.
CA(A) Competent Authority for an Emergency Abroad	A single institution within a State that is designated by its Government and is authorized to receive a notification/initial advisory/follow-up message, a request for/offer of assistance and a request for information or verification; it may also issue follow-up messages, a request for/offer of assistance and a request for information or verification regarding a nuclear or radiological emergency originating in another State.
INES National Officers	One or more specialists within a State who are designated by their respective Government and authorized to perform INES rating of an event in accordance with the INES methodology and to post the event rating on USIE by using the ERF.
IRMIS Data Providers	One or more technical organizations within a State that are authorized by the CA to report radiation monitoring data (routine and emergency) on IRMIS.
State's PM to the IAEA Permanent Mission of a State to the IAEA	The State's PM to the IAEA receives copies of relevant communications sent from the IEC to its State's CPs, as appropriate, and it may have read-only access to the USIE website. The State's PM is requested to assist in the event of communication problems between the IEC and the State and to assist if the State has not yet nominated an NWP or CAs. They also assist with matters such as obtaining visas for personnel entering their State, and with customs clearance for equipment being brought into the State as part of providing assistance, if requested.
CPs in international organizations	The officially designated CPs in international organizations within the framework of the JPLAN [7].

Practice 8. Emergency situations at nuclear power plants for the period 1952-2023

Task: Based on materials taken from open sources (the Internet, the Rosatom website), to conduct a systematic and statistical analysis of emergency events included in the INES international scale of nuclear events that occurred at nuclear power plants during the period 1952 – 2023.

Give the dates of accidents and incidents. To identify the countries in which nuclear power plant emergencies occurred with the release of radioactivity.

Identify the main objects of emergency situations related to radioactive emissions.

Identify the main causes of emergency events.

Note the types of reactors where accidents and incidents with radioactive emissions have occurred.

Draw conclusions from the results of statistical and system analysis.

Currently, 191 nuclear power plants are in working condition, which include 423 power units with a total electrical capacity of about 378,754 MW. Today, nuclear power generates 15.54% of the total electricity production in the world. Electricity generation at the NPP is 2.48 million GWh per year. Nuclear energy production is an important and integral part of the global economy.

To conduct a system analysis , consider the following countries like USA, Japan, USSR, England, Russia, Germany, Spain, France, Canada, Switzerland, Slovakia, Hungary, Ukraine, Sweden, Czech Republic, Pakistan, India.

Pay attention to:

- the number of accidents, the year of the emergency event, the objects of the accident (reactor core, control system failure and automation failures, transformers and cable channels, reactor circuit and cooling systems, other accidents, steam generators and steam pipeline systems, pipeline systems, reactor vessels, pumps and pumping systems, process channel),

- causes of emergency events (due to the fault of personnel, due to technical malfunctions, due to short circuits, due to natural disasters (earthquakes), due to automation failures),

- types (name) of reactors (PWR, BWR, RBMK, VVER, PHWR, FBR, NRX, Windscale-1, SL-1, UNGG, VHTR, GCR, AGR, BN).

The classification of the main types of power nuclear reactors is as follows:

– RBMK (uranium-graphite reactor of the channel type), using graphite as a moderator, and ordinary (light) water as a coolant.

– AGR, GCR, UNGG (gas–cooled reactors), where graphite is the moderator and carbon dioxide or helium is the coolant.

– VHTR (high-temperature reactor) using graphite as a moderator and helium as a coolant.

– PHWR (pressurized heavy water reactor), where heavy water (deuterium oxide) is used as a coolant and neutron moderator.

– NRX (research nuclear reactor), which uses heavy water as a moderator and light water as a coolant. When operating these types of reactors, there is a danger of overheating of the reactor core with subsequent explosion and fire.

– BWR, SL-1, Windscale-1 (boiling water-water reactors), which use graphite as a moderator and light water as a coolant.

– VVER, PWR (water-water power reactors), in which light water is a coolant and moderator. The danger lies in overheating of the reactor core and in a possible explosion of hydrogen inside the reactor vessel.

– BN, FBR (fast neutron reactors), in the core of which there are no moderators, and sodium is used as a coolant. The danger of these types of reactors lies in the possibility of a sodium fire and overheating of the reactor core with subsequent explosion and fire.

Build a diagram on which to display what most often became the objects of accidents:
- reactor core – ___%,
- control system failure and automation failure – ___%,
- transformers and cable channels – ___%,
- reactor circuits and cooling systems – ___%,
- other accidents – ___%,
- steam generators and steam pipeline systems – ___%,
- pipeline systems – ___%,
- reactor vessels – ___%,
- pumps and pumping systems – ___%,
- technology channel – ___%

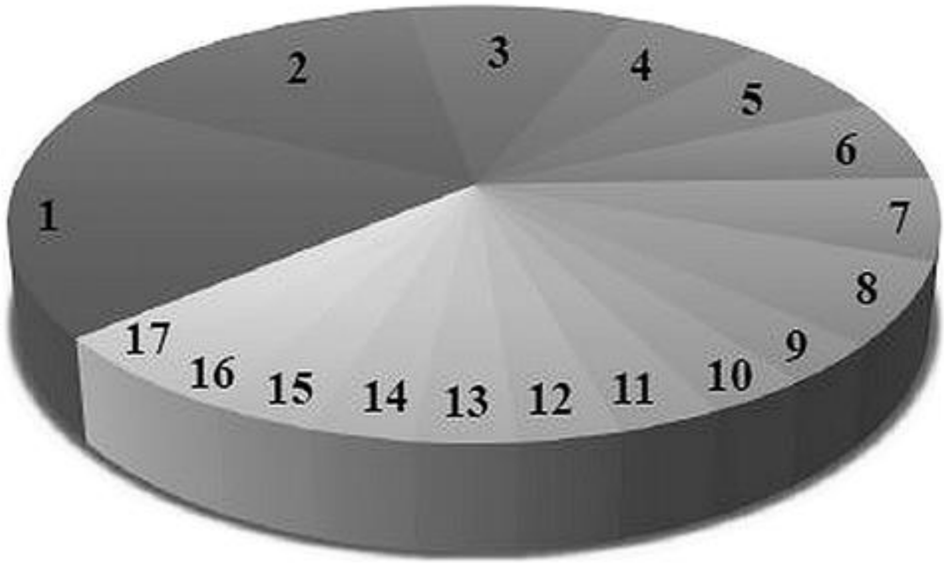

Fig 1. The percentage of the number of emergency events to the total number of reactors in the countries where accidents and incidents occurred at nuclear power plants

Emergency situations in the reactor core occurred ___ times:
- country – year _______.
control system failure and automation failures – ___ times:
- country – year _______.
in transformers and cable channels – ___ times:
- country – year _______.
in the reactor circuit and cooling systems – ___ times:
- country – year _______.

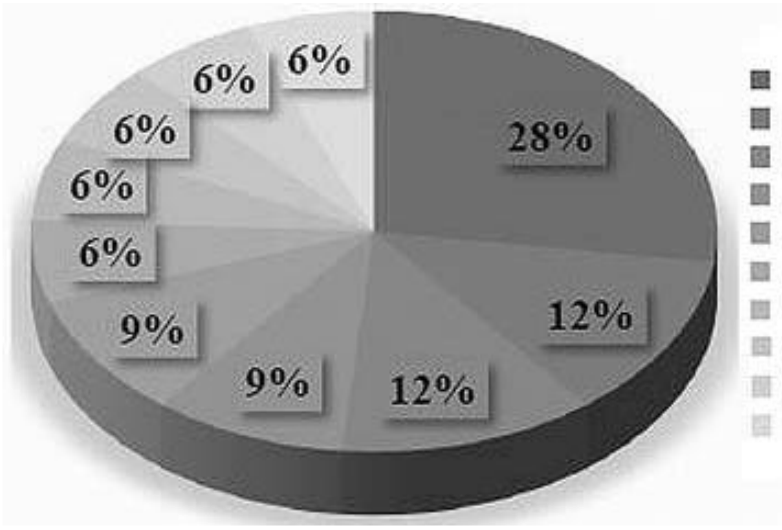

Fig 2. The main objects of accidents at nuclear power plants

Other cases of an emergency – ___ times:
- country – year _______.
in steam generators and steam pipeline systems – ___times:
- country – year _______.
in pipeline systems – ___ times:
- country – year _______.
in the reactor vessel – ___ times:
- country – year _______.
in pumps and pumping systems – ___times:
- country – year _______.
in technological channels – ___ times:
- country – year _______.

During the study period, emergencies were most often caused by _____________.
The number of accidents that occurred:
- through the fault of the staff – ____%;
- for technical malfunctions – ___%;
- short circuits – ___%;
- natural disaster (earthquake) – ___%;
- automation failure – ___% (make a diagram).

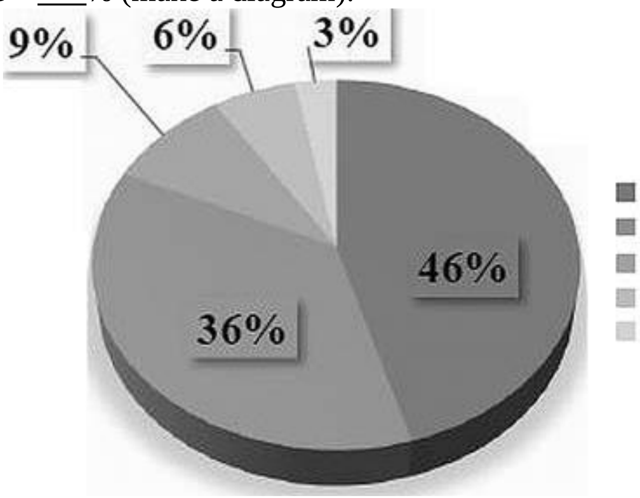

Fig 3. The main causes of emergency events at nuclear power plants

Most of the emergency events with
radioactivity emissions at nuclear power plants occurred:
- through the fault of the staff – ___;
- for technical malfunctions – ___;
- due to a short circuit – ___;
- due to a natural disaster (earthquake) – ___
- automation failure - ___.

The largest number of emergency events were registered at
PWR reactors – __;
BWR – __;
RBMK – __;
WWER – __;
PHWR – __;
FBR – __;
NRX – __;
Windscale-1 – __;
SL-1 – __;
UNGG – ___;
VHTR – __;
GCR – __;
AGR – __;
BN – ___.
Chronological events of accidents at various types of reactors are indicated in the table.

Conclusion

The analysis of emergency events with radioactive emissions at nuclear power plants in various countries for the period 1952 – 2023 allows us to conclude that most often emergency situations with emissions of radioactivity occurred in
____, ____, ____.

The two largest accidents of the seventh level on the INES scale were registered in _____ and ____.

The main objects of emergency situations are as follows:
– reactor core (___% of all situations);
– control system failure and automation failure (___% of all situations);
– transformers and cable channels (___% of all situations).

The main causes of emergency events are:
– personnel fault (___% of all events);
– technical malfunctions (___% of all events).
The most frequent emergency events with radioactive emissions at nuclear power plants occurred at reactors ____(__); ____(__); ____ (__); ____(__).

Safe operation of a nuclear power plant depends on the quality of the design and construction of the plant, as well as on compliance with special rules and regulations of work by NPP employees, which ensures the protection of personnel and the public from the effects of radiation accidents

Practice 9. Emergency situations at nuclear power plants (Methods for assessment of radiation situation at anticipated nuclear reactor plant accident)

Methodology for assessing the radiation situation in case of an out-of-design accident at a nuclear power plant

The methodology for assessing the radiation situation in case of an out-of-design accident at a nuclear power plant (methodology) is designed to assess the radiation situation in case of an out-of-design accident at an NPP with VVER-440, VVER-1000 and RBMK-1000 type reactors by forecasting method.

The radiation situation depends on the type of reactor, the amount and radionuclide composition of radioactive substances (RV) released into the external environment as a result of an out-of-design accident at the NPP, the distance to the NPP, meteorological conditions, the state of the underlying surface, etc. The amount of RV is taken by analogy with the accident at the 4th unit of the Chernobyl nuclear power plant - 3% of their content in the reactor core.

The quantitative composition of the RV emission adopted for calculating the elements of the radiation situation is determined separately for each radionuclide, %, of its maximum content in the core in relation to the VII level of the accident on the international scale.

The propagation of the RV cloud in the atmosphere occurs due to wind transport, dry and wet deposition, gravitational deposition and scattering as a result of turbulent diffusion.

The methodology considers three main types of atmospheric stability:

- unstable (convection) characteristic of sunny summer weather;
- neutral (isothermy), characteristic of variable cloud cover during the day, cloudy day and cloudy night, as well as rainy weather;
- stable (inversion), characteristic of a clear night, a frosty winter day, as well as for morning and evening hours.

The values used in the methodology are given for the conditions of an open area and an unprotected population. The dose of external radiation caused by the impact of the particle flux while in the emission cloud and in the contaminated area is not taken into account.

The technique allows you to determine:

- the size of the predicted areas of radioactive contamination of the area, limited by the isolines of external radiation doses for certain periods of time (from 1 day to one year);
- the predicted size of the terrain areas limited by the isolines of the thyroid radiation doses of children and adults during the passage of the cloud;
- the dose rate of external -radiation on the cloud trail;
- the density of radioactive fallout on the cloud trail;
- the maximum volume concentration of radionuclides in the surface layer of the atmosphere;
- the dose of external radiation during the passage of a radioactive cloud;
- the dose of external radiation when located on the trail of the cloud;
- the dose of internal irradiation with inhalation intake of RV;
- the dose of thyroid radiation for children and adults;
- the dose of external radiation when overcoming the cloud trail;
- acceptable start time for overcoming the cloud trail;
- permissible time spent in a contaminated area;
- the permissible start time of work in the contaminated area.

To determine the effect of radioactive contamination of the terrain and the surface layer of the atmosphere on the population, the radiation situation is assessed. The requirements for limiting the exposure of the population in the conditions of a radiation accident are established in the radiation safety standards.

Assessment of the radiation situation in the framework of situational planning during the exercises is carried out in advance. Either the most probable or unfavorable meteorological conditions are used as initial data.

When assessing the radiation situation , the following tasks are solved to determine:
- the size of the areas of radioactive contamination of the area;
- the size of the thyroid irradiation zones of children and adults during the passage of the cloud, as well as their display on maps (plans, diagrams);
- external radiation dose rates on the cloud footprint;
- the density of radioactive fallout on the cloud trail;
- the maximum volume concentration of radionuclides in the surface layer of the atmosphere;
- external radiation doses during the passage of a radioactive cloud;
- external radiation doses when located on the cloud trail;
- internal radiation doses during inhalation of RV;
- radiation doses of the thyroid gland;
- external radiation doses when overcoming the cloud trail;
- the permissible start time for overcoming the cloud trail;
- the permissible time spent in the contaminated area;
- the permissible start time of work in the contaminated area.

The initial data for assessing the radiation situation by the forecasting method are:

a) information about the reactor; type of nuclear power plant (RBMK, VVER); electrical power of nuclear power plant, W_e MW; coordinates of the reactor (X, Y), km; astronomical time of reactor destruction (number, month, h, min);

b) meteorological characteristics: wind speed at an altitude of 10 m U_0, m/s; wind direction at an altitude of 10 m, φ, °C; cloud cover (clear, variable, solid);

c) additional information that is provided separately when considering each specific task.

Determination of the size of areas of radioactive contamination of the area

Zones of radioactive contamination are areas of terrain limited by isolines of external radiation doses that an unprotected population can receive in an open location for time intervals determined from the moment of the start of the release of RV (the time of formation of a given radiation dose). The actual time of radiation dose formation is less, taking into account the time of the cloud approach t_p.

Additional information:
- the specified dose of external radiation at an open location D_o, sGr; the values of external radiation doses D_o are selected, as a rule, in accordance with the requirements of radiation safety Standards and criteria for decision-making (see Table A.1 of Appendix A of the methodology);
- the time of formation of a given dose of external radiation t_f (in the range from 1 hour to one year from the start of the release of RV into the atmosphere).

The order of solving the problem:
- according to the drawings, the degree of vertical stability of the atmosphere corresponding to weather conditions and time of day is determined.

Note - The term "morning" means a period of time within 3 hours after sunrise; under the term "evening" - within 3 hours after sunset.

The period from sunrise to sunset minus three morning hours is day, and the period from sunset to sunrise minus three evening hours is night;

- the position of the emergency reactor is indicated on the map (plan) and, in accordance with the specified wind direction, the axis of the trace of the radioactive cloud is applied;

- in accordance with Tables B.3-B.22 of Appendix B, the length of the predicted zone of radioactive contamination is determined L_x, corresponding to the specified values of the external radiation dose D_o and the time of its formation t_f, weather conditions, and the type of nuclear power plant.

If there are no set values in the tables D_o & t_f, the predicted length of the zone is determined by linear interpolation;

- the maximum width of the zone (in the middle of the length) L_y, km, is calculated by the formula

$$L_y = a \cdot L_x, \quad (1)$$

where is the coefficient depending on the degree of vertical stability of the atmosphere (see table A.1);

- the area of the radioactive contamination zone S, km, is calculated by the formula

$$S = 0{,}8 \cdot L_x \cdot L_y; \quad (2)$$

- using the found dimensions, the zones on the map scale are displayed in the form of regular ellipses.

When solving problems with the destruction of VVER-440 type reactors, the length of the radioactive contamination zones is calculated from the data selected for the VVER-1000 reactor and by multiplying the corresponding values by a coefficient of 0.663:

$$L_x \text{ (VVER – 440)} = 0{,}663 * L_x \text{ (VVER – 1000)}.$$

Practice 10. Analysing emergency and emergency response

Task: Create an essay (no more than 10 pages in Word format) with a short briefing (no more than for 10 min in PPT format) in which to summarize the main lessons:

1. Nuclear accidents, conclusions and correct responses.
2. Radiological incidents, conclusions and correct responses.