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EMERGENCY PREPAREDNESS
AND RESPONSE

Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency

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EPR-EXERCISE (2005) Emergency Preparedness And Response

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FOREWORD

The aim of this publication is to serve as a practical tool for the preparation, conduct and evaluation of exercises to test preparedness for response to a nuclear or radiological emergency. It fulfils in part the functions assigned to the IAEA under Article 5.a(ii) of the Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency (Assistance Convention), namely, to collect and disseminate to States Parties and Member States information concerning the methodologies, techniques and available results of research on such emergencies. To ensure effective response to radiation emergencies when needed, provisions should be made for regular training of emergency response personnel.

As stated in Preparedness and Response for a Nuclear or Radiological Emergency (Safety Requirements, Safety Standard Series No. GS-R-2), "…The operator and the response organizations shall make arrangements for the selection of personnel and training to ensure that the personnel have the requisite knowledge, skills, abilities, equipment, procedures and other arrangements to perform their assigned response functions…". A further requirement is that "…Exercise programmes shall be conducted to ensure that all specified functions required to be performed for emergency response and all organizational interfaces for facilities in threat category I, II or III and the national level programmes for threat category IV or V are tested at suitable intervals…". In 2004 the IAEA General Conference, in resolution GC(48)/RES/10 encouraged Member States to "implement the Safety Requirements for Preparedness and Response to a Nuclear or Radiological Emergency".

This document is published as part of the IAEA Emergency Preparedness and Response Series to assist in meeting these requirements and to fulfil Article 5 of the Assistance Convention. It was developed based on a number of assumptions about national and local capabilities. Therefore, the exercise structure, terms and scenarios must be reviewed and customized in the preparation phase of the exercise. This guidance was developed with resources from the Nuclear Security Fund and Technical Cooperation Fund. The IAEA officer responsible for this publication was E. Buglova of the Division of Radiation, Transport and Waste Safety.

CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

The adequacy of emergency response arrangements can be evaluated through the audit and review of plans, procedures and infrastructure (preparedness). The ability to carry out the required emergency actions (response) can be assessed through audits and reviews of past performance, but it is most commonly evaluated through exercises.

Emergency response exercises are a key component of a good emergency preparedness program. They can provide unique insight in the state of preparedness of emergency response organizations. They can also be the basis for continued improvement programs for the over emergency response infrastructure. However, to be most useful, emergency response exercise need to be well organized, professionally conducted and their evaluation must focus on constructive improvement potential.

Nuclear and radiological emergency response exercises are a powerful tool for verifying and improving the quality of emergency response arrangements. Each exercise represents a significant investment of effort, financial resources and people. It is therefore important for each exercise to yield the maximum benefit. That benefit depends primarily on the quality of the preparation, conduct and evaluation of the exercise.

This guidance, published as part of the IAEA Emergency Preparedness and Response Series, is consistent with IAEA Safety Standard Series No. GS-R-2, *Preparedness and Response for a Nuclear or Radiological Emergency* [1]. It builds on the practical recommendations for training drills and exercises provided in the *Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency* (EPR-Method, 2003) [2] and elaborates information provided in the Safety Series No. 73 (*Emergency Preparedness Exercises for Nuclear Facilities: Preparation, Conduct and Evaluation*) [3].

1.2. PURPOSE

The purpose of this publication is to provide practical guidance for planners to efficiently and effectively prepare, conduct and evaluate emergency response exercises.

1.3. SCOPE

This publication covers response exercises for emergencies involving all types of nuclear or radiological practices, given in threat categories I to V, as described in GS-R-2 and EPR-Method (2003) [1, 2]. It also includes a section on special considerations for exercises for response to emergencies arising from malicious acts.

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

The preparation, conduct and evaluation of exercises usually involves the coordination of several organizations. Exercises demand a great effort and require the input of several staff and disciplines to yield good results. Drills, on the other hand, demand less preparation and coordination, and are usually easier to evaluate. Their preparation and conduct are not specifically addressed in this document.

1.4. STRUCTURE

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

2. CONCEPTS

2.1. EMERGENCY PREPAREDNESS PROGRAMME AND EMERGENCY EXERCISES

An adequate emergency preparedness programme includes inter alia:

- emergency plans and procedures that address all of the potential hazards related to the relevant practices;
- training programmes that include an appropriate amount of theoretical and practical courses as well as testing and refresher training for all of the key organizations and positions identified in the emergency plans;
- resources, including human, equipment, communications and facilities to support the execution of the emergency procedures;
- appropriate coordination arrangements;
- drills and exercises;
- a feedback process to improve all of the above based on lessons identified from real events, during training and following exercises.

Emergency preparedness programmes should also include considerations and arrangements for international liaison, notification, exchange of information and assistance. These arrangements also need to be exercised.

In most cases, exercises are conducted once the plans and procedures have been implemented, the resources have been allocated and the training has been delivered.

An emergency response exercise should not be an isolated event, but rather one that is part of an overall exercise programme that is normally implemented over a cycle of several years. Leading to any major exercise, there will be training, drills and smaller-scale exercises.

Over the exercise cycle, all response objectives and all major organizations in the plan should be targeted by at least one exercise. Some objectives will of course be tested more often than others. The type of programme and the frequency with which exercises are conducted will vary depending on the organization(s).

2.2. PURPOSE OF EXERCISES

The objectives of an exercise are:

- to validate plans and procedures and to test performance (*performance evaluation)*;
- to provide an opportunity for training in a realistic situation (*training*); and
- to explore and test new concepts and ideas for emergency arrangements (*trials*).

2.2.1. Performance evaluation

This is by far the most common reason for holding an exercise. The focus here is on the performance of the entire organization as opposed to that of individuals, the latter often being tested in drills.

A successful exercise identifies where improvements are necessary in the plan, assesses the correctness of revised procedures introduced as a result of previous exercises, and furthers the development of adequate emergency preparedness. A good exercise is one that allows many lessons to be identified. An exercise should not be seen as an opportunity to demonstrate the flawlessness of a response.

> *A good exercise is not necessarily one where everything goes well, but rather one where many good lessons are identified.*

When a new plan is being implemented, it allows for the validation of that plan. Periodically, as changes are introduced to the plan and procedures, an exercise serves as a verification of the continued effectiveness of emergency response arrangements. Communications between organizations is one of the major challenges during a real emergency; and an exercise can test the communication arrangements better than any other activity. In that context, communication is not limited to the technological means of communicating but also includes the substance, format and the way in which the information is communicated.

2.2.2. Training

Although the main purpose of exercises is to validate and test performance, every exercise has a significant training value. It is one of the few opportunities for individuals and organizations to work together under realistic conditions. However, if an exercise is the only method used to expose individuals to the roles they must play during an emergency, these individuals will be left with a skewed impression of their responsibilities. Therefore, exercises are not usually conducted solely for the purpose of training.

2.2.3. Trials

In some cases, new concepts, procedures, systems or arrangements must be developed, explored and pre-tested so that they can be improved before they are implemented. This can also be accomplished in the context of exercises.

The examples presented below are representative of cases where conducting an exercise may be appropriate.

Example 1:

An emergency response organization wishes to implement a new web-based system for sharing key emergency information. The system has been developed as a prototype but has not yet been tested in a realistic environment.

Example 2:

The basic concept for longer-term protective actions and post emergency response and recovery has been developed, but the problematic and decision-making coordination aspects are so complex that they require a realistic simulation in order for all the issues to be explored. This would allow potential methods of resolving problems between several key national and regional organizations, to be revealed.

Exercises often contain a trial component.

2.3. TYPES OF EXERCISES

The term "exercise" is usually loosely interpreted as meaning any practical implementation of response plans and procedures in a simulated situation. This includes drills, tabletop exercises, partial and full-scale exercises as well as field exercises. The preparation and conduct of each varies in complexity, scope and objectives.

2.3.1. Drills

Drills normally involve small groups of persons in a learning process designed to ensure that essential skills and knowledge are available for the accomplishment of non-routine tasks such as emergency radiation measurements or the use of emergency communication procedures. A drill is conducted primarily as a training tool to develop and maintain skills in certain basic operations or tasks, or to reinforce a skill or practice/review a procedure. A drill can also be used to assess the adequacy of personnel training and is usually supervised and evaluated by qualified instructors. It normally covers a particular component, or a group of related components, associated with the implementation of the emergency plan. It may also be a sub-component of an integrated exercise, for example, fire and first aid drills. Several types of drills can be conducted. The type of drill to be used depends on the function being practised and the group being trained. Drills are primarily used for training and should be conducted several times per year.

The use of live radioactive sources in drills can add realism and a healthy respect for radiation. In this case, safety is paramount and close supervision is required. However, the use of live sources is not normally recommended because it is difficult to maintain close supervision of the players' actions.

Appendix I gives a list of basic operations or tasks associated with the implementation of an emergency response plan, for which the use of drills may be relevant. This list is not necessarily exhaustive and is only provided as an illustration of possible drills.

2.3.2. Tabletop exercises

A tabletop exercise is a discussion-type exercise conducted around a table. All the participants are in the same room or building (players, controllers/evaluators, observers). Therefore, no communication link with any outside body is necessary.

Tabletop exercises are not usually conducted in real time (refer to Section 2.4.1). Their main focus is on decision-making, assessment, public and media communication policy definition, and implementation. Therefore, a tabletop exercise may also be the most appropriate exercise for:

- identifying, understanding and evaluating new response issues;
- developing new response concepts;
- trying new response concepts or new response areas;
- formalizing new concepts, plans, procedures, arrangements and systems;
- improving the mutual understanding between stakeholders in emergency situations, particularly when those stakeholders typically don't interact routinely (e.g. international response).

Key points in the preparation and conduct of a tabletop exercise include the following:

- define the objectives of the tabletop exercise;
- prepare a clear scenario, including all associated data, that meet the objectives of the table-top;
- clearly identify and prepare all logistics requirements, i.e. data presentation, communications, tools required by the players, etc.;
- organize the room so that it is clearly perceived by the players to be the setting of an exercise and NOT a meeting;
- ensure all the players are introduced and that their roles and responsibilities are clearly understood by all;
- clearly explain that the goal of the table-top is to assess and try to make decisions and that these decisions will be used for improving the overall emergency preparedness; avoid never-ending discussions and pontificating;
- explain that the players are accountable for their contribution;
- explain that the discussions will be recorded.

These rules make tabletop exercises very different from workshops. In a workshop, participants tend to be in a receiving and discussing mode. In a tabletop, they need to be pro-active and concrete.

2.3.3. Partial and full-scale exercises

Partial and full-scale exercises are simulations used to allow a number of groups and organizations to act and interact in a coordinated fashion. The focus of partial and full-scale exercises is on coordination and cooperation.

Exercises can be partially or fully integrated. In a partial exercise, only selected organizations and interfaces are activated. The rest can be simulated. For example, a partial exercise may involve only the on-site or the immediate response components of the emergency organization, with the off-site organizations being simulated. Another partial exercise may involve only the off-site component of the emergency organization, with the on-site response being simulated.

The most demanding and exhaustive test of emergency response capability is an integrated full-scale exercise involving the full participation by all on-site and off-site response organizations. Its major objective is to verify that the overall coordination, control, interaction and performance of the response organizations are effective and that they make the best use of available resources.

Exercises can vary in magnitude and scope. In the case of a fixed facility, on-site exercises test the ability of the facility staff to deal with facility problems. An on-site exercise can also test on-site/off-site interaction mechanisms and media relations, but unless off-site organizations are actually involved, they must be simulated and the value of the interface portion of the exercise remains low.

Off-site exercises similarly test the off-site portions of the response and unless the facility participates, it must be simulated, and the interface aspects of the response are not truly tested.

A combined on-site/off-site exercise is effective in testing both the individual on-site and off-site responses and the interface mechanisms in place, which are so important to a proper overall response. In fact, the interface aspects, where successes are usually critical for protecting the population, are often the weak link in the emergency response system.

In the case of a threat category IV practice (e.g. transportation, large-scale contamination and lost or stolen sources), there is no fixed facility and exercises will always take place “off-site”.

Appendices III through VIII provide examples of scenarios for threat category I to V facilities/practices (as defined in Ref. [1]).

2.3.4. Field exercises

Field exercises focus on the tasks and coordination of “field resources”. Field resources are defined as those people and teams that must operate at or around the site of an emergency. For example, a field exercise could be conducted to evaluate the integrated performance of survey teams, police, medical first aid and fire fighting teams.

A field exercise can be conducted on its own or combined with a partial or full scale exercise. In the first case, the emphasis is on team procedures and coordination between several teams with a common task. In the second case, the focus is on communications and coordination between the field resources and the decision-making components of the emergency organization. However, field and table-top exercises are often conducted in different time modes, and the exercise organizers need to take this into consideration in the exercise schedule.

In some cases, it may also be possible to involve part of the public in a field exercise (e.g. for practising a partial evacuation). This can be done with appropriate preparation.

2.4. METHODS OF CONDUCTING AN EXERCISE

Time mode, stimulation versus free play and the use of simulators, are important factors that must be determined when preparing an exercise.

2.4.1. Time mode

An exercise is carried out in a *real time mode* when each activity is conducted on the same time scale as it would during an actual emergency. The time scale is *compressed* when otherwise necessary steps or time lapses are simulated or foreshortened during the exercise. An *expanded* time scale may result from the provision either of additional time to that normally required to complete a particular event or of a prolonged time period within a sequence of events to enable the convenient management of the exercise.

Compression or expansion of the time scale for certain sequences in the scenario may be advisable in order to make efficient use of the time personnel invest in the exercise. This is often appropriate for tabletop exercises and for drills, but not usually for larger exercises, where coordination between various groups makes it harder to synchronise the exercise unless real-time is used. There are exceptions. For example, in the early stages of an emergency exercise, off-site government officials may be relatively slow in arriving at the site, and time compression may be advised. For the purpose of the exercise, the time scale for this stage may be compressed in order that their particular assessment and decision-making activities be put into practice without prolonged delays. Another case where time compression may be appropriate is a reactor event sequence leading to a major failure, which in reality could take many hours.

There are cases where time compression is definitely disadvantageous. A prime example is the compression of the time required for off-site monitoring teams to check equipment, travel to a monitoring point, take samples, perform measurements and record and communicate results. These time delays are crucial to the understanding by the off-site dose assessment staff of the time delays that would be incurred in data collection and monitoring procedures under real emergency conditions.

Where possible, however, this procedure (and, in particular, time expansion) should be avoided during the early stages of an integrated exercise as it is essential that players obtain a genuine appreciation of the actual time available for the completion of particular tasks, especially when these involve coordination with other groups. As a guiding rule, the time sequence of the associated series of events in an exercise may be compressed or expanded, provided that this does not compromise exercise objectives.

2.4.2. Free play versus stimulation

Two factors, which are at odds in the design and conduct of exercises, are free play and stimulation.

Free play means that players are free to react to a simulated problem according to their perception of the most appropriate solution. A scenario that allows free play is the preferred method of training technical staff members to carry out their assigned functions under emergency conditions. Free play also allows the evaluators to determine more accurately the adequacy of emergency preparedness. However, a scenario incorporating the facility for free play requires much more effort to produce and implement due to the complication of accommodating multiple actions by, and options available to, the players.

Stimulation refers to actions that controllers may take to correct errors or to interrupt actions made by the players, which might otherwise lead them to depart from the scenario and possibly jeopardise the overall objectives of the exercise. In general, the controllers should avoid correcting players' errors whilst the exercise is in progress unless it is absolutely necessary so that the exercise can stay on track.

This guidance regarding free play and stimulation does not apply to drills, where, if anything, the opposite approach should be taken. Free play is generally less important because drills are relatively short in duration and rigidly structured. As drills are largely instructional by nature, there is a need for the immediate correction of errors and for the repetition of difficult parts of the drill. Such requirements are part of the objectives of most drills.

2.4.3. Using a simulator during an exercise

For facilities such as power reactors, a simulator may be available to develop the scenario and/or run the exercise. This can add realism and reduce the requirement for including extensive simulation data (e.g. all control and safety parameters) in the exercise manual.

If the data stream from a full-scope simulator is delivered to the actual or simulated data acquisition systems that would be used by operators and plant systems engineers during an emergency, the training of these staff will not be limited by the resources required to prepare detailed event descriptions or the lack of realism inherent in bypassing actual information systems.

The scenario should be tested on the simulator for the full length of the exercise. Simulators have been known to crash under certain conditions and you want to guard against that. You should also ask the training staff about any operator interventions that could fix the problem and stop the emergency, thereby also stopping the exercise. To deal with those, additional failures may have to be entered into the simulator.

The advantages of using a simulator are:

- The shift crew will have to react realistically and perform many of the actions that they would perform during a real emergency.
- Simulators allow a test of compatibility between emergency operating procedures (EOP) and the emergency response plan. The shift crew will execute both sets of procedures. If the requirements are incompatible, this will be detected. Also, the shift crew and training staff will have positive changes to suggest at the end of the exercise.
- Simulators allow a test of notification delays. Delays resulting from operators executing the EOPs and emergency procedures simultaneously can be assessed more accurately.
- Simulators generally give realistic timing for the simulated events.
- The use of simulators involves important stakeholders. The shift crew and training staff get a chance to be involved with emergency response issues from their perspective and will undoubtedly give valuable feedback.

The disadvantages are:

- The location is different from the one normally used by operators. Interactions between the on-site emergency response organization and the operators, which would be simple in the real control room, may become difficult because the simulator room is in a different building. When the operators leave the simulator room to perform interventions in the plant, they spend more time reaching their workplace.
- The scenario preparation involves more people. The simulator staff will be involved in the preparation and their availability may become an issue.
- The simulator may not be able to execute the scenario. There are scenarios that are not regularly used for operator qualifications and which can make the simulator crash because of snags or limitations of the simulator.

To complete the instruction manual for the exercise, ask the training staff for a copy of the procedures that will be executed. Collect the work permit forms and maintenance tags that will be required during the exercise. Once the complete scenario (on-site and off-site) has been defined, check the timing and the sequence of events to ensure the causality of the required actions.

Each simulator has its limitation. For example, not all data are simulated and some of those data may be critical for the exercise. They would have to be developed and provided to the control room personnel through exercise inputs and messages. The most serious limitation is probably the inability of some simulators to go into the "severe emergency" domain. Many simulators crash when you try to simulate conditions that could lead to extensive fuel failures. It is wise to run through the emergency and possible responses well before the exercise!

One of the risks of using the simulator is that a clever operating crew may be able to fix the problem before real trouble starts, which would jeopardise the rest of the exercise. This requires a back up plan.

2.5. HOW OFTEN SHOULD EXERCISES BE HELD?

Exercise frequency depends on the exercise type and specific objectives. The frequency of an integrated exercise should be determined based on:

- the necessity to change major portions of the emergency plan;
- the turnover rate of key personnel (e.g. senior off-site services staff, government staff or the operating organization's senior staff);
- the degree of normal contact between the major response organizations;
- the type and frequency of partial exercises;
- the need to maintain training; and
- the degree of success observed in previous exercises.

The interval between integrated exercises at major facilities is a matter to be determined by the regulatory authorities of the individual Member States. For guidance, this interval is unlikely to be less than 12 or more than 36 months long. Exercises for category IV practices, e.g. transportation, should be integrated with other exercises for similar emergencies (e.g. hazardous chemical spill exercises).

Exercises should allow each person assigned a key role in each emergency organization to obtain practical experience. Since there is no guarantee that any given individual would indeed be present should an actual emergency occur, it is not prudent to rely exclusively on one person to perform a specific role. The responsibilities of key individuals should be rotated, exchanged or otherwise varied from one exercise to another to demonstrate and develop a wider range of expertise and experience.

2.6. FOLLOW-UP ACTIONS

The evaluation of an exercise identifies areas of emergency plans and preparedness that may need to be improved or enhanced. As a result of an exercise evaluation, there may also be recommendations on ways to correct the identified deficiencies, problems or weaknesses. However, it will be the responsibility of each organization to review the evaluation report and to determine what corrective actions need to be adopted. These could include the following:

- changes in plans and procedures such as modifications of tasks and responsibilities, more appropriate response goals and procedures, more or less details, etc.;
- upgrading of equipment, facilities, assessment tools and information material; and
- enhancement of the training, drills and exercise programmes in identified weak response areas.

Subsequently, action plan should be developed. This plan identifies:

- the tasks;
- the responsible persons; and
- the implementation schedule.

The implementation schedule would depend on the type of response plan and operations. The following is an example of a follow-up action schedule based on the classification of weaknesses and deficiencies (Table 1).

TABLE 1. EXAMPLE OF A FOLLOW-UP ACTION SCHEDULE BASED ON THE CLASSIFICATION OF WEAKNESSES AND DEFICIENCIES

Deficiency or weakness	Corrective action
Critical	Solution to be identified within one month. Corrections to be implemented within three months.
Major	Solutions to be identified within one month. Corrections to be implemented within six months.
Minor	Solution to be identified within three months. Corrections to be implemented within one year or at the next revision of plans.

The implementation plan progress should be tracked; completed items should be recorded and reported.

2.7. EXERCISE PROGRAMME

Exercises should be seen as an integral part of the process, which also includes planning and training to develop, maintain and improve emergency response plans and preparedness. This process includes planning, training and exercises.

An exercise programme should be prepared by each organization and coordinated with other organizations. The exercise programme and training programme should be coordinated and form a coherent structure.

An exercise programme typically includes a detailed one-year plan and a more general long-term plan. The one-year plan describes:

- a statement about the aim and objectives of the one-year plan;
- the types of exercises to be conducted: drills, table top exercises, field exercises, partial and full scale exercises;
- the tentative schedule for these exercises; and
- the participating organizations.

The long-term plan identifies the exercises that must take place over the next few years. The long-term plan should cover a period of several years (e.g. five) as set by the appropriate national authority. This long-term plan should also address international exercises, which are typically planned and implemented over a period of more than one year. This plan should be fairly detailed for major exercises, which require much advanced planning. The long-term plan will also address the requirement for smaller-scale exercises, but their detailed schedule and specifications should normally be part of the one-year plan.

The following factors should be considered in the development of the long-term plan:

- all response objectives identified for each organization in the emergency plan should be covered over the period stipulated in the long-term plan;
- allowances should be made to adjust the exercise programme based on feedback from previous exercises;
- some response objectives need to be exercised more frequently, e.g. those relating to activation, notification and communication procedures, hazard assessment and public information;
- the scenarios and event types to be considered should cover a broad range of postulated events;
- all designated personnel (including backups) should participate as players on a regular basis;
- the exercise programme should take into account the schedule for the revision and improvement of plans, procedures, assessment tools, equipment, etc.

Implemented activities and participation of individuals in exercises should be recorded to monitor the achievements of the exercise programme.

3. PROCESS OVERVIEW AND MANAGEMENT

3.1. PROCESS OVERVIEW

Preparing a large-scale exercise can take six to twelve months. The duration of the process is dependent on the complexity of the exercise and the targeted level of participation. Presented below are the general steps involved in the process; these are further examined in sections to follow. The timeline provided is meant only as an example and must be adjusted taking into account:

- the scope of the exercise;
- the diversity of participating organizations;
- the amount of exercise data that must be prepared;
- the availability of people and organizations; and
- the level of priority of the exercise over other planned activities.

Step 1 *(Several months prior)*

- Appoint an exercise management committee in which the director also assumes the role of chair. A model for the committee's structure and its members' roles and responsibilities is described in Section 3.2.
- Develop the exercise specifications (see Section 4). This includes national and international requirements.
- Obtain approval on the exercise specifications from major stakeholders.
- Distribute the exercise specifications to all participating organizations.
- Define the policy to deal with the real media in the context of the exercise (see Section 9).

Step 2 *(6 months prior)*

- Appoint a scenario design team. A model for the committee's structure and its members' roles and responsibilities is described in Section 3.2.

- Begin developing the scenario and exercise data (see Sections 5 and 6). The exercise management committee will periodically review the data to ensure that they remain consistent with the exercise specifications.
- Begin developing the exercise controller's and evaluators' guide (see Section 7), starting with the evaluation criteria.

Step 3 *(5 months prior)*

- Validate the exercise scenario concept with specialists in the relevant fields. These specialists must not be players in the exercise.
- Develop training, drills and exercises leading to the date of the major exercise, making full use of tabletop exercises for managers and coordinators. If the exercise is low scale, or intended to audit the current state of emergency preparedness without bias, this step may be omitted. However, since large-scale exercises often involve people who have had a limited amount of nuclear or radiological emergency response training, this step can be a useful part of the overall emergency preparedness programme.

Step 4 *(2 to 3 months prior)*

- Conduct drills and tabletop exercises.
- Identify logistics requirements and begin making arrangements.
- Make hotel bookings and transportation arrangements.
- Develop media briefing package (see Section 9).
- Identify by name all controllers and evaluators.
- Make arrangements for observers.
- Keep in mind that some participating organizations may need to develop their own internal exercise guide with the necessary information to ensure that staff members participate effectively.
- In exercises involving a large number of organizations, such as international exercises, this should be the deadline for the exercise scenario, evaluation guide, coordination mechanisms and communications protocols (i.e. how will the international part of the exercise will be controlled).

Step 5 *(1 month prior)*

- Complete preparation of the scenario and exercise data.
- Complete the guide for exercise controllers and evaluators.
- Distribute the guide for exercise controllers and evaluators to the exercise control and evaluation team members.
- Develop the guide for players (see Section 8).

Step 6 *(2 weeks prior)*

- Distribute the guide for players to every participating organization and observer.

Step 7 (*1 week prior)*

- Hold a final meeting of the exercise management committee to review the exercise scenario and data, as well as the guide for controllers and evaluators and the arrangements made in preparation for the exercise.
- Agree on the media releases for the real media.
- Finalise logistics arrangements, including the set-up of simulation cells and rooms for players and controllers.
- Complete and publish an exercise telephone/fax/e-mail list that contains the coordinates of the simulation cells (i.e. of the organizations and people being simulated). This list or

simulated coordinates are to be used by players during the exercise in lieu of real coordinates. All simulated phone numbers should be tested within that week.

Step 8 *(At least 2 days prior)*

- Train the exercise controllers and evaluators.
- Provide the radiological qualification training for team members needing access to restricted facility areas.
- Provide familiarisation tours to the exercise controllers and evaluators of the area(s) where the exercise will take place.
- Ensure exercise controllers and evaluators customise their guide so that they may readily obtain the information they need.
- Make the final amendments to the scenario and exercise input and data lists, if required. It is preferable not to make any significant changes, as even a single small change can have large repercussions on the overall scenario. Before a modification is made, the implication on all other aspects of the scenario must be carefully considered.

Often, a "full dress rehearsal" is scheduled approximately one month prior to the exercise. This is not absolutely necessary, but it allows the "ironing" out of bugs with respect to the players and exercise organizations.

Personnel and players should be made aware of an imminent exercise, but need not know its exact date or start time. As many people and organizations are involved, keeping this type of information confidential may present a major challenge. It is important however, at the very least, to ensure that the start time remains a surprise.

3.2. PROCESS MANAGEMENT

3.2.1. Organization for the preparation of an exercise

A typical exercise preparation organization is shown in Figure 1. The exact structure and number of people involved depend on the scope of the exercise. The functions and associated roles presented are common to any exercise. The exercise director must ensure that responsibilities are clearly assigned.

The members of the exercise preparation organization must not become players during the exercise. Some, if not all of the members of this organization, will most likely be part of the core group for the control and evaluation of the exercise (although this is not a requirement).

Exercise management committee

The exercise management committee consists of:

- an exercise director;
- a lead controller and lead evaluator;
- on-site/off-site representatives; and
- representatives from major stakeholders.

The exercise management committee should consist of senior decision-makers and planners from *key* participating organizations as well as regulators. The chair of the exercise management committee is normally the exercise director.

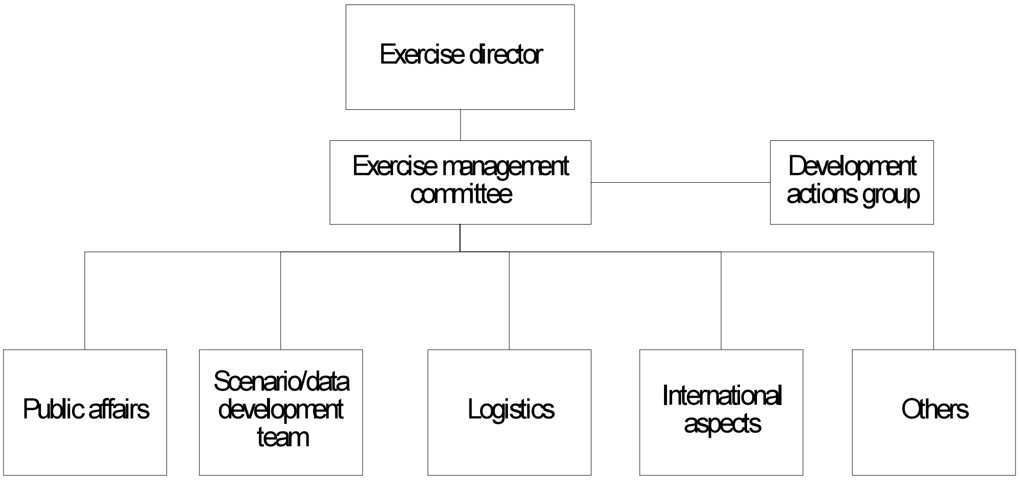


FIG. 1. Typical organization for the preparation of an exercise.

This *exercise management committee* is responsible for:

- developing the exercise specifications;
- developing the exercise evaluation criteria;
- developing the guide for controllers and evaluators;
- developing the guide for players;
- managing the process described in Section 3.1;
- selecting the scenario development team and assigning all major functional responsibilities within the exercise preparation organizations;
- periodically reviewing the exercise scenario manual to ensure that it remains consistent with the exercise specifications;
- determining the extent of international participation;
- approving the media strategy;
- selecting the exercise controllers and evaluators; and
- approving the presence of observers.

Exercise scenario/data development team

The exercise scenario development team is composed of:

- emergency planners from the organization responsible for the nuclear or radiological practice;
- technical specialists with a thorough knowledge of the practice, its design as well as operational and safety issues;
- health physicists and emergency modellers; and
- emergency planners from the participating authorities, as appropriate.

This team must involve people from all functional areas being exercised. Proper coordination of input and knowledge of plans and procedures will be key in ensuring that the exercise remains realistic.

It is essential for one person to be given overall responsibility for the preparation and organization of the exercise scenario. This person must have a thorough knowledge of the nuclear or radiological practice, and be familiar with the site of the exercise and its surroundings. Representatives from other groups may, and should, help by providing inputs for their respective parts of the scenario, but the responsible person must coordinate and consolidate all inputs to ensure that there are no conflicts and that the exercise objectives can be met.

The scenario development team is responsible for the development and validation of the exercise scenario and exercise data in accordance with the exercise specifications. Those specifications are described in detail in Section 4. Scenario and exercise data development are dealt with in Sections 5 and 6.

Logistics

The logistics function can be carried out by a team or assigned to an individual member of the exercise management committee or support staff, depending on the scope of the exercise. Logistical preparations include:

- making hotel reservations or other accommodations;
- reserving conference room workspace, which is required for the entire exercise control and evaluation team the day before the exercise, and for the evaluators following the exercise;
- obtaining supplies (do not expect that controllers and evaluators will bring their own supplies);
- arranging proper transportation;
- organising communications for the controllers and evaluators;
- obtaining safety equipment;
- identifying badges; and
- producing and distributing copies of the scenario, guides for controllers and evaluators, and guides for players.

Transportation to and from the site must be addressed. This is particularly important for exercise team members who must travel with the players. For example, it could be rather problematic if the controller who is supposed to provide input to the players is not able to accompany them in the survey vehicle.

Avoid communications systems with blind spots, insufficient range or radio channels used by players or other emergency services. The list of phone numbers and radio frequencies to be used by controllers must be available and distributed in advance. All numbers and frequencies should be tested one day prior to the exercise.

It is necessary to determine ahead of time those who will need special protective equipment to gain access to areas where safety requirements are in place. For example, controllers who must follow the emergency response team in the facility will need dosimeters.

All controllers and evaluators must wear some sort of identification. This could be an armband, a badge or a distinctive hat.

It is important that spare copies of the exercise instructions be brought to the briefing the day before the exercise.

3.2.2. Public affairs

The public affairs team is responsible for:

- formulating the strategy for dealing with the real media leading to and during the exercise;
- assisting the exercise director in his/her duties as official spokesperson; and
- leading the preparation of a media simulation cell for the exercise, if it is required in accordance with the exercise objectives.

3.2.3. Development actions group

In some countries, there are major initiatives under way to improve nuclear and conventional emergency preparedness at the national level. Often, these programmes benefit from international assistance. The improvement programmes are subject to schedules and constraints that involve several organizations and agencies. It is important to ensure that the programme schedules, objectives and tasks are well coordinated with any planned major nuclear emergency response exercise. This coordination is the responsibility of the development action group, established for the exercise. This group is responsible for maintaining liaison with the national organizations and individuals in charge of the other major programmes.

3.2.4. International liaison team

The international liaison team is responsible for:

- maintaining liaison with other participating countries and international organizations;
- developing agreements on the international objectives and exercise specifications with other participating countries and international organizations; and
- ensuring that the national scenario and the international objectives and specifications are consistent.

4. DEVELOPING THE EXERCISE SPECIFICATIONS

This section describes what should be in the "exercise specifications" portion of the exercise manual.

The exercise specifications consist of the objectives, scope and constraints related to the exercise. Determining the exercise specifications is the first step of the exercise preparation process. No other work should proceed until the exercise management committee has agreed upon these specifications.

4.1. EXERCISE OBJECTIVES

Exercise objectives are based on the *response* objectives relevant to the plans being exercised. A *response* objective is defined as the result that must be achieved when performing an action, i.e. *what is the action trying to accomplish* [4, 5].

The most recent IAEA guidance for emergency response objectives is EPR-Method [2]. This document provides checklists of emergency preparedness elements and emergency response functions that cover nuclear as well as radiological emergencies (threat categories I to V). Each emergency response function is defined in terms of a main response objective and, where appropriate, by a performance objective. These suggested performance objectives are intended as guidelines and must be adapted to local conditions.

Examples from EPR-Method [2]

Under the functional element of Identifying, Notifying and Activating for threat category I facilities, one of the response objective is "to ensure that operators promptly determine the appropriate emergency class or the level of the response, initiate on-site actions, and notify and provide updated information to the off-site notification point", and the suggested response time objectives at the facility level are to classify the emergency in less than 15 minutes, to notify local (PAZ and UPZ) authorities after classification within 30 minutes, and to fully activate emergency organization within 2 hours (Appendix X [2]).

Response objectives must be clearly defined as part of an adequate emergency preparedness programme.

Exercise objectives are defined as a subset of *response* objectives that will be tested during the exercise. For practical reasons, a single exercise does not test ALL response objectives. Therefore, it is necessary to choose which response objectives will be tested. Over an exercise cycle, the aim would be to test all response objectives.

Furthermore, for practical reasons, it is not always possible to test the complete response objective during an exercise. The most obvious example is evacuation. If the response objective for evacuation affects, say, 10,000 people, it would be difficult in reality to exercise the full evacuation of that entire group. On the other hand, it may be possible to evacuate a smaller sample in a shorter time to verify if the procedures for doing so are adequate. This would provide an indication, and only an indication, that the actual response objective can be met with the arrangements in place. In this case, the exercise objective would be a modified or scaled down version of the response objective. Examples of exercise objectives are included in Appendix II.

There is often a tendency to go overboard in exercises and test as many objectives as possible. This is not recommended. It is preferable to focus on a few key objectives, and on those which have been weak in the past. This ensures that the lessons identified are manageable and lead to concrete changes.

- Select compatible objectives: Do not attempt to conduct an exercise at night to test recall and test the evacuation of daytime employees, concurrently.
- Avoid being overly ambitious: Select a reasonable core set of objectives.
- Avoid doing everything all at once: When organizations fall behind, they try to catch up by including as many objectives as possible in one massive exercise. Pick a few different ones at each annual exercise and ensure coverage over a reasonable cycle (e.g. five years).

4.2. EXERCISE SCOPE

The exercise scope should be determined before any real work on the exercise scenario begins.

The scope of the exercise includes:

- selecting the organizations that will participate and the extent of their participation;
- deciding on the time and duration of the exercise; and
- determining the extent of the actions that will be carried out during the exercise.

The extent of participation by organizations, teams or individual specialists depends on the objectives of the exercise. In the case of partial exercises, the presence of some organizations may not be essential and others need only be observers. A particular organization that does not play an active role can be requested to evaluate the ability of the participating organization(s). As a benefit, the observers of the non-participating organizations can obtain a thorough understanding of the tasks and working conditions of the acting organization.

When involving government organizations such as national departments or ministries, a considerable amount of lead-time to prepare may be required. In practice, this may limit participation.

Each participating organization, especially large ones, must clearly identify which internal sections, departments or individuals will participate in the exercise, and to what extent, or subject to what restrictions. These must be consistent with the exercise objectives.

Decisions related to the selection of players may include the following considerations:

- should the first assigned person participate or should alternates participate?
- over time will everyone have a chance to participate?
- will there be enough qualified non-players to control and evaluate the exercise?

In choosing organizations and individuals, their availability should be taken into account, e.g. do normal duties, major events (e.g. plant shutdown, major political activities) or other major exercises prevent them from participating in the exercise? Although a particular exercise may be important, the priorities of participating organizations may conflict with those of the host organization.

Another important aspect to keep in mind is the size and location of the selected exercise sites. Consider the availability of locations and the practicality of involving them in a major exercise.

4.3. EXERCISE CONSTRAINTS

Exercise objectives are often subject to constraints imposed by practical considerations. For example, it may not always be possible to start the exercise in the middle of the night, even though this would allow a useful test of the functions at a time when people are least available. Financial resources may also be limited and prevent the conduct of an exercise lasting more than one day. There may also be other priorities, political or other, that restrict the time available for the exercise, or that limit the participation of important organizations. Constraints should be identified early in the process to avoid wasting efforts in designing an exercise that cannot be implemented.

5. DEVELOPING THE EXERCISE SCENARIO

This section describes what should be in the "scenario" portion of the exercise manual.

5.1. INTRODUCTION

5.1.1. Getting started

Start by defining a broad scenario outline that reflects and supports the various objectives of the emergency exercise. Examples of general scenarios are presented in Appendixes IV to IX (for threat categories I to V).

Depending on the exercise scope, the scenario may need to be divided into several parts, each being developed by a dedicated team or sub-team. For example, in the case of a nuclear power plant exercise, the scenario should at least include two major parts:

- the on-site scenario; and
- the off-site scenario.

In this example, the on-site scenario would contain all the information required by the on-site team to carry out its response. It would be driven by the plant conditions, on-site radiological data, and any other conventional input required to add substance and realism to the exercise (e.g. corporate management involvement, injuries, etc.) The off-site scenario would contain the information related to the off-site context, situation and response. This part of the exercise would be driven by the off-site radiological data, the weather data and any other societal and conventional input required to provide a realistic response environment (e.g. media enquiries, political pressures, public reactions).

To the extent possible, the scenario should exercise the judgement, knowledge and training of the emergency response staff under simulated emergency conditions. Those in charge of developing the scenario can best accomplish their objectives by ensuring that the simulated emergency provides the same type, form and sequence of information as would actually be available during an emergency.

Consult with other members of the scenario development team. Ensure that the scenario outline is reasonable, realistic and that it will allow all exercise objectives to be tested within the existing constraints. Once a firm scenario outline has been agreed upon, you are ready to fully develop and document the scenario.

5.1.2. Components of an exercise scenario

A general outline of the scenario should include:

- start state;
- key events and critical timeline;
- technical scenario;
- detailed sequence of events;
- narrative;
- master events list; and
- exercise inputs and data.

These elements are discussed in more detail below, with the exception of exercise inputs and data, which are dealt with in Section 6.

5.1.3. Challenging the players

The simulated emergency description should also include non-essential inputs that challenge the players. For example, this could include one or more of the following:

- large amounts of non-essential data that would force the player to identify the most significant parameters;
- harsh working conditions;
- harsh weather;
- political pressures;
- media pressure;
- etc.

5.2. START STATE

The start state describes the initial conditions as well as the context for the exercise and should reflect realistic conditions. The amount of details provided should be limited to those that are actually necessary for conducting the remainder of the scenario.

The start state should include (but is not necessarily limited to) the following topics:

- the facility's status (e.g. full power, maintenance schedule, etc.)
- the facility's history
- the condition of the facility
- the staffing arrangements
- the status of equipment
- the road conditions
- the weather conditions
- the socio-political situation.

5.3. SCENARIO

5.3.1. General description

The general description of the scenario is a quick overview that is often provided in narrative form to describe the events involved in the scenario. It is a "story" that contains all the main events that will drive the exercise. This description of the scenario is provided mainly for the exercise personnel and organizers who may not have the technical need, background or knowledge to understand the more technical scenario (see below).

5.3.2. Technical description

This is the technical description of the scenario, which gives details as to the failures, accidents or events that lead to the emergency. This includes, for example:

- the initiating event (e.g. pipe failure, road accident, fire, etc.)
- facility conditions that lead to the accident
- successive component failures.

The technical scenario also describes the plant or facility behaviour during the course of the emergency. This is the most difficult part to formulate, especially if the facility operators are participating in the exercise, as their exact response is not predictable. This is why the key events and critical timeline are so important.

The technical scenario is developed around the critical events. There will be some iterations before the technical scenario and the key events converge. In general, the technical scenario will rely on events that are very improbable. This is acceptable given the fact that the emergency response plan is often aimed at dealing with very improbable events. However, higher probability of occurrence events should also be considered in the exercise programme.

Reference [6] provides examples of technical scenarios that can be used for exercises.

5.4. EXERCISE EVENTS SEQUENCE

5.4.1. Key events and critical timeline

Key events are those that must take place in order for all exercise objectives to be met. The critical timeline is the time at which key events must occur in order to allow the participating organizations to take appropriate actions.

Example 1

If the evacuation of a representative part of the population is planned and the duration of the exercise is restricted to one day, the release or other conditions that would normally lead to the evacuation must occur early enough in the day to allow the natural decision-making process, preparation, resource mobilisation and action to take place. In this example, a release occurring at 1600 h would probably not provide sufficient time for the evacuation to take place.

Example 2

An exercise is planned to test the response of the ambulance services before normal working hours. The simulated casualty comes as a result of an attempt by the facility operators to correct a component failure that ultimately leads to a release. In this case, the component failure and the operator action must happen before the normal business day begins.

Example 3

The simulated accident must lead to contamination, but it is possible that operator actions may prevent this through either foresight on their part or "pure luck". In this case, the key events must make provisions for controllers to intervene and to disallow the operator action. The exercise controllers during the exercise must correct any deviation from critical timelines.

5.4.2. Master events list

The master events list (MEL) is a time-ordered list of the major exercise events. It is a tool designed for the lead controller. The MEL controls the pace of the exercise. A sample MEL can be found in Appendix X. A MEL is often developed in table format and should contain the following information:

- input sequential number;
- time at which the input is to be provided;
- the message, data or action that is to be delivered;
- comments, if needed.

5.5. VALIDATING THE SCENARIO AND EVENT SEQUENCES

Before a scenario is finalised, it must be validated. Scenario validation requires the help of specialists and experts in order to verify and approve the accomplished work. Training staff are also extremely valuable in this respect. The engineering and safety analysis staff can be useful as long as they understand the requirements and methodology of an emergency response exercise and recognise the need for conducting one.

When presenting the scenario for validation, the methodology must first be explained, starting with the exercise type and objectives. Discussions concerning the safety of the scenario should involve specialists. Compromising elements should be identified and removed. If at all possible, a scenario practice run should be executed (for example using a simulator when available).

In validating the scenario, information should not be shared with the players.

6. DEVELOPING THE EXERCISE DATA

This section describes what should be in the "exercise data" portion of the exercise manual.

6.1. GENERAL CONSIDERATIONS

6.1.1. What are exercise data?

Exercise data should be no different from real data except for the fact that they are simulated. They provide the information that is used to assess the severity or impact of an emergency and determine the response actions that must follow in order to mitigate the situation. There are various ways of providing exercise data. The simple principle is to adopt a method that will most resemble reality.

The data types needed are presented in:

- messages;
- tables;
- graphs;
- figures or pictures; and
- maps.

Several types of data are commonly used during the course of an exercise. They can be divided into three categories:

- radiological data;
- meteorological data; and
- other data.

The data that will have to be part of the exercise manual includes all data that:

- would normally be available to the exercise players during a real emergency;
- are essential for the exercise objectives to be met;
- are important for the exercise realism to be maintained; and
- would not be available during the exercise due to the simulated nature of the event.

6.2. RADIOLOGICAL DATA

Depending on the scope of an exercise, a large quantity of radiological data may be required. All types will not necessarily be applicable to each exercise. A decision will need to be made in terms of which data will be required to exercise all functions associated with the exercise objectives.

The type of data that is used will also depend on the threat category (I to V) being exercised. Table 2 illustrates the type of data that is involved in the exercise of each threat category.

TABLE 2. TYPE OF DATA THAT IS INVOLVED IN THE EXERCISE OF EACH THREAT CATEGORY

Data type	**Threat Categories**				
	I	**II**	**III**	**IV**	**V**
Plant data (process and safety parameters)	✓	✓	✓		
Dose rates in the facility	✓	✓	✓		
Surface contamination in the facility	✓	✓	✓		
Air concentration in the facility	✓	✓	✓		
Plume data	✓	✓	✓	✓	✓
Large-scale off-site surface contamination	✓	✓			✓
Local off-site surface contamination	✓	✓		✓	
External dose rate from a source			✓	✓	
Contamination of people	✓	✓	✓	✓	
Doses to emergency personnel	✓	✓	✓	✓	

6.2.1. Plant data

Plant data refers to the simulated process and safety parameters. This also includes any fixed radiation monitor and radiation alarm. It is mainly applicable to nuclear power plants or other facilities that involve a *process*. It does not usually apply to facilities such as storage depots, medical laboratories and industrial gamma radiography facilities.

In an on-site or combined on-site/off-site exercise, the plant conditions drive the scenario. To arrive at a realistic exercise, simulated plant data must be available for all critical process and safety system parameters. This is a challenging task due to the number and complexity of the data.

There are two ways of simulating plant data:

- using charts, tables and messages that replace the actual readings obtained from the control room panels; and
- using a simulator (see Section 2.4.3).

In the first case, it is necessary to use basic safety analysis techniques to duplicate the readings that the facility operators or the responders would normally have during the emergency. This requires a lot of work and the input of people with experience in facility operations. All relevant facility data must be introduced at various times. Operator and response personnel actions must be anticipated. In some cases, several options may need to be available to account for possible player actions.

Appendix XI includes examples of simulated plant data.

6.2.2. Dose rates in the facility or at the accident site

Dose rates in the facility or at the accident site include external dose rates from airborne and surface contamination throughout the facility or over the entire affected area. For example, following a release of fission products in the containment of a nuclear reactor, the rooms adjacent to the containment will have high radiation fields. Areas close to the coolant recirculation system components will also be affected. Rooms where exhaust dampers are located will have high radiation fields if there is a release through the stack. Airlocks will also be affected, etc.

In simulated emergencies involving a category III facility, high dose rates may result from the spill of contamination, or unshielded sources, etc.

It is important to determine what the radiation fields in all areas of the facility would be as a function of time so that the exercise contains some degree of realism for the emergency response teams that must circulate throughout the facility.

Dose rates can be obtained from a simple model of the facility or of the accident site. Dose rates from surface contamination can be calculated using surface to ambient dose rate conversion factors. Dose rates from airborne concentration can be estimated using volumetric activity to ambient external dose rate conversion factors. Dose rates for unshielded sources can be calculated using simple point source models and by taking into account the shielding between the source and the receptor.

Appendix XII includes an example of how environmental data can be presented.

6.2.3. Surface contamination in the facility

In cases involving the spread of contamination in the facility, it is necessary to simulate where the contamination may be, and what measurements may be obtained. Two types of measurements are required to be simulated: ambient dose rate (at 1 m or 50 cm or 2 cm, depending on the measurement procedures at the facility), and contamination monitor readings.

The first type can be generated using the same approach as that discussed in the preceding section. The second type can be estimated based on the assumed quantity spilled and on the area contaminated. It is also important to remember to take into account the sensitivity of the instruments used and the geometry of the measurement procedure.

6.2.4. Concentration in the facility air

In exercises involving dispersion of radioactive material through the air space within a facility, e.g. following a fire in a category III facility, it will be necessary to determine what would be the airborne concentration of radioisotope as a function of time. This can be estimated based on the volume of the facility and the assumed release fraction from the sources in a fire.

Airborne concentrations can then be used to generate simulated ambient radiation dose rate readings and air sampling measurements. The simulated readings will have to take into account the type of instruments used and the sampling procedure in effect (e.g. sampling rate and duration, measurement in a shielded enclosure or not, etc.).

6.2.5. Plume and exposure rate data

Data include, as appropriate:

- dose rates from immersion in a radioactive plume,
- dose rate from a source (category IV) or criticality (category II or III), and
- concentrations, either gross gamma or beta, in air or isotopic data depending on the procedures used by the survey team.

Data is required for any simulated emergency that leads to an environmental release or exposure off-site. This includes category I and II facilities, as well as category IV in some cases where the material in the source is dispersed (e.g., fire or human action) or shielding is lost. For category III the off-site data should confirm that no off-site actions are needed. Data are also required for category V emergencies, although in this case the levels would be consistent with that seen at few hundreds or more kilometres from Chernobyl NPP.

The calculation of plume data requires assumptions regarding the source term, which can be estimated from safety analyses or from generic release fraction data for sources involved in a fire. Doses from this source term can be calculated using dispersion and dose projection computer codes such as InterRAS and COSYMA (as well as many others). The average dose rate can be estimated based on the total dose estimate and the assumed release duration. It is also possible to use a time-dependent source term to vary the dose rates as a function of time.

If the software used can generate results based on time-dependent source terms, all the better. Otherwise, separate calculations can be made for each time interval and integrated. The challenge is to generate realistic readings from the various components: plume shine, immersion, and ground shine.

For plume shine, in practice, it can be assumed that the dose rate is constant over the time interval considered. The dose obtained can be divided by the release duration over the time interval considered. It is important to remember what the instrument measures; i.e. if it is ambient dose rate, the dose used should be the external dose, not the effective dose. Keep in mind that cloud shine disappears when the plume has passed, and that ground shine then decays.

Air sampling data can be generated using the same dose projection software, which normally provides instantaneous time integrated isotope concentrations. In the event that only the time integrated concentration is available, the instantaneous concentration can be obtained by dividing that value by the time interval. The data must then be adjusted to take into account sampling time and detector configuration according to applicable procedures.

When a roaming team uses the sampling equipment, the activity captured on the filters during the sampling time must be calculated. When the sampling equipment is fixed and is in the path of the plume, the total activity collected must be calculated.

To keep the data as realistic as possible, it is important that an element of randomness be introduced to reflect uncertainties in the readings. The data must also take into account plume travel time, calculated from the simulated wind speed.

Exercise data, i.e. simulated dose rates, doses and airborne concentrations can be presented in table or graphical format. Appendix XIII shows some examples of simulated plume data formats.

6.2.6. Large-scale off-site surface contamination

Simulated large-scale surface contamination data refers to the surface contamination that would result from a large release of radioactive material in the environment. It is normally calculated from plume data, based on the deposition velocity of the various isotopes. For most exercises, only the gross gamma-beta dose rates measured close to the ground will be needed. In cases involving the dispersion of an alpha emitter such as plutonium, alpha contamination readings will be needed.

Once again, it is important to take into account the type of instrument used and the geometry of the measurement as described in the procedures. Nuclide-specific data may be needed if the survey teams carry out this type of measurements.

In longer span exercises, simulated sample contamination may also need to be developed. This can be calculated by computer codes that simulate dispersion. It is important that these data be consistent with the other radiological release data.

There are two basic methods of providing simulated large-scale surface contamination data. The simpler method involves the use of pre-calculated values of contamination density or the activity of samples. The second method involves the use of actual radioactive material (usually a short-lived activation product) which may be used to 'spike' an appropriate environmental medium to appropriate levels. Depending on the objectives of the exercise, either method, or a combination of the two, may be used. Refer to Appendix XIV for details on these two methods.

6.2.7. Local off-site contamination data

Local contamination data includes surface contamination readings and ambient dose rates at 1°m and close to the ground. These data are required for all exercises that involve the spread of contamination by people and vehicles. This includes, for example, contamination at the scene of transportation emergencies and contamination at relocation/reception centres for category I and II facilities.

Use of phosphorescent powder to simulate contamination could allow tracking the spread of contamination and efficiency of actions taken by the exercise participants.

When the contamination is due to a source, contamination levels can be simulated based on the source activity, the assumed release fraction and the area that is contaminated. This requires judgment on the part of the exercise designer to simulate the surface area contaminated, which will vary with time.

When contamination results from the spread of contaminants from an affected area into another previously uncontaminated area, the simulated levels of contamination will be based on the amount of contamination present in the affected area and on the amount of traffic in and out of that area. Again, a deal of engineering judgement is needed, however accuracy is not important in the context of the exercise. It is generally sufficient to provide representative and consistent simulated levels to test the ability of the responders to deal with the contamination.

6.2.8. External dose rate from a source

When the exercise involves an unshielded source, simulated dose rate data need to be provided. These can be calculated using simple point source models and allowing for the shielding between the source and the area where the dose rate is expected to be measured.

Dose rates in all areas where responders may go is needed.

6.2.9. Data for the contamination of people and vehicles

Contamination data for people and vehicles are less precise. They depend on the location of the vehicle and the people at the time of the initial dispersion, and on their egress route. Levels are usually selected to meet the exercise objectives. As a result, they are essentially arbitrary, however they must be consistent.

6.2.10. Doses to emergency personnel

Dose control procedures, if they are exercised, call for emergency personnel to monitor their dose periodically. Therefore, simulated dose data may be required.

Dose data should fit the exercise objectives. For example, if it is desired to test shift replacement due to high dose, a key event should be inserted to signal to the players that someone's dose is approaching the turn-back limit.

It is extremely difficult to simulate dose data because it is not known at the time the exercise is designed where exactly the emergency workers will choose to spend their time. Personnel movements will greatly affect the dose they are supposed to receive. Hence, providing dose data during an exercise requires quick thinking and improvisation on the part of the controllers. Accuracy is not so important as consistency and realism. For example, if an emergency worker verifies his/her dose several times during the exercise, the simulated reading provided by the controller must reflect the dose rate in the areas visited and the time spent in each area. The dose also increases with time. Hence, controllers need to keep track of the simulated dose readings they provide from time to time to ensure that the next reading is realistic.

6.2.11. Limitations

All the tools used for calculating radiological data have limitations. They are based on idealised models and do not necessarily reflect reality. That is why an element of randomness is often introduced. On the other hand, accuracy is less important than consistency.

Similarly, tools used to display data for the controllers also have their limitation. That is why training is particularly important for field survey controllers. They have to be able to rapidly manipulate considerable amounts of complex data, interpolate and interpret them where necessary.

6.2.12. Advanced simulation tools for field data

There are several tools that facilitate the development of simulated data for nuclear/radiological emergency exercise scenarios and the conduct of such exercises. These tools are commercially available and have demonstrated reliability and versatility. Table 3 provides examples of the types of tools available to simulate field data during an exercise.

TABLE 3. ADVANCED SIMULATION TOOLS FOR FIELD MEASUREMENTS

Tool	How it works	Applicability
Probes with remote-radio controller	Reading varied depending on signal sent by a controller using a radio-transmitter.	Source detection exercises; simulation of readings in contaminated environment.
Probes with ultrasound detector	Reading varies based on proximity to a simulated source that emits a signal.	Source detection exercises.
Hand-held computer with GPS	Reading varies as function of time and location based on internal clock, GPS location and pre-programmed accident scenario. Dose integrated over time based on surveyor position.	Field measurements following simulated atmospheric release and/or ground contamination; simulated dose measurement.
Laptops with geo-referenced maps	Reading varies as function of time and pointer location on map based on scenario time and pre-programmed accident scenario.	Decision-making and coordination tabletop exercises; real-time simulation of monitoring stations.

These tools are not essential but they bring a considerable degree of realism to an exercise and reduce the preparation time and the workload of controllers during the exercise.

6.3. METEOROLOGICAL DATA

Weather conditions can be problematic. In most cases, it is easiest to use pre-calculated simulated, or so-called “canned” weather conditions. However, in some cases, using real time weather data offers real advantages. For example, in the INEX-2 NPP exercise series [7], real weather data were used to test the real time interface between countries and the role that regional specialised meteorological centres play in the exchange of information and decision-making. However using real weather data means that simulated data maps for radiological readings must also be created real time.

The exercise scenario of a partial or integrated exercise involving off-site players will normally include a specification of the meteorological conditions. One method is for the scenario to state that actual meteorological conditions prevailing at the time should be used throughout the course of the exercise. This approach enables data analysis personnel to consult weather forecasting organizations and to use this information in conjunction with raw or analysed scenario data on the release of radioactive materials to predict the likely development over time of off-site radiological conditions.

However, there are at least two serious difficulties involved in using actual meteorological conditions:

- The meteorological conditions at the time of the exercise may be such that the off-site players might not be adequately exercised and the objectives of the exercise not met. For example, the actual wind direction may be toward the sea, which may preclude the need for protective measures in the urgent protective action zone.
- The scenario writers, not knowing what the meteorological conditions would be at the time of the exercise, are unable to prepare beforehand a self-consistent set of radiological readings for input by controllers. One possible solution is to generate the radiological readings at the time of the exercise and to adjust them if meteorological conditions change. In practice, it is presently very difficult to coordinate this task with the exercise.

6.4. OTHER DATA

Other data may also be required, to describe, for example:

- road conditions;
- population management;
- demographics;
- topography;
- medical conditions;
- interactions from the media and other simulated organizations;
- response from other organizations;
- response by the public;
- response of international organizations;
- etc.

These data may need to be highly flexible to account for the specific response during the exercise.

There are several types of delivery methods for such data, one of which is through a pre-set message that is delivered by phone, fax, communiqués or other communications mode. The message should state:

- the originator;
- the person receiving the message;
- the delivery method;
- the time of delivery; and
- the message content.

7. DEVELOPING THE GUIDE FOR CONTROLLERS AND EVALUATORS

This section describes what should be in the "controller and evaluator guide" portion of the exercise manual. References [8, 9, 10, 11] contain examples of exercise guides for controllers and evaluators. Some of the information contained in this section is based on these references.

7.1. GENERAL INFORMATION

7.1.1. Exercise control and evaluation organization

The exercise control and evaluation team is responsible for the conduct and evaluation of the exercise. It is important that controllers and evaluators be appropriately selected and that they be familiar with their role and the steps involved in conducting an exercise.

Controllers and evaluators should ideally not be the same individuals. Exercise control is a full time job, as is exercise evaluation. However, in some cases, due to staff restrictions or physical constraints (e.g. space limited to one extra passenger in a survey vehicle), a controller may also be an evaluator.

A typical organization of exercise control and evaluation team is shown in Figure 2.

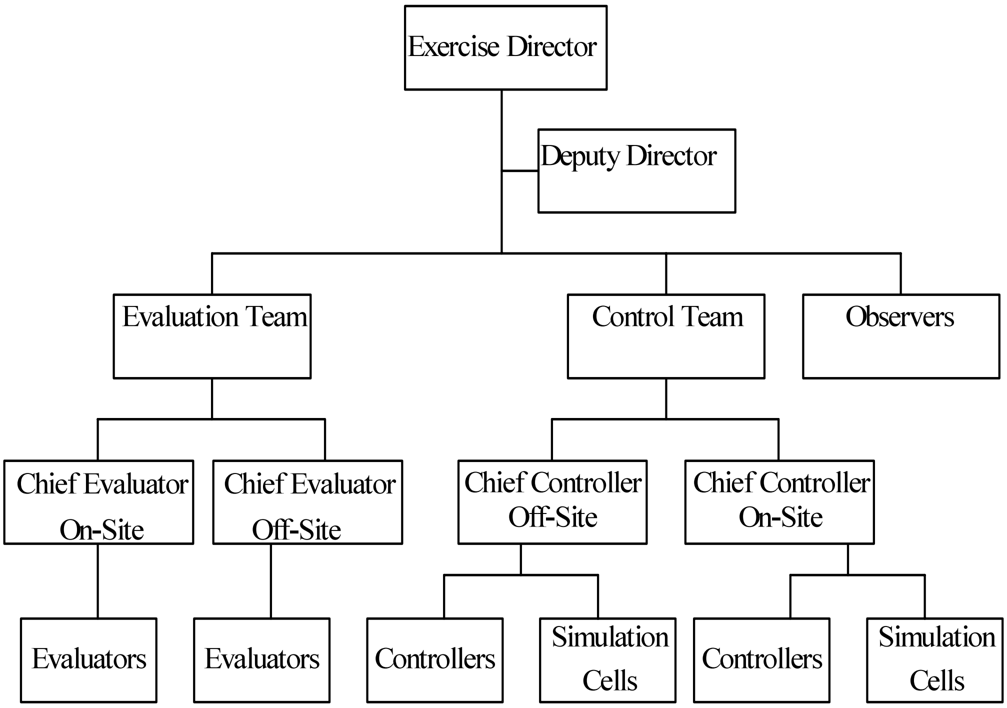


FIG. 2. Typical exercise control and evaluation team.

Exercise director

The exercise director is responsible for the overall exercise, its preparation, conduct and evaluation.

Deputy director

The deputy director assists the exercise director and assumes the role of director in the director's absence.

Lead controllers

The on-site and off-site lead controllers are responsible for the conduct of the on-site and off-site portions of the exercise, respectively.

Lead evaluators

The on-site and off-site lead evaluators are responsible for coordinating the evaluation of their respective portion of the exercise.

Observers

Most exercises attract observers, VIPs and others. Observers should not be allowed to disrupt the exercise or to interact with the players. Make arrangements early on to deal with observers in a controlled manner. Split the groups into smaller manageable groups. Make arrangements for their transportation and visits of emergency locations. Do not generally allow observers to roam freely. Players can ask observers to leave if they are disrupting their team. Interest group representatives can make good observers. Observer should be briefed about their expected conduct before the visits to exercise location.

7.1.2. Schedule

The exercise instructions should include a schedule detailing timings for:

- startex (start of the exercise);
- endex (end of the exercise);
- in-briefings (briefing before the exercise);
- debriefings (briefing after the exercise); and
- any other essential timings.

7.1.3. Locations

The guide must give the specific locations where exercise activities are to be held. These can be provided on maps or in textual format.

7.1.4. Logistics

Logistics arrangements to be described in the exercise manual include:

- hotel reservations or other accommodations;
- meeting locations and times;
- office supplies;
- transportation before and during the exercise;
- communications for the controllers and evaluators;
- safety equipment;
- identifying badges; and
- copies of the scenario, guides for controllers and evaluators, and guides for players.

Any other special supplies that might be needed will be stated in the manual.

7.1.5. Communications

Communications methods and protocol that will be observed during the exercise need to be included within the manual. This includes a contact list for the exercise staff and a list of contact numbers for simulated organizations. This section would also describe the communications rules, including the need to precede any discussion over communications networks with “FOR EXERCISE” or an equivalent statement.

7.1.6. Safety

All safety legislation and procedures remain in effect during emergency exercises. The stress of emergency exercises tends to cause people to focus on their emergency tasks to the extent that they may neglect to follow all standard safety precautions. The exercise manual must emphasise that evaluators and controllers are responsible for monitoring exercise play to ensure a safe environment. Therefore, clear arrangements on how to stop exercise for safety reasons should be established and reflected in the exercise manual.

7.2. GUIDE FOR CONTROLLERS

7.2.1. Roles and responsibilities

The role of the controller is to:

- direct the exercise by providing exercise inputs to the players; and
- keep the scenario on track by ensuring that the actions of the players do not jeopardise the rest of the scenario.

Controllers must ensure they are thoroughly familiar with the overall exercise scenario and evaluation objectives, and their particular roles and responsibilities. Prior to or during the exercise, controllers should not hesitate to discuss matters of concern with the lead controller to obtain guidance or clarification.

7.2.2. Simulation cells

General

Some organizations may not be participating, but may need to be contacted by the players for the purpose of obtaining information. These organizations must therefore be simulated. The most effective way of accomplishing this is to provide one or several simulation cells (e.g. media, government, public simulation cells), equipped with phones, faxes and e-mail as required. There may be a need for several simulation cells if the exercise spans over several geographic areas. Simulator cell staff will have to be thoroughly familiar with the organizations they are simulating.

It will be necessary to provide the players with special phone numbers or with contact information for all simulated organizations. This information will most likely be different from the one included in the normal procedures. Obviously, the fewer organizations simulated, the more realistic the scenario.

When simulation cells are established, their telephone numbers and contact information must be listed and provided to the players before the exercise commences.

Simulated media

Simulated media input can add realism to an exercise. Indeed, interacting effectively with the media is a major challenge for most emergency situations. The coordination of information provided to the media by the various response organizations, the need to monitor the media to detect false information or rumours and to correct them, are key elements of the response system that should be exercised often.

It is not simple to simulate the media in a realistic manner. There are challenges in terms of logistics, personnel selection and distribution of the simulated media information in real time. The following measures may help achieve a realistic media simulation:

- The simulated media personnel can be real media people who agree to cooperate with the exercise organization. They could also be journalism students who have some experience in real media.
- The simulated media personnel should ideally not be technical or operational staff who have intimate knowledge of the emergency plans and who have no media experience.
- A separate simulation cell should be established for the simulated media personnel. In some cases, several cells may need to be established at various locations. They should be linked through proper communications systems.
- The simulated media should be given as much freedom as possible in carrying out their function. Their script should be limited to key events and inputs.
- The simulated media should not know the scenario in detail.
- Information distribution, e.g. simulated media reports, can be broadcast through closed circuit televisions or radios.
- Written media products can be distributed by fax.
- The simulated media should be instructed not to "overplay". Overplay is when the controllers put undue and unrealistic pressure on the players because "it is just an exercise".

7.2.3. Controller instructions

These instructions provide guidance to controllers prior to, during and following the exercise and should be included in the exercise instructions for controllers. It is the responsibility of the controllers to ensure that working locations are kept, and left, in a safe state. A sample guide for controllers appears in Appendix I.

7.2.4. How to start the exercise

There are several ways of starting an exercise. The simplest of these ways is to present yourself on location and phone in or send the initial message that will trigger the start of the exercise. There is no need for an elaborate ceremony. If a simulator is used, the simulator programmer will initiate the exercise by triggering the right event. It is best to let the players do their normal work for a while before starting. It is preferable not to start as soon as the players are in place, but rather to allow them some time to adjust to their surroundings.

The key to a successful exercise is skilful coordination between the controllers. The lead controller is responsible for making this happen.

7.2.5. How to deliver the exercise inputs

Supplying data during an exercise is an art. It is good to minimise the interaction between controllers and players. Data should be supplied in as subtle a way as possible. If a message would normally be transmitted by phone, then try to use an actual phone during the exercise. If data would be displayed on a panel, try writing the appropriate value on the dial. Do not engage in a long discussion with the player to explain the data. Provide clarification only if required. Do not provide data for meters or instruments that are turned off.

7.2.6. What to do when the exercise gets off-track

Occasionally, exercises will get off-track. Consider for instance the players outsmarting the controllers and scenario development team by finding an unexpected solution to a problem. This will have the potential of disrupting all events downstream and may require controller intervention. If this becomes the case, controllers will have to recognise the players' achievements and explain to them why, for exercise purposes, they will be assumed to have failed. Another way of tackling this is to have the controller inject an additional event in order to get the scenario back on track (although this is not the most desirable solution). In any event, the lead controller is the only one who has the authority to permit deviations from the script.

If the exercise appears to be off-track, a controller should immediately inform the lead controller. The lead controller will then adjust the timeline or event as required and inform all affected controllers, all the while keeping exercise objectives in mind.

7.2.7. How to end the exercise

The exercise ends upon instruction from the exercise director. Normally, this occurs at the end of the scenario or when all exercise objectives have been met. The groups will not necessarily end their portion of the exercise all at once. For example, it is possible to end an on-site component of the exercise and let the off-site authorities continue to deal with off-site issues.

Players and remote organizations must be clearly informed of the termination of the exercise. There have been exercises in the past where organizations were not properly notified and they continued to play several hours after all others had quit.

Controllers are not officially part of the evaluation team, however, they may have valuable input to contribute towards the evaluation process.

7.3. GUIDE FOR EVALUATORS

Most organizations understand that evaluations are an essential part of emergency preparedness. However, evaluations are not always well understood or conducted. Without a proper understanding of evaluations, it is impossible to determine gaps or weaknesses in response capability. A poorly conducted evaluation could result in instilling a false sense of security as to the organization's state of preparedness.

The overriding principle for evaluating an exercise is that the performance of the entire organization and plan be measured as opposed to that of individuals. It is important to assess whether or not the organization is able to achieve the response objectives.

If weaknesses are not identified through exercises, the problems may surface during an actual emergency. Valuable time and resources will be wasted in trying to solve problems under the worst of conditions.

7.3.1. Roles and responsibilities

Evaluators are responsible for taking notes during the exercise and participating in the production of the final evaluation reports, as instructed by their respective lead evaluator.

The evaluation team is composed of a representative sample of personnel who possess the requisite knowledge and expertise in the area(s) to be evaluated. It is essential that the evaluation team have, as a minimum, an excellent understanding of the plan, the procedures and the distribution of responsibilities within the emergency organization. Evaluators other than the lead evaluator can lead a small team. For example, the lead evaluator may assign an evaluator to evaluate the reception centre response. The reception centre evaluator may then lead a team of evaluators who assess logistics, public affairs, social services and other reception centre functions.

It is important to choose the right evaluators for each function. An operator's team should be evaluated by someone with operating experience. Police teams should also be evaluated by people with relevant experience. This is sometimes difficult due to lack of resources. However, efforts should be made early in the exercise planning process to find suitable and credible evaluators.

During the exercise the role of the evaluator is to observe and record facts on the organization's emergency response actions. The record of actions is the key to a good evaluation. Good chronological notes must be taken, concentrating on aspects that are critical to the response.

It is only once the exercise has ended that evaluators actually begin to *evaluate*. This evaluation is based on the evaluators' consolidated notes. Performance should not be evaluated until all the pieces of the puzzle are put together. The reason for this is illustrated in the following example.

Example

During an exercise at a nuclear power station, the technical assessment group calculates a projected dose on the basis of a low release rate, whereas the evaluator knows that the release rate is high and the field data should confirm that. At the time, this appears to be a deficiency of the technical assessment group. However, when comparing notes with the evaluators for the field monitoring team and for the control room, the evaluation team realises that the control room had noticed the increased release rate but forgot to notify the technical assessment group, and that a communications breakdown in the field survey team introduced a 30 minute delay in the transmission of field data to the technical assessment group. Therefore, the identified weakness may not have originated at the technical assessment group, as initially thought.

7.3.2. Evaluators' instructions

These instructions provide guidance to evaluators prior to, during and following the exercise and should be included in the exercise instructions for evaluators. A sample guide for evaluators can be found in Appendix XIX.

7.3.3. Evaluation techniques

A good evaluation is normally made after the exercise, when all the observations from all evaluators are combined to form the complete picture. Therefore, during the exercise, it is important to objectively observe response actions and make detailed notes on the sequence of events that can later be analysed to identify response problems and their cause.

The exercise manual should provide evaluation techniques, which may have to be supplemented by evaluator training. These techniques would include, for example, the need to:

- record the time of arrival of players and observe their actions;
- identify players by name and function;
- record the actual time of major scenario events;
- observe how many times, and at what frequency players perform repetitive interventions (such as on-site surveys or reporting);
- listen and record commands, instructions, information and announcements given by one player to another and observe the actions that follow;
- listen to input delivered by controllers; and
- evaluate individual doses received by emergency workers.

The way an exercise is conducted by the controllers can affect the response by the players, either in a positive or a negative way. Evaluators should record observations regarding the effectiveness of the exercise play:

- Observe the manner in which data are provided to players: they should be given when the player demonstrates or simulates the normal method of obtaining the data and they should be given in the format and units the player would normally expect (i.e. players must earn the information, and units should be compatible with equipment used).
- Note if players simulate their actions, even when equipment and facilities allow the players to perform their actions. Ask the controller if there is a safety concern to justify simulated actions.
- Note how controllers intervene when players depart significantly from the scenario.
- Look for problems with exercise realism. Does it look like the scenario was compromised or was executed in a previous drill? Are reports neatly written, even though they should have been prepared in a rush? Is anyone anticipating events? Is there unusual equipment already in place, turned-on and ready to be used? Is anyone reading a script?

Evaluation checklists, i.e. forms with check boxes, can make the evaluator’s life a lot easier. However, they are not encouraged in isolation for the following reasons:

- they can bias the evaluation by directing the focus away from performance and onto procedures;
- they are not appropriate for evaluating decision making, judgement and common sense in a complex environment with multiple locations; and
- in most cases, they are very long and require the evaluator to shuffle through paper during the exercise, which can distract attention away from the action.

However, it may be useful for the evaluator to have a list of the critical timings and functional requirements that must be met by the team being evaluated.

Evaluators must know what is important to note during the exercise. Experience, competence and training must be sufficient to allow this.

Appendix XIX shows an example of evaluator notes taken during an exercise as well as a worksheet.

After the exercise, the evaluators need to collect and review all material that was produced by the players during the exercise, including log files, faxes, status boards, maps, etc.

There are other evaluation techniques available, such as video recording or voice recording of the response teams. The exercise director should choose the method that is best suited to the group being evaluated. In some cases, for example, video recording may not be allowed by an organization, or it may be too cumbersome because of the restricted space available at the emergency location, or there may not be sufficient staff to operate the necessary equipment at all the locations.

7.3.4. Players' feedback and debriefing

The participating group leaders usually conduct a player debriefing. The purpose of this debriefing is to obtain the players' impression of what went well and what did not. It also serves as a stress reliever. The exercise manual should contain instructions for evaluators regarding the set-up and conduct of those sessions.

Evaluators should encourage players to hold a debriefing. They should attend these debriefing sessions as observers only; this is a chance for them to see how consistent their evaluation is with that of the players. They must not discuss the evaluation. If asked, evaluators can say that "this has been a useful exercise and the evaluators will be meeting shortly to discuss the evaluation".

Another way to obtain feedback from the players is to prepare questionnaires structured along the list of exercise objectives. In some cases, it may also be useful to conduct post-exercise interviews with key players. For some types of exercises, such feedback can be useful for the evaluation. In other cases, for example if the exercise is fulfilling a regulatory requirement for a license, this may not be appropriate.

7.3.5. How to evaluate performance

A performance-based evaluation focuses on results, not process. It is based on response objectives and response time objectives (see Appendix X of [2] for details). It answers the question: was the response objective achieved and in what time it was achieved?

In this type of evaluation, performance is measured against exercise objectives. Whether an objective is achieved or not is based on criteria such as:

- key actions that should be completed;
- time within which an action should be completed;
- number of people that should be processed;
- results that must be calculated;
- sources that must be found;
- etc.

Performance requirements address the ability of the people and the infrastructure to perform actions. Performance requirements are generally satisfied when the actions taken are the right ones, are performed adequately, are performed within the required time, and lead to the desired results. Hence, in theory, whether or not procedures were followed does not matter, as long as the desired results are achieved. However, in practice, a proper evaluation must consider both the process and the results achieved because the result is not always easy to measure.

Example

In an exercise involving administering first aid to a contaminated casualty, the objective is to save the casualty while minimizing the radiological impact on the medical first aid personnel. However, results are difficult to achieve because, generally, the person simulating the casualty is not really *in danger, and the contamination is not real. Hence, in this case, the evaluation will have to focus on the process.*

Focusing on performance is a departure from other traditional approaches, which often focus on the ability to adequately follow procedures. This can be misleading because procedures cannot account for all situations, and may prove to be inadequate during an exercise or a real event. Although experienced evaluators can usually differentiate between the ability of exercise players to follow procedures and their ability to adequately perform the required function, observing that procedures are followed during an exercise may not be a sufficient nor consistent way of measuring performance.

The main advantage of a performance-based evaluation is that it concentrates on priorities: the significance of the observations is determined by their impact on specific goals that should be achieved. As a result, the evaluation is more credible, more thorough, more defensible and more useful. However, during an exercise, it is not always possible to measure the true result of emergency actions, because many of the hazardous conditions are actually simulated. It is therefore necessary to: 1) make a judgement of the likelihood that the action taken would meet the desired goal; and/or 2) ensure that the process followed is appropriate. Therefore, in practice, evaluations should focus on:

- the results, when they can be measured; and
- the process, i.e. the actions taken which led to the result.

It is thus important to record as many of the relevant facts and observations as possible during the exercise.

The problem of evaluating performance then becomes one of determining criteria by which performance can be judged. Evaluation criteria are indicators — but only indicators — that the right actions are being taken and that the response is achieving the right exercise objective. In a generic sense, in order to successfully complete an action, it is necessary to:

- Be able to gather the relevant information that could affect what action must be taken and how it must be implemented. It could be, for example, knowledge regarding the location of a fire
- Be able to analyse the information available. This analysis may be simple or complex. For example, in fire fighting, it is necessary to know the nature of the fire (wood, chemical or electrical) before a fire fighting method is adopted.
- Be able to promptly make decisions based on the available information.
- Be able to make a decision that leads to the desired action. In other words, the objective will probably not be met if the action taken is not in agreement with the analysis

performed. There are many ways by which this could happen. For example, a site area emergency may be declared instead of a general emergency because the available information was misinterpreted, or because of a miscommunication between the decision-makers and the person declaring the emergency. In both cases, an emergency would be declared, but the objective would only be met if a general emergency was declared.

- Implicit in each of the items above, be able to *communicate* effectively.

In a performance-based evaluation, it is not necessary to meet all criteria in order to meet an exercise objective. The actual success of the response depends on the conditions at the time and may require creative solutions on the part of the players, including prioritising some actions over others. It is not possible to always guess which actions, hence criteria, will be most important. Therefore, the evaluation must take into account the relative importance of each evaluation criterion based on the situation.

Whether or not objectives are met, lessons can be drawn from the exercise. For example, if an objective was met but the procedures were not used, this may indicate that the procedures are inadequate. If the objective was not met, it may have been because of the scenario and may not be a reflection of the plan or ability of the players.

If the performance objective was met, ask the questions: was the procedure followed; was the result achieved in good faith or by accident? If the performance objective was not met, ask the questions: why not? Was the procedure followed? Was training lacking?

Examples of exercise objectives and evaluation criteria are presented in Appendices II and III respectively.

7.3.6. Exercise report

An evaluation report should be prepared and submitted to the participating organizations in a timely fashion.

It is critical that the evaluation report be submitted, at least in draft form, within a reasonable period. What constitutes a reasonable period depends on the scale of the exercise and the number of organizations involved. The longer the delay, the less impact the report will have on the overall improvement of emergency response. For small-scale exercises, this delay should not exceed a few days. For major exercises, it should not exceed a few weeks.

The report is a compilation of the assessed observations of the evaluators. It should include observations, grades, deficiency classifications and, where pertinent, recommendations. The report should contain sufficient details to permit the evaluated organization to use the report to commence rectification of problems.

After receipt of the evaluation report, participating organizations may seek clarification. Although the entire approach described above aims at ensuring that the evaluation is impartial, defensible and based on facts, it does happen that some aspects of the evaluation may be inaccurate or subject to a different interpretation. The lead evaluator must try to avoid this situation but when faced with it he/she must be receptive to criticism by the players. However, the evaluation should not necessarily be changed on the basis of players' feedback and comments on the evaluation report. The players should be reminded that the purpose of the evaluation is to improve preparedness and response by identifying potential weaknesses, and not to blame individuals or organizations. It is normally the response organizations themselves that determine the actions to take in response to the evaluation report.

An internal review of the emergency organization, plans and procedures used during the exercise and personnel training levels should commence as soon as possible after acceptance of the report. Plans, procedures, checklists, etc., should be amended as soon as possible after identifying and addressing the deficiencies. Stakeholders should be notified in writing of the changes and if required, will be provided with amended copies of the plans and procedures.

Normally, the exercise director is responsible and accountable for the evaluation report. However, in some cases, this charge can be delegated to the lead evaluator.

7.3.7. Assessment of deficiencies

Deficiencies or weaknesses that are identified by the evaluation should be classified in terms of their impact on response performance. The following is an example of deficiency classification.

Critical. The deficiency or weakness significantly impairs the ability of the organization to perform its role and responsibilities, or jeopardizes personnel safety.

Major. The deficiency significantly reduces the response effectiveness of the organization but does not prevent it from performing its role, and does not jeopardize personnel safety.

Minor. The deficiency reduces the response effectiveness of the organization but does not prevent it from performing its role, and does not jeopardize personnel safety.

The purpose of this classification scheme is to help prioritize follow-up actions and to establish a target schedule for improvements.

The evaluation of the exercise performance will allow identifying lessons to be learned in order to increase efficiency of emergency response capabilities.

8. PRODUCING THE GUIDE FOR PLAYERS

This section describes what should be in the "players' guide" portion of the exercise manual.

This guide is intended to prepare players for the exercise. Its purpose is NOT to promote top performance, but to ensure that the exercise goes smoothly so that maximum value is achieved.

The guide for players should cover the following topics:

General statement of intent

This is generally a statement on the purpose of exercises that is consistent with the discussion contained in Section 2.

Applicable laws, statutes and regulatory texts

This is a brief statement on the regulatory and legal requirement for the exercise. It can help establish the seriousness and importance of the exercise.

Exercise scope and objectives

This is a summary of the exercise specifications determine in the first stage of the exercise preparation process.

Participating organizations

This is a list of the organizations that are participating, including the extent of their play. Players must know this so that they understand which organizations can actually be counted on or contacted (for real) during the emergency. When omitted, this can lead to embarrassing situations.

Example

In an exercise involving response at the national level, one organization was not properly informed that the minister and his office were not participating in the exercise. So they sent regular updates on the situation to the minister's office, initially forgetting to "stamp" the information with the word "EXERCISE". This caused the minister's office, who had not been fully briefed on the exercise, to activate for real.

Exercise rules

This is a brief description of how the exercise will be conducted, how the inputs will be provided, when they will be provided and what the players must do to deserve the information. It also provides rules for the players to interact with the exercise staff and for conducting themselves in the application of their procedures.

Exercise communications

This is a list of exercise phone numbers and contact information that is to be used during the exercise. For example, this list will contain the simulation cell numbers for the organizations that are simulated.

Simulation cells

This is a list of the organizations that will be simulated by the simulation cell.

Safety

This section will make a strong statement regarding the need to maintain safety during the course of the exercise, the responsibility of the players to follow standard safety procedures, and the duty of the exercise staff to stop the exercise if the safety of the facility or personnel is jeopardised.

Media arrangements and guidelines

This section contains instructions regarding interaction with the media by the players.

Feedback required from players

This section will describe the importance of obtaining players feed back at the end of the exercise and will provide instruction for the conduct of the post-exercise debriefing by the players.

Appendix XXI has a sample guide for players, which addresses most of the topics mentioned above.

9. DEALING WITH THE REAL MEDIA IN THE CONTEXT OF AN EXERCISE

This section describes what should be in the "media arrangement" section of the exercise manual.

9.1. LIAISON WITH THE PUBLIC AND MEDIA

Any exercise, especially a large-scale one, may attract media interest. This may present several challenges, including the following:

- the real media can interfere with the conduct of the exercise;
- the real media may interfere with the simulated media;
- the presence of simulated and real media can confuse the players;
- the media may mistake the exercise for a real emergency;
- the results of the exercise can be misinterpreted by the real media and cause an unnecessary crisis after the exercise, especially if the exercise revealed areas for improvement in the plans and procedures.

Hence, it is important to develop an effective organization and strategy to interact with the real media. This strategy should be implemented several weeks or months prior to the exercise.

9.2. MEDIA ARRANGEMENTS AND GUIDELINES

9.2.1. Strategy

There must be a clear strategy for dealing with media and public requests for information concerning an exercise. It is preferable that the strategy be consistent for all exercises rather than specific for each exercise. The strategy should be as open and proactive as possible commensurate with the aim and objectives of the exercise. If outside organizations (e.g. federal, provincial and/or municipal authorities) are participating in the exercise, a joint, or at least coordinated, information strategy should be adopted. A strategy which takes into account the preceding points will reduce the opportunities for misinformation and confusion and a consequent loss of credibility for all concerned.

In general, it is recommended that the real media strategy contain the following key points:

- the real media should be informed of the exercise prior to its conduct;
- the media should be informed of the purpose of exercises, emphasising the fact that it is normal and, indeed, desirable to find deficiencies, weaknesses and areas for improvements as a result of exercises;
- a separate section/department of the exercise organization should deal with the media during the exercise; the personnel in this group should not be players in the exercise.

At any given time, the media may be viewed as any or all of the following: a possible asset; a potential resource; and/or a time-consuming liability. It is preferable that the media strategy foster a positive relationship with the media so that they are an asset and a resource. In general, the exercise should be viewed as an opportunity to familiarise the real media with the plans and procedures in place.

9.2.2. Media arrangements

The arrangements should include the following:

- *Media Announcement*. The purpose of the media announcement is twofold: to get timely and accurate information to the public; and to keep the media informed. The announcement should include a brief description of the exercise including approximate date, time and purpose. A phone number for public inquiries should also be included. The person(s) responsible for answering the phone must be properly briefed.
- *Media Briefing*. For tabletop and field exercises, a media briefing prior to the exercise could be presented. This would be in addition to any media announcement. The purpose of the briefing is to keep the media informed and to integrate them into the overall exercise process.
- *Media Photo Opportunity*. A particular exercise, for example a field exercise, may lend itself to media coverage such as a photo opportunity. This does not obviate the need for a media announcement and possibly a media briefing.
- *Media Participation*. Tabletop and field exercises may lend themselves to actual media participation in the exercise. This does not obviate the need for a media announcement and a media briefing. Media participation could include any or all of the following: briefings, photo opportunities, interviews, media scrums and reporters providing spontaneous and/or scripted inputs.

For all of the above, a spokesperson must be appointed. This person must be an articulate representative, who is thoroughly familiar with the facility and with the particular exercise. This person should also have current media training.

9.2.3. Public notification

Persons who may be affected by or be concerned about exercise play should be notified of the exercise prior to its commencement or as soon as possible after the start of the exercise, commensurate with the exercise aim and objectives. For example, persons residing in the immediate vicinity of a field exercise should be informed of the time, nature and scope of the exercise. By doing so, the potential for conjecture, unfounded rumour or possible panic is reduced or avoided. Therefore, the public information strategy should be one of open dialogue geared to promoting public interest, awareness and also goodwill. The normal method for informing the public is the media announcement. Consideration should be given to delivering announcements door to door in the immediate exercise area. The distribution of this announcement should include contact details for local authorities such as the police, fire and/or other emergency services since the public may call them with questions.

If the exercise is likely to:

- involve operations near a neighbouring country;
- generate a high level of interest in another country; or
- generate rumours in another country,

then the potentially interested countries should be notified in advance through the appropriate national organization and contact point.

10. SPECIAL CONSIDERATIONS FOR EXERCISES FOR RESPONSE TO EMERGENCIES ARISING FROM MALICIOUS ACTS

10.1. GENERAL FEATURES OF EMERGENCIES ARISING FROM MALICIOUS ACTS

In recent years, malicious acts have been given additional focus in nuclear/radiological emergency preparedness and response. Such acts are not technically bound by the laws of probabilities. The only limit to the potential for such acts is the imagination of the potential perpetrators and the availability of resources. Therefore, the range of possible consequences and, hence, possible responses, is very wide. In some cases, the response to emergencies involving malicious acts would be almost identical to the response to other nuclear/radiological emergencies. In some cases, it could be significantly different.

In general, the main differences are as follow:

(a) There are increased considerations for security of facilities, people and strategic interests;
(b) The media impact is enhanced by the fear factor following a malicious act;
(c) The magnitude of the potential medical consequences can be extensive given the underlying aim of the act;
(d) The impact could be "directed" to maximize the health or economic consequences;
(e) There may be secondary threats (e.g. booby-traps) to hinder the recovery operations, harm responders and embarrass the authorities;
(f) The potential location is unknown, a priori; and
(g) Many jurisdictions may be affected.

There are also significant differences in the response to malicious acts. These differences can be summarized as follows:

(a) Intelligence, tactical response force and crime-of-scene procedures are critical issues during the immediate response;
(b) The media response immediately takes on a national dimension;
(c) There is an increased need for coordination of national medical capabilities;
(d) Specialized response services must be ready to act anywhere in the country;
(e) There is an increased need for coordination at all levels (national, regional, local and facility) of a large number of organizations; and
(f) The lead organization may be a security or law-enforcement agency.

Given those differences, exercises for response to nuclear/radiological emergencies involving malicious acts need to focus on the distinctive nature of such acts. They need not duplicate other types of exercises, but rather complement the exercise programme, at a national level, for, on the one hand, all types of potential nuclear/radiological emergencies, and on the other, all types of emergencies involving malicious acts.

Examples of malicious acts involving the use of radioactive material are as follows:

(a) A threat to commit a malicious act involving the use of radioactive materials;
(b) A deliberate act to irradiate persons;
(c) A deliberate act to contaminate food or water supplies with radioactive materials;
(d) The use of an explosive radiation dispersal device (RDD);
(e) A deliberate act to contaminate a site or the environment with radioactive materials;
(f) Sabotage or an attack upon a nuclear facility aimed at causing an uncontrolled release of radioactive materials.

Most of these types of events can be classified as category IV in the threat categorization of GS-R-2 [1]. Some, i.e. those involving attacks on fixed facilities, fit within the categories I, II or III threat categories. The material provided in this document thus far also applies to these types of events. However, in addition special considerations are needed to take into account the distinctive nature of malicious acts. This section discusses these special considerations.

10.2. PURPOSE OF EXERCISES FOR RESPONSE TO EMERGENCIES ARISING FROM MALICIOUS ACTS

Given that the consequences of malicious acts are in many ways the same as emergencies, with some key differences as noted above, the purpose of these exercises should be to test those aspects of the response that are not normally evaluated during other types of exercises. Hence, it is suggested that such exercises should have the following aims:

(a) Test the coordination between intelligence agencies, response forces and law enforcement agencies with first responders, specialized radiological emergency response units and facility management;
(b) Test the coordination of media communications on a national level in a situation of increased public fear and media scrutiny;
(c) Test the coordination of national medical arrangements to respond to an event with mass casualties, possibly contaminated and a full spectrum of medical consequences within the context of increased security concern;
(d) Test the ability of specialized response services to respond anywhere in the country;
(e) Test the coordination with organizations that are not normally involved in the response to nuclear/radiological emergencies; and
(f) Test the ability of all response organizations to operate in a response structure where the lead may be a security or law-enforcement agency and where there may be secondary threats to response personnel.

10.3. TYPES OF EXERCISES

The types of exercises for response to emergencies arising from malicious acts are the same as for traditional nuclear/radiological emergency response exercises, namely:

(a) Drills (see Appendix I for examples);
(b) Table-tops;
(c) Partial and full-scale exercises (see Appendix VIII for examples); and
(d) Field exercises.

In each case, the main difference will be the number and nature of the participating organizations. Some organizations, such as criminal investigation units, who would not normally participate in nuclear/radiological emergency exercises, **must** participate in such exercises. This means that the preparation, coordination and evaluation will be more complex and time-consuming.

10.4. PROCESS FOR ORGANIZING SUCH EXERCISES

The process outlined in Section 3 is the same for these exercises, with two major differences: coordination and confidentiality.

10.4.1. Coordination

The coordination of these exercises is, by their nature, more complex than for nuclear/radiological exercises for emergencies, due to the larger number of organizations that must be involved in the process. This means that the preparation process may need to start earlier. Depending on the scale of the exercise, a lead-time of 12 months is desirable. For tabletop exercises, the process can be shortened to a minimum of approximately 2 months. Drills, depending on their degree of complexity, can be organized within approximately one month.

10.4.2. Confidentiality

Prior knowledge of exercise scenarios is normally restricted to controllers and evaluators. However, for exercises to test response to situations resulting from malicious acts there are special needs for confidentiality in order to protect sensitive information about potential scenarios and vulnerabilities that could otherwise be used by possible perpetrators of such acts.

The need for confidentiality provides a new challenge during conduct and evaluation, as well as preparation, which must be properly managed. While there is a need to protect the detailed scenario and evaluation for the reasons described above, there remains a need to ensure that non-participating public and staff know that an exercise will take place so that confusion and fear that the exercise is real can be avoided.

10.5. SAFETY

As for any exercise, safety is paramount. This is even more important for exercises testing response to situations arising from malicious acts, since the response will usually involve physical combat and/or use of firearms or weapons. There is a potential that security and law enforcement agents may react to exercise events as if they are real, which could result in injuries. Moreover unless all exercise players are adequately briefed and clearly identifiable, security personnel may use firearms to confront exercise players. Some exercises may call for the use of real explosives and blank rounds to enhance realism. In order to avoid injury, there must be strict safety procedures in place and a safety officer or team must be designated with the responsibility for designing safety protocols and ensuring that they are followed.

10.6. SPECIFICATIONS OF EXERCISES FOR RESPONSE TO EMERGENCIES ARISING FROM MALICIOUS ACTS

10.6.1. Scope

The scope of these exercises will depend on the type of exercise being conducted. However, in most cases, the scope will include a multi-agency participation. In particular, agencies and organizations that are not normally involved in traditional nuclear/radiological emergency exercises should be included. This is a key feature of such exercises.

10.6.2. Objectives

In addition to performance objectives for traditional nuclear/radiological emergency exercises, which will also apply to these exercises, the following performance objectives should be specifically considered as possible response objectives to be evaluated:

Performance objectives related to the threat of a malicious act

(a) Assess the threat in terms of credibility and potential impacts.
(b) Effectively communicate the threat level to emergency response organizations and, when appropriate, the public. This includes informing potentially exposed segments of the population, in a period of heightened threat, about the nature and likelihood of the threat, threat recognition, basic protective actions in case the threat materializes and methods by which authorities would inform them on what to do in case of an actual emergency.
(c) Develop an appropriate plan for precautionary protective actions in case of a credible threat.
(d) Implement appropriate precautionary protective actions to protect people and workers from the potential impacts of a malicious act in a threat situation.
(e) In periods of heightened threat, activate a network of medical services and facilities capable of responding to a malicious act and keep the network informed about the situation during the threat period.

Performance objectives related to response to malicious acts

(a) Establish an effective command and control system at all levels in a multi-agency and multi-jurisdictional response environment.
(b) Implement appropriate defensive/precautionary actions to protect people from the potential impacts of a malicious act in a response situation.
(c) Rapidly dispatch medical teams to the scene of a malicious act to triage and manage a large number of casualties.
(d) Arrange for triage areas staffed with medical, radiological, counseling and security personnel.
(e) Arrange for security of medical staff at the scene, during transport of casualties and at the hospital.
(f) Dispatch victims to the appropriate medical facilities.
(g) Consider the possibility of secondary attacks/booby traps.
(h) Arrange for the protection of response personnel.
(i) Arrange for proper handling of potential evidences.

10.6.3. Constraints

As for traditional nuclear/radiological emergency exercises, exercises for response to emergencies arising from malicious acts are subject to the same constraints regarding time, location and duration. However, in practice, there are added considerations for these exercises that may affect when, where and how such exercises should be conducted:

(a) If the exercise is conducted in a public area, disruption to normal activities should be minimized. This means that the day and time of the exercise should be chosen so as to incur minimal disruption to normal activities.
(b) Exercises conducted on weekends tend to attract less public attention than during the working week.

(c) At facilities, exercises conducted during off-hours are less likely to affect non-emergency response staff.
(d) Choose times and locations that do not comprise safety, security or confidentiality.

Whereas most exercises for response to emergencies arising from malicious acts can be of relatively short duration, some response functions can only be tested if the exercise lasts several days. Examples include:

(a) Exercises that focus on medical treatment of acute health effects, which may not appear for several days;
(b) Exercises involving the covert exposure of a large number of people, who need to be identified, screened and processed;
(c) Exercises involving an ill-defined, yet realistic threat;
(d) Exercises based on a stolen source or sources that are located at unknown locations.

In these cases, the exercise duration itself becomes a challenge, both in terms of preparation and conduct, as well as in terms of response. It is possible to run an exercise in several phases separated by bridging injects and start states. This allows an exercise to cover an extended period of time. For example, it is quite common for exercise day 1 to cover the acute phase, followed by exercise day 2, that covers the situation several days or weeks later.

10.7. SCENARIOS

For each type of malicious act, there are many possible scenarios. Unlike emergencies arising from emergencies, the possible scenarios are not limited by considerations of probability. They are essentially limited by the ability of the scenario developers to think maliciously.

Appendix IX gives examples of possible exercise scenarios.

10.8. EXERCISE DATA AND INJECTS

Data and injects for these exercises are similar to those for traditional nuclear/radiological emergency exercises. However, depending on the type of exercise and on the scenario, managing exercise data and injects can be a very demanding task. Potential challenges include the following:

In the initial response to the scene of a malicious act, there may be several organizations and many emergency responders present. Radiological data and simulated injects must be provided to several people at the same time, by several controllers, in a coordinated manner. A lack of coordination on the controllers' part could create exercise-induced confusion for the players. One way to minimize this risk is by minimizing the number of injects, using stage set-up as much as possible to represent realistically the scene and using GPS-driven instruments to simulate field readings.

In exercises that involve a large number of real and potential casualties, with a mix of conventional trauma, radioactive contamination and potential overexposure, medical data need to be provided for each victim. This means that a large number of controllers will be needed, and that they must be able to provide information about the patient to the medical response teams in the most realistic and non-intrusive way possible. This is not easy to achieve. To facilitate this type of simulation, realistic make-up should be used to simulate physical injuries, the simulated patient must be thoroughly briefed on their symptoms, and cue cards can be provided at various times, when the patient is examined, to provide vital parameters with minimum controller intervention.

One major element of these exercises is the “intelligence input”. This is very difficult to prepare and to script. During a threat, hostage situation, highjack etc., there would be considerable intelligence resources engaged in supporting the front-line response, where the objectives will be to identify the perpetrators, their organization and their aims. There would also be actions undertaken such as psychological profiling, voice analysis and a whole range of other functions to assist in the management of the emergency. This requires special knowledge and expertise to simulate. Therefore, if appropriate, members of intelligence services should be included in the scenario development team.

The most successful exercises are those where the need for controller intervention, i.e. providing data and injects, is minimal. To achieve this, good scene set-up and field measurement simulation tools, such as GPS-driven gamma or contamination detectors, are invaluable tools. Nevertheless, in the end, controllers always need to maintain control of the exercise and may need to intervene. In exercises for response to emergencies involving malicious acts, there may be many more controllers than for those for response to other radiation emergencies. It is therefore essential that controllers be trained thoroughly and together.

10.9. SIMULATION

The best exercises are those where the degree of realism is highest and the amount of simulation (i.e. pretending to do certain actions or get certain information) is minimized.

However, in practice, it is difficult to incorporate extensive realism in such exercises. The reason is simple: malicious, especially terrorist, acts, are often aimed at maximizing damage, injuries and disruption, which is difficult to produce realistically in a safe manner or during an exercise. Furthermore, conducting a very realistic exercise involving a malicious act may unduly alarm non-participants, especially if it is unannounced. Therefore, the exercise designers must compromise between the need for realism while maintaining safety.

10.10. PUBLIC COMMUNICATION ASPECTS

The real media management of exercises for response to emergencies arising from malicious acts is subject to conflicting needs:

(a) The need for confidentiality before the exercise;
(b) The need to ensure that the exercise itself does not set off an adverse reaction among the public;
(c) The need to ensure that the disruption caused by the exercise, if any, will remain manageable;
(d) The need to meet exercise objectives without undue interference from the real media; and
(e) The need to avoid attracting attention to vulnerabilities and system weaknesses, which could be used in favour of potential adversaries.

Therefore, the media strategy for an exercise for emergencies resulting from a malicious act will also be a compromise. Each exercise must be considered on a case-by-case basis. The following can be used in the design of the media strategy for such exercises.

(a) Consider the consequence of not being media-proactive before the exercise. What would happen if the media finds out that there is such an exercise planned? What will happen if the media is suddenly confronted with the actual exercise?

(b) If the consequences are not acceptable, consider a proactive media strategy before the exercise.
(c) Some aspects of the exercise need to be kept confidential. This should be explained to the media if a pro-active approach is adopted.
(d) Regardless of the pre-exercise approach adopted, set up a strong media management team to handle the real media during the exercise. This must be completely separate from the players. The media can be invited to observe. However, keep in mind that some aspects of the response, equipments and facilities may be confidential.
(e) All organizations involved in the exercise need to coordinate on the media strategy. However, a single spokesperson should be designated for liaising with the media during the exercise.
(f) Ensure all players, controllers and evaluators know the policy with respect to the need to protect the evaluation results.

In general, a proactive media strategy is best. Giving the media necessary information before the exercise is likely to minimize possible negative impacts of the exercise on public psyche.

11. CONCLUSION

Nuclear and radiological emergency exercises are part of a comprehensive risk management programme. Exercises vary in scope and in scale from small drills, which focus on training, to large-scale exercises, which aim at testing the overall command, control, coordination and communications arrangements. The purpose of exercises is not to “demonstrate” the quality of the arrangements, but rather to identify weaknesses and areas where improvements can be made. Hence, exercises are an integral part of a sustainable and continuous improvement programme for emergency preparedness and response.

The material provided in this document is intended as an example of a logical process for preparation, conduct and evaluation of exercises, which needs to be adapted to national systems, local circumstances and the specific aim of each exercise. It constitutes a starting point for organizations that have not previously organized or managed exercise programmes, as well as a reference for organizations that wish to validate or improve their existing exercise programmes.

APPENDIX I: EXAMPLES OF DRILLS

Drills can be performed to test:

- Communications [1, 2]
  - activation;
  - notification (off site);
  - notification (national);
  - notification (international authorities, in the event of a trans-national emergency);
  - communication procedures.
- Initial response [12, 13]
  - safe evacuation and assembly of plant personnel;
  - accounting for the presence of plant personnel;
  - establishment of safety and security perimeter;
  - operating under incident command system;
  - operating following personal protection guidelines.
- Radiological monitoring [14]
  - availability and correct functioning of equipment;
  - in-plant surveys;
  - initial rapid environmental monitoring;
  - ingestion pathway monitoring;
  - sample collection and analysis;
  - data assessment;
  - trend monitoring.
- Off-site exposure assessment [12, 13, 14]
  - source term evaluation;
  - meteorological data evaluation;
  - monitoring data evaluation;
  - projected dose estimation;
  - correlation between in-plant and environmental data.
- Personnel dose assessment and control [12, 13, 14]
  - dosimeter processing;
  - dose assessment;
  - exposure authorisation and control;
  - issuing of work permits;
  - specific radiation protection measures;
  - contamination control.
- Off-site protective measures [12, 13, 14]
  - provision of advice for decision-making;
  - command and control in the public sector;
  - distribution of stable iodine;
  - sheltering procedures;
  - evacuation procedures;
  - traffic control;
  - access and egress control;
  - establishing evacuee reception centres;
  - agricultural controls.
- Medical service [15, 16]
  - first aid;

– field triage of potentially exposed and/or contaminated persons;
– medical management of contaminated and/or exposed persons;
– management of public health issues.

- Accident analysis [12, 13]
  – identification of status of main safety systems and fission product barriers;
  – emergency classification;
  – possible corrective actions;
  – possible actions to mitigate release of radioactive materials.

- Public information [12, 13]
  – prompt warning of the public;
  – activating a Public information centre (PIC);
  – communicating with the public and media;
  – prevention of public anxiety and distress.

- Administration [1, 2]
  – activating emergency control and coordination centres;
  – record keeping;
  – implementation of special security arrangements;
  – staff shift changes;
  – logistics support.

- On-site recovery measures [12, 13]
  – emergency rescue;
  – fire-fighting;
  – use of respiratory protection equipment;
  – access control to affected plant damage assessment and repair.

Examples of drills specifically related to emergencies arising from malicious acts

The following drills can be held to practice response procedures for emergencies arising from malicious acts

- Intrusion drills.

  This drill applies to fixed facilities. It involves the response of facility security, possibly aided by off-site law-enforcement agencies, to intercept and neutralize intruders with malicious intent.

- Crime of scene procedures in a contaminated environment.

  This drill is similar to the traditional first responders' drill for radiological emergencies involving contamination (e.g. following a traffic accident), except that the scene must now be treated as a criminal investigation scene.

- Triage of mass casualties with mix of conventional injuries, contaminated victims and overexposed persons.

  This drill focuses on the medical management of the crime scene. Diverse organizations must cooperate with the medical team, with support from the radiological specialists.

- Media management drills with multiple agencies.

  This drill is based on a hypothetical attack scenario. Its aim is to practice the cooperation between law-enforcement agency media teams and media teams from the organizations traditionally involved in the management of other types of nuclear/radiological emergencies.

- Rapid dispatch of specialized resources

  In this drill, specialized teams (e.g. radiological, medical) practise mobilization and transport to the scene of a simulated malicious act with their specialized equipment.

- Source search in urban environment

  This drill consists of locating a source or sources in public areas. For the drill to be useful, the area must be wide and require the cooperation of law-enforcement and radiological experts. Initially, drills can be conducted over a small area. Progressively, drills can extend to a large urban area or even an entire city. Some drills may involve the use of aerial surveys.

- Source recovery

  This drill is similar to the source recovery drills for traditional radiological emergencies. However, in this case, the scene must be treated as a crime scene and the proper chain of custody procedures must be practiced.

APPENDIX II: EXAMPLES OF EXERCISE OBJECTIVES

A variety of possible exercise objectives are presented below:

1. Exercise Objectives for on-site response at Category I, II or III Facilities

The possible objectives for an operating organization's (category I or II) on-site emergency response exercise could be to:

(a) demonstrate proficiency in classifying the emergency;
(b) demonstrate efficient and effective notification and alerting procedures and methods;
(c) demonstrate the precise and clear transfer of responsibilities for off-site response from the on-site Emergency Response Organization;
(d) demonstrate the ability of Emergency Response Organization personnel to maintain continuity of command and control throughout the exercise;
(e) demonstrate protective measures considered, determined and used to protect on-site personnel and the general public;
(f) demonstrate the reliability of and the effective use of emergency communications equipment, communications procedures and methods;
(g) demonstrate the capability of producing public information releases in the best interest of all concerned;
(h) demonstrate the ability to provide adequate medical care for personnel affected by the emergency conditions;
(i) demonstrate the ability to perform radiological monitoring and the necessary off-site dose assessment projections to provide advance warning to Government agencies, and to the general public;
(j) demonstrate the ability to conduct a post-exercise critique to determine areas requiring further capability improvements;
(k) demonstrate the physical adequacy of the various emergency response facilities for the working space and communication usage of individual members;
(l) demonstrate the primary functional responsibilities and/or problem-solving capabilities of the Emergency Response Organization;
(m) demonstrate recovery techniques and the ability of the Emergency Response Organization to de-escalate corporate and site emergency response activities and those concerning the general public; and
(n) demonstrate the ability of the Emergency Response Organization to integrate its activities with those of the other emergency response organizations participating.

The possible exercise objectives for a (category III) on-site emergency response could be to test the ability of participants to:

(a) operate under incident command system following personal protection guidelines;
(b) establish safety and security perimeter;
(c) assess the consequences of radiological exposure;
(d) survey the contamination of exposed personnel, if any;
(e) survey the contaminated room(s) to determine radiological conditions (dose rates, surface contamination, air contamination);
(f) organize and implement decontamination procedures (including field decontamination);
(g) prepare post-emergency reports.

2. Exercise Objectives for off-site response at Category I or II Facilities

The possible objectives of an off-site response exercise could be to:

(a) test the communication links between the facility and the various off-site emergency organizations;
(b) test the off-site emergency organizations' reactions;
(c) call in emergency monitoring teams and to check that these teams are familiar with the measuring procedures and appropriate instrumentation;
(d) check the arrangements made by the police and the fire brigade to divert and control traffic;
(e) test the siren network; and
(f) familiarise the public with the siren signals and their meaning.

3. Exercise Objectives for Response to Emergencies at Category IV Practice

The possible objectives for this type of emergency exercise could be to:

(a) demonstrate proficiency in classifying the emergency condition, taking into account all the
possible risks;
(b) demonstrate the ability to initially respond to the emergency, to perform dose calculations and to make decisions;
(c) demonstrate the local jurisdictions' capacity to provide control of access to restricted areas;
(d) demonstrate the ability of competent authorities to implement coordinated protective measures;
(e) demonstrate the capacity to perform an adequate emergency response with appropriate instruments and equipment;
(f) demonstrate the ability to provide adequate medical care to injured people;
(g) demonstrate the ability to produce and present information for the media and public; and
(h) demonstrate the ability to conduct a post-exercise critique to pinpoint elements of the response requiring improvements.

4. Exercise Objectives for Response to Emergencies at Category V Practice

The possible objectives for this type of emergency exercise could be to:

(a) examine the process for alerting and communicating with neighbouring countries and the international community in the case of a nuclear emergency, taking into consideration bilateral/multilateral agreements and international obligations;
(b) examine the real time exchange of information;
(c) examine the process for reaching decisions regarding the need for national interventions or protective measures;
(d) examine actions proposed in relation to the export and import of contaminated food and feeding stuffs;
(e) examine the process for identifying the need for and requesting assistance to cope with a radiological emergency;
(f) examine the many aspects of public information; and
(g) examine decision making based on realistic data and real weather conditions.

5. Exercises Objectives for Response to emergencies involving malicious acts

The possible objectives for this type of emergency exercise related to threats of malicious acts could be to:

(a) assess the threat in terms of credibility and potential impacts.
(b) effectively communicate the threat level to emergency response organizations and, when appropriate, the public. This includes informing potentially exposed segments of the population, in a period of heightened threat, about the nature and likelihood of the threat, threat recognition, basic protective actions in case the threat materializes and methods by which authorities would inform them on what to do in case of an actual emergency.
(c) implement appropriate precautionary protective actions to protect people and workers from the potential impacts of a malicious act in a threat situation.
(d) in periods of heightened threat, activate a network of medical services and facilities capable of responding to an emergency involving a malicious act and keep the network informed about the situation during the threat period.
(e) establish an effective command and control system at all levels in a multi-agency and multi-jurisdictional response environment.
(f) develop an appropriate plan for precautionary protective actions in case of a credible threat.
(g) implement appropriate precautionary protective actions to protect people and workers from the potential impacts of a malicious act in a response situation (e.g. evacuation of appropriate radius when a "dirty bomb" is discovered).

The possible objectives for this type of emergency exercise related to response to emergencies involving malicious acts could be to:

(a) rapid dispatch of medical teams to the scene of a malicious act to triage and manage a large number of casualties.
(b) arrange for triage points/facilities staffed with medical, radiological, counseling and security personnel.
(c) arrange for security of medical staff at the scene, during transport of casualties and at the hospital.
(d) coordinate with media teams to inform the public on where to report if contamination or exposure is suspected.
(e) dispatch victims to the appropriate medical facilities.
(f) establish a joint media centre near each scene of a malicious act, with one designated media liaison officer at each location.
(g) provide security to protect each media centre.
(h) promptly brief all emergency responders on the media relations protocol to follow in case they are approached by reporters.

APPENDIX III: EXAMPLES OF EVALUATION CRITERIA

In general, exercise evaluation is based on a selected list of response objectives, which should be verified over a set period of time. These response objectives are supported by evaluation criteria, which are measurable or observable actions or results that indicate that the response objectives are being met.

The following example is drawn from a category I type emergency exercise. For other categories, subsets can be used with slight variations (see Appendix X of [2]) for response time objectives.

1. ON-SITE EMERGENCY RESPONSE EVALUATION CRITERIA

1.1. EMERGENCY INITIATION, CLASSIFICATION AND NOTIFICATION

1.1.1. Detection

Response objective

Initiating events or situations that have led or could lead to an emergency, are promptly detected.

Evaluation criteria

(a) The emergency is promptly detected or recognized.

(b) The discoverer promptly reports the emergency to the shift supervisor.

1.1.2. Classification

Response objective

The emergency is correctly classified in order to trigger appropriate immediate response actions.

Evaluation criteria

(a) An initial emergency classification, based on plant conditions, is made within 15 minutes of detection.
(b) The emergency is properly classified.
(c) The emergency classification is reviewed and if necessary revised every time new significant information becomes available.
(d) Changes in emergency classification are promptly communicated to station personnel, the off-site emergency centre (when activated) and the outside emergency organization.
(e) The emergency classification reflects the projected risk to the population based on plant conditions.

1.1.3. Notification

Response objective

Off-site authorities are notified in due time to allow an effective off-site response, in accordance with local emergency plans.

Evaluation criteria

(a) Local (PAZ and UPZ) authorities are notified within 30 minutes of the classification of an emergency.
(b) The notification message includes, at the very least: emergency classification, nature of the hazard, actual or potential release, immediate actions required, time of next call.
(c) The local (PAZ and UPZ) authorities are notified within (expected time) minutes of any change in emergency classification.
(d) The station will keep the local (PAZ and UPZ) authorities informed of the situation as it develops.

1.1.4. Activation

Response objective

The generating station emergency organization reaches the capability to perform its functions within prescribed time limits.

Evaluation criteria

(a) Recall of essential station personnel is completed within *(expected time)* minutes of classification of an emergency.
(b) The emergency personnel report to their emergency assembly points within the following timelines depending on the class of the emergency:
  - On-site groups:
    - during normal working hours: *(expected time)* minutes
    - outside normal working hours: *(expected time)* minutes
  - Station Emergency Operations Facility (EOF) / Incident Command Post (ICP): *(expected time)* minutes
  - External fire assistance: *(expected time)* minutes

1.2. ESTABLISHING EMERGENCY MANAGEMENT OPERATIONS

Response objective

Emergency management operations are established in a timely manner.

Evaluation criteria

(a) Operational Support Centre (OSC) is functional within 30 minutes after the classification of an emergency;
(b) EOF/ICP is activated within 1 hour after the classification of an emergency;
(c) EOF/ICP is fully functional within 2 hours after the classification of an emergency.

1.3. MITIGATION

1.3.1. Mitigation at the scene of the emergency

Response objective

Prompt and effective actions are taken to confine or eliminate the hazard.

Evaluation criteria

(a) Immediate actions at the site are promptly taken to confine the hazard and protect vital equipment.
(b) When appropriate, the station Emergency Response Team (ERT) is dispatched to the site within *(expected time)* minutes of detection.
(c) In the case of a security alert, a strategy to survey and protect the critical equipment is initiated within *(expected time)* minutes of notification/detection of the threat.
(d) Off-site emergency services support is obtained within 30 minutes after classification of an emergency.
(e) Technical Support Centre (TSC) is activated and technical assistance is provided to the on-site responders within 1 hour after the classification of an emergency.

1.3.2. Mitigation in the control room

Response objective

Prompt and effective actions are taken to reduce the consequences of an emergency inside the station and in the environment.

Evaluation Criteria

(a) Mitigation actions are initiated within 15 minutes after an emergency classification.
(b) Emergency operating procedures to limit the consequences of the emergency are followed.
(c) Measures are taken to reduce the release to the environment.
(d) Measures are taken to protect vital equipment.
(e) Minimum staff is maintained in the control room at all times.

1.4. PROTECTION OF PLANT PERSONNEL

1.4.1. On-site notification

Response objective

All the on-site personnel are promptly alerted in order to trigger immediate protective actions and to activate the emergency organization.

Evaluation criteria

(a) A public address message is broadcast immediately upon classification of an emergency.
(b) Actions are taken to alert people outside the effective range of the public address system.

1.4.2. Hazard assessment - On-site

Response objective

The consequences for on-site personnel are properly evaluated and appropriate decisions are made regarding on-site protective actions.

Evaluation criteria

(a) The source of the hazard to personnel is promptly identified.
(b) Unsafe areas are promptly identified and isolated.
(c) Radiation levels and conventional hazards at non-essential personnel assembly points are monitored during the emergency and compared with operational intervention levels for evacuation.
(d) Radiation levels and conventional hazards at emergency personnel assembly points (including the control room) are monitored and compared with operational intervention levels for evacuation.
(e) The hazard to emergency personnel for entry into contaminated or high radiation field areas is assessed. This includes, but is not limited to; ambient gamma fields and airborne concentrations.

1.4.3. Protection of on-site emergency personnel

Response objective

The dose to on-site emergency workers is kept below established dose criteria.

Evaluation criteria

(a) Emergency personnel entering and leaving potentially contaminated or high radiation areas follow good radiation protection practices.
(b) Dosimeter turn-back guidance is established prior to emergency operations in potentially contaminated or high radiation areas. The turn-back guidance takes into account both the internal and external hazards.
(c) Dose control procedures are established for the station Emergency Response Team (ERT), on-site emergency personnel and off-site survey teams. This includes:
    - monitoring and recording doses as measured by electronic dosimeters;
    - ensuring that emergency personnel do not exceed their turn-back guidance;
    - promptly replacing personnel before or when they have received the dose at the level of turn-back guidance; and
    - informing the shift supervisor when any personnel exceeds the turn-back guidance.
(d) Emergency personnel entering and leaving hazardous areas follow good conventional protection practice. This includes the use of protective clothing and equipment, such as hard hats and ear defenders as required for protection against conventional hazards.
(e) Qualified radiation protection personnel supervise re-entry to contaminated or high radiation areas.
(f) Stable iodine tablets are administered when required.
(g) In the case of a security alert, appropriate measures are taken to ensure the safety of the search teams.
(h) Personnel are monitored and, if required, decontaminated upon leaving a contaminated area
(i) Protection of emergency personnel is continually re-assessed based on plant conditions and field readings, and updated as necessary.

1.4.4. Protection of non-essential personnel

Response objective

Personnel are removed from dangerous areas and their doses are kept below established dose criteria.

Evaluation criteria

(a) All site personnel are accounted for within *(expected time)* minutes of the declaration of an emergency.
(b) Non-essential personnel are assembled in safe areas.
(c) Appropriate actions, based on plant conditions and field readings, are taken to relocate non-essential personnel prior to operational intervention levels being exceeded.
(d) Search and rescue operations are initiated within *(expected time)* minutes of the completion of the accounting procedures when a person is identified as possibly missing.
(e) When contamination in the station or in the environment is suspected, evacuation routes in the station, including the parking lot, are assessed prior to evacuating non-essential personnel.
(f) When contamination in the station or in the environment is suspected, evacuated personnel and their vehicles are monitored at a suitable location off-site.
(g) When levels of contamination on the on-site evacuation route or on the parking lot preclude a safe evacuation, suitable transportation arrangements are made to evacuate non-essential personnel.

1.4.5. Medical

Response objective

Appropriate medical actions are provided to casualties while minimizing the spread of contamination.

Evaluation criteria

(a) First aid and medical treatment are administered in a timely manner and are not delayed by non-life-threatening radiological considerations.
(b) Medical first aid priorities are:
  - life threatening injuries,
  - minimizing the dose to the casualty,
  - minimizing the dose to the rescue team, and
  - minimizing the spread of contamination.
(c) If required, casualties are promptly evacuated from the station.
(d) Equipment and expertise for the treatment of contaminated casualties at the designated hospital is available when required.
(e) Provisions are made for the medical follow-up of emergency personnel and potentially overexposed casualties (e.g. whole body count, bioassays, chromosome aberration counts).

1.5. PROTECTION OF THE PUBLIC

1.5.1. Hazard assessment - Off-site

Response objective

The off-site impacts and needs for protective actions are correctly and promptly evaluated.

Evaluation criteria

(a) As a minimum, off-site hazard assessments include:
- assessment based on plant conditions;
- detailed assessment based on field survey data; and
- follow-up assessment based on further field survey data and analysis.

(b) Environmental monitoring near the facility is conducted within 1 hour after the classification of an emergency.
(c) Initial recommendations for urgent protective actions for the public based on emergency classification are made within 30 minutes of emergency classification.
(d) The magnitude of the off-site risk is correctly assessed on the basis of the available information.
(e) The hazard assessment takes into account:
- the plant conditions and likelihood of fuel failure;
- monitored releases;
- unmonitored releases;
- field survey data.

(f) Affected areas or potentially affected areas are promptly determined.
(g) The local (PAZ and UPZ) authorities are kept informed of the situation, including periodic updates of:
- protective action recommendations;
- projected plume trajectory;
- field survey data.

(h) Expertise and advice is provided to the local authorities when requested.

1.5.2. Liaison

Response objective

The information, expertise and resources required to support off-site authorities are provided in accordance with emergency response plans.

Evaluation criteria

(a) An effective system for on-site/off-site liaison is in place within *(expected time)* hours of the classification of an emergency.
(b) An effective communication (i.e. common understanding and timely sharing of information on priorities, issues and actions) is maintained between the following groups:
- the Control Room, the TSC, and the OSC;
- the Control Room and the EOF/ICP;
- the EOF/ICP and the outside response organisations Emergency operations centres (EOC);

- the Incident Commander or Group and the Emergency Response Team;
- the Control Room and the personnel assembly points;
- the station and the PIC; and
- the station, the Radiological Monitoring and Assessment Centre (RMAC) and the EOC.

1.5.3. Public information

Response objective

Timely and consistent information is provided to the public concerning on-site events and actions of the on-site organization.

Evaluation criteria

(a) The on-site organization informs the public of on-site events and of its interventions.
(b) Accurate information is provided to the local (PAZ and UPZ) authorities in a timely manner.
(c) Public information is coordinated with the local (PAZ and UPZ) authorities.
(d) Rumours are monitored.
(e) Effective measures are adopted to dismiss or validate rumours.

1.6. RECOVERY

1.6.1. Assessment

Response objective

The conditions that terminate the emergency are recognised and properly assessed.

Evaluation criteria

(a) When determining that an emergency at the station has ended, the shift supervisor correctly assesses that the following are stable and under control:
    - plant conditions;
    - release to the environment, including the potential for secondary release; and
    - residual threat to equipment and personnel.
(b) The hazard for the return of essential personnel for continued operation is assessed.

1.6.2. Recovery planning

Response objective

Changes in organization and operations that will be required during the transition to recovery are identified and due regards are given to workers' safety.

Evaluation criteria

(a) A recovery plan of action is established in coordination with the station TSC.
(b) The recovery plan takes into account the need for a recovery operation, continued media relations, protection of essential personnel and recovery action priorities.

1.6.3. Notification

Response objective

On-site and off-site organizations are notified of the end of the station emergency so that appropriate actions can be taken by all response organizations.

Evaluation criteria

(a) The station personnel, the EOF/ICP, and EOCs of other response organizations are promptly notified that the station emergency has ended.

2. OFF-SITE EMERGENCY RESPONSE EVALUATION CRITERIA

2.1. ACTIVATION

2.1.1. Notification

Response objective

The local (PAZ and UPZ) authorities are notified in order to permit a timely and effective response.

Evaluation criteria

(a) EOF/ICP with participation of local authorities is activated within 1 hour after the declaration of the emergency.
(b) The emergency organization at the local level is fully activated after the initial notification from the facility.
(c) Initial warning of the public within the PAZ and UPZ is performed and information on urgent protective actions required is provided within 1 hour after the initial notification from the facility.

2.1.2. Communication

Response objective

All information and data required to allow effective decisions and implementation of protective actions are shared between relevant response organizations.

Evaluation criteria

(a) An effective communication (i.e. common understanding and timely sharing of information on priorities, issues and actions) is maintained between all response organizations and stakeholders.

2.2. URGENT PROTECTIVE ACTIONS

2.2.1. Assessment and decisions

Response objective

The assessment and decisions on urgent protective actions by the outside emergency organization’s TSC are correct, based on the information available at the time, and lead to a reduction of the dose and hazard to the exposed population.

Evaluation criteria

(a) The outside emergency organization makes decisions on urgent protective actions within 30 minutes of the receipt of initial notification from the facility.
(b) The outside emergency organization adjusts urgent protective measures, as information becomes available.
(c) The magnitude of the off-site risk is correctly assessed on the basis of available information.
(d) RMAC is fully functional within 24 hours.
(e) Environmental monitoring within PAZ, near facility is conducted within 4 hours.
(f) Environmental monitoring within UPZ is conducted within 12 hours.
(g) Ambient dose rate measurements within affected area(s) are updated on a regular basis.

2.2.2. Alerting the public

Response objective

The public is promptly alerted of an emergency so that prompt urgent protective actions can be implemented without undue delay.

Evaluation criteria

When urgent protective actions are required, the population within the PAZ and UPZ is informed within 1 hour after the initial notification from the facility.

2.2.3. Evacuation

Response objective

When required, the evacuation of the population is conducted in an efficient and timely manner that reflects the degree of risk.

Evaluation criteria

(a) The public from the PAZ (in all directions) is promptly evacuated within *(expected time)* hours.
(b) Measures are established to control spontaneous evacuations of areas outside the protective action zone.
(c) Verification of the evacuation is conducted in a timely manner.
(d) When an evacuation is required, the following services for the evacuees are operational within one hour of the order to evacuate:
    - access/egress control to and from the protective action zones;
    - traffic control; and
    - reception and evacuee centre(s) with sufficient capacity and essential services (including radiation monitoring).

2.2.4. Sheltering

Response objective

When required, sheltering of the affected population is implemented in a timely manner.

Evaluation criteria

(a) If an evacuation is not possible, substantial shelter is provided for the public in the PAZ (in all directions) within *(expected time)* hours.
(b) Verification of the sheltering implementation is conducted throughout the sheltering period.
(c) The sheltered population is informed of the expected sheltering duration.

2.2.5. Stable iodine

Response objective

When required, stable iodine is made available to the exposed population in a timely manner.

Evaluation criteria

Stable iodine prophylaxis is provided to the public within PAZ and UPZ within *(expected time)* hours.

2.2.6. Contamination control for the population

Response objective

Evacuees are monitored for radioactive contamination in a timely manner and, if required, decontaminated. When affected by a release, the sheltered population implements basic personal decontamination techniques.

Evaluation criteria

(a) Evacuees and sheltered populations affected by a release are provided with instructions on how to self-decontaminate within *(expected time)* hours.
(b) When an evacuation takes place during or after an atmospheric release, all evacuees are monitored for radioactive contamination.
(c) Contaminated persons are promptly dispatched to a suitable facility for decontamination.
(d) Contaminated persons are decontaminated.

2.3. EMERGENCY WORKER PROTECTION

2.3.1. Dose control during emergency response

Response objective

The dose to emergency personnel is kept below established dose criteria.

Evaluation criteria

(a) The outside emergency organization establishes and periodically revises the emergency workers' turn-back guidance (maximum dosimeter readings).
(b) One designated person from the facility controls personnel doses of off-site emergency workers.
(c) An emergency worker accounting system is operational as soon as response organizations are activated.

(d) Emergency workers are accounted for at all times during the emergency.
(e) Dosimeter readings are recorded for all emergency workers exiting the protective action zone.
(f) High self-reading dosimeter readings and dosimeter alarms are reported to the EOF/ICP within *(expected time)* minutes of detection.

2.3.2. General contamination control

Response objective

The spread of contamination outside the emergency zone is minimised. The health impact of contamination on emergency workers is minimised.

Evaluation criteria

(a) Emergency equipment, vehicles and facilities are monitored and, if appropriate, decontaminated before leaving the emergency zone.
(b) Emergency workers are monitored and decontaminated, as required before leaving the emergency zone.

2.4. MEDICAL AND EMERGENCY SERVICES

2.4.1. Medical care

Response objective

Medical screening and first aid to injured people are provided in a timely manner.

Evaluation criteria

(a) Injured emergency workers and members of the public receive initial treatment and transportation to a medical facility as soon as possible. Medical treatment for the seriously injured is not delayed due to actual or potential contamination. Screening criteria are applied.
(b) Overexposed persons are identified within *(expected time)* hours of the initiating event and are dispatched to a suitable facility for treatment. Medical authorities arrange for treatment as required and practical.
(c) Public Health Authorities track and arrange medical follow-up of members of the public who have received doses above predetermined criteria for long-term medical follow-up.
(d) Public Health Authorities track and arrange medical follow-up of members of the emergency workers who have received doses above predetermined criteria for long-term medical follow-up.

2.4.2. Emergency services

Response objective

Emergency services are provided and maintained during the implementation of urgent protective actions.

Evaluation criteria

(a) Emergency Services respond within the times given in their respective Response Time Guidelines.
(b) There are emergency medical and security services at emergency facilities (i.e., reception centres).
(c) Emergency Services (fire, medical and security) are maintained in the emergency zone.
(d) Measures are in place to allow ingress of emergency services in the emergency zone without impairing on-going evacuations.

2.5. PUBLIC INFORMATION

2.5.1. Informing the public

Response objective

The public is kept continuously informed of the hazard and of measures in place to protect the population.

Evaluation criteria

(a) The public is provided with timely and accurate information throughout the emergency.
(b) PIC is activated and coordinated (facility and offsite officials) briefings to the media are provided within 4 hours.
(c) Response organizations provide information to PIC.
(d) All emergency public information is distributed through the PIC.
(e) Each response organization is represented by a single spokesperson.
(f) The activities of the response organizations' spokespersons are coordinated by the PIC.
(g) Media briefings and news conferences are scheduled, organized and conducted by the PIC.

2.5.2. Rumour control

Response objective

False rumours are promptly corrected to avert public information crises.

Evaluation criteria

(a) The PIC monitors broadcasts and publications for rumours, misinformation and public concerns.
(b) The outside emergency organization is promptly informed of rumours.
(c) The PIC is provided with information to correct rumours.
(d) The PIC broadcasts information aimed at correcting rumours.

2.6. LONGER TERM PROTECTIVE ACTIONS

2.6.1. Assessment

Response objective

The affected area where longer-term protective actions may be required is identified.

Evaluation criteria

(a) Criteria are established and clearly stipulated for the following:
- dose rate levels at which protective actions are required;
- dose rate levels at which sampling is required;
- density of contamination at which protective actions are required;
- generic action levels for contamination of food, milk, and water;
- generic action level for animal feed.

(b) Ground surface contamination surveys are conducted within *(defined distance)* km of the station.
(c) Isotopic analysis of ground samples are performed within *(expected time)* hours.
(d) Surveys and sampling are conducted outside the *(defined distance)* km zone if readings indicate that contamination above the screening levels may be present.
(e) The affected area where longer-term protective actions may be required is defined, mapped and communicated to all relevant response organizations.

2.6.2. Food control

Response objective

The dose through ingestion to the population is kept below established criteria through food control measures.

Evaluation criteria

(a) Agricultural countermeasures are implemented, in accordance with established reference levels.
(b) Measures are put in place to prevent the egress of contaminated food from the affected area.
(c) Verification of agricultural countermeasures is conducted throughout the implementation period.

2.6.3. Temporary relocation and resettlement

Response objective

The population is relocated or resettled on the basis of established criteria.

Evaluation criteria

The population within the emergency zone is temporarily relocated, as required.

(a) The outside emergency organization determines the guidelines for permanent resettlement in conjunction with the national government.
(b) Appropriate consultations with people potentially affected are made before initiating programmes of permanent resettlement.
(c) Suitable temporary or permanent areas and accommodations are provided.

2.6.4. Psychological impact

Response objective

The psychological impact on the population and emergency workers is minimized.

Evaluation criteria

(a) Evacuees are kept informed of the likely time to return to their homes and/or work places and about the measures taken to safeguard their property.
(b) Evacuees and persons in affected areas are kept informed about the potential short-term and long-term health impacts.
(c) Emergency workers and their families are kept informed about the potential short-term and long-term health impacts.
(d) Response organizations respond to related questions in a timely manner. This information is to be provided through the PIC.

2.7. RECOVERY

2.7.1. Assessment

Response objective

The conditions that downgrade or terminate the emergency are properly assessed.

Evaluation criteria

(a) The operational intervention levels below which protective action instructions can be lifted are clearly stipulated.
(b) When determining that an emergency is over, the outside emergency organization correctly assesses the following:
   - that conditions are under control and are stable
   - that measurements are below operational intervention levels for lifting protective action instructions
   - that public concern is properly managed
   - that downgrading the emergency will not have an adverse effect on the management of consequences
(c) Protective action(s) are rescinded at the appropriate time(s).

2.7.2. Transition

Response objective

Plans are developed to ensure smooth and coordinated transition from state of emergency to recovery.

Evaluation criteria

(a) The outside emergency organization establishes a recovery plan.
(b) The recovery plan takes into account the need for continued operation in the affected area, emergency worker safety and continued media relations.
(c) The outside emergency organization promptly informs response organizations of the end of the emergency and of the recovery measures to be taken.
(d) All relevant documents and other evidence are maintained and secured for post emergency investigations.

3. MANAGEMENT OF RESPONSE TO EMERGENCY INVOLVING MALICIOUS ACTS

The following example contains response objectives and evaluation criteria that complement but do not replace the previous ones.

3.1. THREAT ASSESSMENT AND RESPONSE

3.1.1. Threat classification

Response objective

The threat level is correctly assessed and communicated.

Evaluation criteria

(a) The threat is assessed based on available information.
(b) The threat is classified according to the methodology in effect.
(c) The threat classification is communicated to emergency response services.
(d) If appropriate, the threat classification is communicated to the public.
(e) The threat classification results in pre-determined automatic actions.

3.1.2. Threat response

Response objective

Appropriate actions are taken to reduce the threat level and mitigate the risks.

Evaluation criteria

(a) Appropriate precautionary protective actions to protect people and emergency workers from the potential impacts of a malicious act in a threat situation are developed.
(b) Threat reduction measures are implemented.
(c) If required, a network of medical services and facilities capable of responding to a malicious event is mobilized.
(d) Emergency services involved in threat mitigation are kept informed about the situation during the threat period.

3.1.3. Command and control

Response objective

The command and control system is effective.

Evaluation criteria

(a) An effective command and control system is established at all levels in a multi-agency and multi-jurisdictional response environment.
(b) Specialized teams or radiological and medical experts are promptly dispatched to the emergency scene.

3.1.4. Security

Response objective

Security is maintained for all emergency personnel and security procedures are followed.

Evaluation criteria

(a) Security of the scene is enforced.
(b) Security procedures are followed.
(c) Chain of custody procedures are followed.
(d) First responders, radiological specialists and medical experts work effectively in cooperation with law-enforcement agents.
(e) Security of medical personnel and patients is assured in transit and at the hospital.

3.1.5. Protection of the public

Response objective

The public is protected from the potential impact of the malicious act.

Evaluation criteria

(a) Appropriate precautionary protective actions are implemented to protect people and emergency workers from the potential impacts of a malicious act in a response situation (e.g. evacuation of appropriate radius when a "dirty bomb" is discovered).
(b) If required, a medical triage centre is established at the scene.
(c) Potentially affected individuals are tracked and screened for contamination and potential overexposure.
(d) Field triage of people involved in emergency is performed.

3.1.6. Media communications

Response objective

The media communications is effectively coordinated in a multi-agency environment.

Evaluation criteria

(a) A joint media centre is established near the scene.
(b) A single spokesperson is designated at the scene.
(c) All agencies coordinate media liaison.
(d) First responders are briefed on media communications protocol.

APPENDIX IV: EXAMPLES OF SCENARIOS FOR CATEGORY I FACILITIES

DETAILED SCENARIOS

The following examples draw upon extracts from emergency scenarios that have been used in various Member States. The examples cover both on-site and off-site emergency responses. Although they are intended to provide suggestions to those changed to prepare and conduct drills and emergency exercises for assessing the efficacy of their own emergency planning arrangements, it must be emphasised that the scenarios for such drills and exercises should be specific to the particular facility/practice and response objectives being assessed, rather than modified copies of what has been produced for other facilities/practices. The development of an emergency exercise in itself is a valuable part of the overall emergency preparedness training programme.

The EPR-Method [2] identifies the critical tasks that must be accomplished as well as the infrastructure and functional elements that are necessary in successfully conducting exercises for category I through V facilities/practices.

Scenario 1: Serious incident at a nuclear power plant (NPP)

Tables IV-1 and IV-2 present an example of the event sequence and the expected response actions for Scenario 1.

TABLE IV-1. EXAMPLE EMERGENCY AT NPP: INITIAL STATUS

Time, T	Conditions in the plant	Response actions on-site	Response actions off-site
10:00	Reactor scrams (reactor shut down). Rapid reduction in primary system pressure and increase in containment pressure.		
10:05	Emergency core cooling system (ECCS) starts to inject into core and primary system pressure returns to 10 MPa, but only one train of a three train ECCS is operational (for unknown reason). Core exit thermocouples (CET) increase to about 330°C but decrease to 300°C and pressurizer indicates that the primary system is full of water. Containment pressure and temperature are increasing and the containment monitor is 3 mGy/h and increasing slowly. Initial assessment is that there is a break in primary system inside the containment. There is no rain and the wind is at about 120-130°at 8 m/s.	Shift supervisor declared an Alert and notified off-site official Shift supervisor activated response organization. On-site staff is attempting to determine reason for partial loss of the ECCS systems and the loss of coolant.	One off-site monitoring team was deployed and instructed to do a survey around the plant.
10:38	Fire detected in Auxilary Building in the area containing some of the motor controls for the ECCS system. All ECCS water injection systems are lost; only one pump with a capacity of 10 m^3 /h is injecting into the vessel. Primary system pressure decreased to 2 MPa and CET are greater than 300°C and increasing.	Off-site fire support is requested. On-site fire fighting team assisted by off-site fire brigade is fighting the fire. Remainder of on-site response organization arrives	
11:00	Accident Assessment Manager [12] arrives at the scene and is briefed by the Shift supervisor.		

TABLE IV-2. EXAMPLE EMERGENCY AT NPP: EVENT SEQUENCE AND EXPECTED RESPONSE ACTIONS

Time, T	Conditions in the plant and available information	Expected response
11:15	Containment monitor has increased to over 100 Gy/h in the past 15 minutes. Wind has shifted direction to 170-210° at 8-10 m/s. Ambient dose rate monitoring results are available. Air sample results are available. All response teams have arrived and await direction of Accident Assessment Manager.	Assignment of tasks. Declaration of a General Emergency based on: -Abnormal core temperature with negative cooling margin and injection rate; or -Radiation level in containment > 5 Gy/h; or -Off-site radiation levels. Recommendation of protective actions to off-site officials on the basis of declaration of General Emergency; providing information to off-site officials on the monitoring results and providing assurance that they are using the guidance for emergency workers for emergency involving core damage. Emergency workers (to include off-site fire fighters) are monitoring their dose and are provided with individual protection equipment, thyroid blocking agents, and are aware of their turn back limits. Evacuation of non-essential personnel from the site. Evaluation of the available results of samples analysis and making appropriate decisions and actions (comparison of the results against predetermined OILs). Providing information for off-site officials about possible extension of the territory warranting evacuation on the basis of environmental monitoring near the site and changes in the plant conditions.

12:00	Wind shift to 100-140° at 8-10 m/s and it starts to rain. Fire is reported out.	Recommendation of evacuation of the areas to North and West with dose rates equal to or greater than predetermined OIL for ambient dose rate. Conducting additional monitoring to identify areas beyond UPZ warranting evacuation. Recommendation that local food and milk produced within food restriction planning radius should not be consumed until further monitoring is conducted. Recommendation to off-site officials that they should not relax protective actions near the site because the conditions are still too uncertain (e.g., vessel melt-through resulting in a containment failure is still possible). Evaluation of the available results of samples analysis and making appropriate decisions and actions (comparison of the results against predetermined OILs). Implementation of the recommended protective actions.
13:35	Damage to ECCS electrical system repaired and water injection in to primary system is reported at > 100 m^3/h. Some CET come back on scale but some show they are off-sale high. Containment spray starts and the containment monitor drops to 200 Gy/h within 10 minutes of sprays coming on.	
14:00	Plant condition stable - monitoring out side the containment confirms only minor ongoing atmospheric releases.	
15:35	Ambient dose rate monitoring results (near and far field) are available. Deposition mix results are available. CET did not go back on scale because they were melted during the accident.	
Day 2 12:00	Containment monitor at 30 Gy/h and other conditions at the site are steady. Ambient dose rate survey results are available. ^{131}I deposition concentration results are available. Food sample analysis results are available.	Making necessary adjustment of predetermined OILs using available results of sample analysis. Evaluation of the available results of samples analysis and making appropriate decisions and actions (comparison of the results against predetermined OILs). Recommendation to off-site officials that milk not be consumed in regions with ^{131}I concentrations above the predetermined OIL. Recommendation to off-site officials that the restriction on milk and local food remain in place until more extensive monitoring is conducted. Recommendation to off-site officials that relocation needs to be performed from the areas where predetermined OIL. This should not begin until the evacuation are completed and could wait further monitoring and assessment. Implementation of the recommended protective actions.

Scenario 2

Context

The scenario takes place at the Allswell nuclear power station. Allswell is a 3000 MWth PWR which has been operating successfully for 10 years, and was just re-licensed. Allswell was recently rated as the third best power station in the world based on availability and safety performance. Recent restructuring has led to drastic staff reduction, which is not perceived by management to be a problem given the excellent safety performance of the plant. There are 600 full time staff at the station, including 12 on-shift personnel. The radiochemical laboratory at the station is permanently staffed by at least one person.

Allswell is located in the country of Nearland, approximately 5 km from the border with Farland.

Detailed Scenario Time-scale

This scenario covers a time period of 25 hours after the start of the exercise.

Table IV-3 presents the scenario events in a summarised fashion.

TABLE IV-3. DETAILED SCENARIO TIME-SCALE

Time T+ΔT	**Event Summary**
T-0:15	Normal operation
T=0	High containment pressure. Containment and emergency core injection (ECI) alarms. Reactor shutdown but ECI and containment spray fail, probably because of the recent maintenance on the logic system.
T+0:16	Temperature inside the core rises. Some noble gases and iodine released, and leak to atmosphere through the inlet and outlet dampers.
T+0:30	Containment is re-established. Design leakage rate is about 0.1% per day at design pressure.
T+1:00	Core melt is extensive. Radiation levels in the containment have been rising steadily. The Fortthree water plant reports high radiation readings (6 mSv/h) and wants to know if the water plant should be shut down.
T+2:00	ECI low pressure injection is initiated but flow is restricted. Fuel is partially cooled. School bus drivers in the local towns are starting their rounds.
T+2:30	Radiation monitors inside the containment report erratic readings between 10^5 and 10^7 mGy/h. CNN calls the town mayors and the national authority and wants a scoop on the event in time for the 8:00 o'clock news.
T+2:40	ECI low pressure injection is made fully operational. Sufficient flow is provided to cool the fuel, but some fuel relocation has occurred and cooling is not effective. Some fission products continue to be released.
T+3:00	Containment pressure reaches about 150 kPa. Environmental readings are high, even though stack monitor readings are near background, suggesting that some leakage is taking place. A suggestion is made to vent through the filtered stack so that containment pressure can be reduced and unfiltered released diminished. In opening the outlet dampers, the operator mistakenly opens the inlet dampers also. CNN provides news on the event.
T+3:20	Water plant workers in the 10 km radius around the plant refuse to go to work, which normally starts at 09:00 h. Plants will keep taking water and feeding the local water mains unless workers go down to shut them off. The Minister of Education wants to know if schools should be closed.
T+4:15	Outlet dampers are closed. Pressure in the containment is low. Inlet dampers remain stuck partially open. Operators believe that the release has stopped. The Farland Prime-Minister calls the Nearland Prime-Minister and wants a full briefing on the situation. The Prime-Minister wants to know why the Farland Prime-Minister does not know about this, and what is the risk for Farland.

Time T+ΔT	**Event Summary**
T+4:30	Radiation readings inside the control room reach 900 μGy/h. The ventilation intake to the control room is next to the inlet containment ventilation dampers. Control room ventilation has not been isolated. Consideration to relocate the control room staff and evacuate all but the minimum personnel. The Nearland Power Corporation, which owns the Allswell power station, suggests that the plant may have to be abandoned. Towns as far as Vilfor report high radiation readings.
	END OF PHASE 1
T+5:00	Someone suggests that the containment inlet dampers may be stuck open. Operators try to close them but can't. Consideration to send an emergency team to close the dampers manually. A major shipment of cod fish from Canada arrives at Townthree. The Townthree port authorities want authorization to ship the cargo inland by train.
T+6:00	Major traffic accident on highway 101 near the intersection with road 21 causes backup of outgoing traffic for 3 km. Accident likely to be removed within 1 to 2 hours. Winds are expected to turn to a north-east direction within 12 hours.
T+7:15	Off-site power is lost. Emergency diesels start within 3 minutes and provide sufficient power for essential load within 5 minutes. Ministries and local agencies are flooded with calls. The Townfive reception centre reports that it is overwhelmed.
T+7:30	One of the diesel generators catches fire and is automatically shut down. Low pressure recirculation pumps are lost. The temperature in the fuel starts to rise again. Unless off-site power is re-established, pressure vessel melt through is possible. The local police report heavy smoke from the reactor building.
T+8:00	The president of the Nearland Power Corporation commits suicide.
T+9:30	Off-site power is re-established through grid re-alignment. Low pressure recirculation resumes. Pressure vessel failure is averted.
T+24:00 (next day)	An emergency team is sent in. Inlet dampers are closed. Containment isolation is effective. The pressure in the containment is low, and leakage is essentially stopped.
T+25:00	Ground survey data is available.

GENERAL SCENARIOS

There are numerous types of emergencies that can be used to drive an exercise. Most can be developed from the emergency descriptions contained in the IAEA accident reports [e.g. 17, 18, 19]. The sequence of events can then be tailored so that the consequences are either more or less severe than those described in the safety report.

The following describes conceptual variations that can be introduced in the scenario to make series of exercises more interesting and to challenge different aspects of the response capabilities. Possible exercise input items that could challenge certain aspects of the response are also presented.

Scenario 1: Mitigating an emergency before major release

The technical support group, operators and plant engineers are allowed to resolve the problem and prevent fuel melt or releases to the environment.

In many exercises, the scenario does not allow actions that would prevent fuel failure or releases. This is because there is often a desire to involve off-site response through a real off-site threat. However, that is often frustrating for the operators and the technical support group who, after a few such exercises, know in advance that whatever actions they take, they will be forced to fail to enable the exercise to go on.

This type of exercise allows a more realistic testing of the technical support group and their working relationship with the operators. If properly conducted, it still allows interactions between on-site and off-site organizations, assessments and in some cases precautionary protective actions.

Scenario 2: Challenging the survey strategy

A release takes place through an unmonitored path.

This type of scenario challenges the survey strategy, particularly for those stations relying entirely on mobile survey teams for the early assessment of environmental readings. By the time the release is discovered, the time left for formulating protective action recommendations and their implementation off-site is reduced.

Scenario 3: Liquid release

The emergency leads to a liquid release, but no atmospheric release.

This type of scenario challenges an aspect of the plan that is generally not well developed. The response time scale is significantly different than for an atmospheric release. Therefore, this scenario tests the ability of response authorities to adapt to different circumstances than the ones to which they are accustomed.

Scenario 4: Non-radiological release

A secondary system failure leads to the release of a large quantity of steam but no radioactive material. The failure could be, for example, a steam relief valve failure or a guillotine break of the steam main. The steam release is audible and visible to the public. Some workers are injured. Ambulances are called to the plant to transport the victims to the hospital. In accordance with standard procedures, ambulance staff wear their protective gear. The media is quickly alerted by somebody from the public and takes photos of the ambulance staff on the way out of the station, wearing their protective gear.

This scenario can test several aspects of the plan that are not routinely exercised. First, it forces the operators to implement emergency procedures and to classify the emergency in the absence of a radiological hazard. Second, it tests their ability to communicate to the public authorities the true severity of an emergency, which in this case is NOT radiological. Third, it tests the ability of the media relations group to deal with a situation that is quite confusing, i.e. the plant staff claim that there is no radiation but the ambulance staff were seen wearing their full protective clothing.

Possible additional challenges

Adding individual events that are not necessarily essential for the conduct of the exercise but that potentially increase realism can enhance the value of the exercise. The following are examples of exercise challenges:

- contaminated casualties in the station;
- overexposed casualties in the station;
- a radiological hazard combined with a fire hazard;
- contaminated off-site emergency workers;
- the emergency is initiated early in the night;
- inclement weather that forces the benefit of protective actions to be reconsidered;
- roadblock during an evacuation due to a massive traffic emergency, for instance;
- heavy media involvement (e.g. media wants to fly over the plant, or wants photos and interviews to be conducted with the plant in the background);
- the emergency happens just before an election, or when the government is going through a major crisis;
- communications systems failure;
- absence of some key groups.

APPENDIX V: EXAMPLES OF SCENARIOS FOR CATEGORY II FACILITIES

Unlike category I facilities, these types of facilities have only the potential for releases resulting in doses off-site above the urgent generic intervention levels (GILs) but with little or no risk of doses resulting in serious deterministic health effects off-site.

APPENDIX VI: EXAMPLES OF SCENARIOS FOR CATEGORY III FACILITIES

DETAILED SCENARIO

Activity release in a laboratory environment

This scenario examines the ability of the response organization to deal with a complex situation involving contamination, off-site impacts, lost radioactive material and the involvement of the media.

Initial Conditions

John was working in the lab early in the morning handling liquid sources containing ^{131}I (7.4×10^9 Bq). During handling operations, he dropped a flask, which shattered to the ground. He cut himself in the process and decided to go home at 09:00. Jane, a co-worker, came into the laboratory at 13:00 and discovered the contamination. As a result, she also became contaminated.

Detailed Scenario Time-scale

Table VI-1 describes the events pertaining to the management group and the survey team participating in the exercise. Part way through the scenario, the events become simulated.

TABLE VI-1. ACTIVITY RELEASE IN A LABORATORY ENVIRONMENT

Time	Actions of the Management group	Actions of the Survey team
13:00		One survey team member discovers Jane who tells him that she has discovered the contamination in the lab. The survey team member informs the management group.
13:05	Management group receives information from survey team member and takes immediate actions.	Survey team is dispatched to the lab and begins confinement, survey and contamination control of Jane. Jane is contaminated (use the resources available to decontaminate her). They decontaminate Jane who ends up joining the team.
13:20	Security reports that one worker went home early this morning with a bleeding hand. The worker is John.	Survey team discovers that there is contamination in the hallway, all the way to the door. They measure the following at 1m from the floor: 25 µSv/h, with one reading of 0.01 Sv/h (erroneous) contamination meter: 5 times background.
13:25		Survey team informs management that there is contamination outside the lab.
13:30	Management is informed by security that John took the bus home. Management decides to call the police to look for the bus.	Survey team continues confinement and decontamination operations.
13:40	Management decides to send survey team to John's home to estimate the dose he may have received.	Survey team wraps up the confinement and controller takes them back to their room. *[Simulated events will be given to participants from this moment forward]*
13:50		Survey team plans operation to go to John's home. They estimate the worst case potential dose to John's thyroid to be: - through ingestion of 1 mCi ^{131}I - 15.9 Sv (4.3 10^{-7} Sv/Bq) - through inhalation of 1 mCi ^{131}I – 7.8 Sv (2.1 10^{-7} Sv/Bq) The estimation of the worst case potential whole body dose is: - through ingestion of 1 mCi ^{131}I – 0.8 Sv (2.2 10^{-8} Sv/Bq) - through inhalation of 1 mCi ^{131}I – 0.4 Sv (1.1 10^{-8} Sv/Bq) [20]
		Survey team arrives at John's home and finds small levels of contamination in the home. John's wife and his two daughters are also home. They have very small levels of contamination on their hands. John is not there. His wife insisted that he go see a doctor, so he went to a local hospital to look after his hand.

Time	Actions of the Management group	Actions of the Survey team
14:05	Management is informed of the contamination present at John’s home, and of the fact that John left for the local hospital. They decide to phone the local hospital to warn them that the patient may be contaminated.	
	The local hospital calls back screaming: they say they are not equipped to deal with radiation victims. Management decides to dispatch the survey team to the local hospital to support the staff there.	Survey team simulates going to the local hospital.
14:15		Survey team arrives at the local hospital and discovers that there is no contamination, except on John’s hands, face, hair, shoes and his cut. *Controller: provide the team with the contamination survey form.* However, local hospital staff are scared and refuse to treat the patient. His hands are very dirty and there is a danger of infection.
14:20	Management group is informed of the situation at the local hospital. They consider sending John to another hospital that is used to dealing with radiation.	
14:30	Management is informed by the police that the bus was found and stopped. Everybody was thrown off the bus and sent onto another one. When asked by the people what was going on, the police answered that the bus was confiscated because of radioactive contamination on board. This made people very worried. Management decides to send the survey team to survey the bus.	Survey team is dispatched to the bus. *For simulation purposes, part of the team is assumed to stay at the local hospital.*
14:45		Initial surveys from the bus indicated trace levels of contamination on the steps.
	Management is informed of the contamination on the bus. They request from the survey team that a comprehensive survey and contamination control plan be developed to bring the situation under control.	

Time	Actions of the Management group	Actions of the Survey team
14:50	The director health physics starts receiving phone calls from the media. They want to know: Whether or not the emergency involved radioactive contamination? Whether or not the bus was carrying many contaminated people? Whether or not at least one person was contaminated and may die as a result? Whether or not the extent of the contamination is known?	Survey team plans confinement and survey operations.
15:00	The Secretary General contacts the director health physics and demands a briefing. The minister is upset because this is the second incident in less than a week. He has told the Secretary General that if the Lab is not able to control its own activities, its chances of receiving a funding renewal is very slim. The minister experienced some embarrassing moments during the latest media inquiries. He is also very worried that this will have a negative impact on his ability to maintain his position as minister.	
15:15	The Secretary General comes in for the briefing.	

GENERAL SCENARIOS

For scenarios involving category III practices, the types of scenario are more limited than for categories II and I. Generally, the scenario will be based on one of the following variations.

Scenario 1: Incineration of radioactive material

The radiation safety officer of a major hospital with a nuclear medicine department is informed over coffee that one of the physicians may have mistakenly disposed of two pacemakers, each containing 10^{11} Bq of ^{238}Pu, in the biohazard trash. The pacemaker consists of the plutonium encased within two stainless steel and titanium capsules. The biohazard waste is routinely incinerated at the hospital. Although the sealed capsule is designed to withstand the high temperatures of the incinerator, there is the potential for airborne contamination and contamination of the incinerator ashes.

This scenario requires the implementation of a monitoring strategy that not only looks at surface contamination but also takes into account the potential need for airborne monitoring around the site.

In this scenario, the plutonium source can also be replaced with other medical isotopes.

Scenario 2: Fire in a storage facility

A fire starts in a facility that stores a large quantity of small sources. The fire is ignited following an electrical fault and is fuelled by combustible materials such as cardboard and crates in the storage room. The room where the sources are stored is approximately 4 m × 4 m, and is located in a large warehouse that is approximately 200 m × 200 m. The ventilation is automatically shut off when the fire alarm is triggered. Most of the smoke is confined inside the warehouse.

This scenario tests the ability of the response organization to assess the hazard to response personnel and to determine priorities. For example, the radiation specialists can be asked to evaluate the airborne concentrations of isotopes in the warehouse based on typical release fractions from the sources stored in the facility. They can also be asked to evaluate the downwind hazard should contaminated smoke be allowed to escape the building, and what protective actions may be required. This also requires all components of the response organization to cooperate and to set up appropriate access control points, contamination control strategies and dose control procedures. It can also be made to involve simulated media who are concerned about the risk to the population downwind.

Scenario 3: Inappropriate storage of radioactive sources

The public works department of city X purchased 12 portable gauges for measuring the soil moisture and the paving density. Each unit uses two sealed sources of 0.37 GBq of ^{137}Cs and 1.48 GBq of ^{241}Am-Be, respectively. Due to the lack of appropriate control, the sources were never used and ended up being stored with other equipment and material for 15 years. When a group of five workers is asked to clean up the storage and discard obsolete equipment, they noticed the gauges with the radioactive trefoil, and become very concerned. They inform the rest of the 140 employees who work at that depot of their discovery, noting that in the last two months, two of the employees died of cancer (lung and liver, respectively). One of the employees goes to the press.

This scenario is not for testing the response team in action, but rather to test the ability of the response organization, particularly the managers and the radiation specialists, to deal with such a situation through assessment and communication. They will have to determine if the risk is real, and they will have to explain to the employees and to the press what that risk is. They may also wish to confirm through surveys that no contamination has ever been present, and may consider medical follow-up (bioassays, whole body counting) to determine if overexposure or internal contamination has ever taken place.

Scenario 4: Criticality emergency

At a research reactor, while reconfiguring the fuel rod arrangement to conduct a series of tests, the operator neglects to implement the control procedures (e.g. partial draining of the pool water, poisoning, etc.) and the reactor core goes critical for approximately 1 second. The operator receives a dose of 7 Gy and is knocked unconscious when he tries to get up very quickly and hits his head on a metal bar. His colleagues enter the reactor room upon hearing the radiation alarm and find him unconscious, not knowing why.

This scenario aims at testing the actions of the response team in a situation where little is known except for the fact that there is a casualty; he may be contaminated; there may still be high radiation fields; there may be airborne contamination of noble gas and, possibly, iodine.

Scenario 5: Undetected contamination

In a laboratory where routine work with ^{125}I, ^{99}Mo and ^{99}Tc takes place, a spill of a few MBq of ^{125}I occurs but goes undetected. This occurs on a Friday. During the weekend, some workers went to work to finish a project that was past due. On Monday, after work, one of the workers takes a detector home to show his children what kind of work he does, and finds contamination in his kitchen. When a survey is conducted, low levels of contamination are found in the laboratory, outside the laboratory, in the vehicles of those employees who worked over the weekend and in their homes. The levels are very low and do not cause serious risks.

This scenario combines the response to a category III emergency with that of a category IV event. Contamination must be delimited, and appropriate actions must be implemented to survey all family members. The dose impacts must be calculated. Media involvement can also be incorporated in this exercise. Decisions on what to do with the houses, vehicles and other contaminated items will have to be made. Decontamination strategies will have to be developed.

Possible additional challenges

Adding individual events that are not necessarily essential for the conduct of the exercise but that potentially increase realism can enhance the value of the exercise. The following are examples of exercise challenges:

- Monitoring equipment malfunction. This could serve two purposes, the first of which is to observe whether or not the team recognises the malfunction and the second of which is to see how the team overcomes the obstacle.
- Survey equipment gets contaminated
- Media interference
- Casualties
- Emergency (e.g. fire) initiated at night or on a weekend.

APPENDIX VII: EXAMPLES OF SCENARIOS FOR CATEGORY IV FACILITIES

DETAILED SCENARIO

Radiation emergency involving transport, missing source and overexposure:

This scenario is summarized below in a non-tabular form and illustrates yet another way commonly used to present events.

Friday, at approximately 22:00 hours, a light truck transporting two gamma radiography devices: one housing a 3.7 TBq ^{192}Iridium source and the other a 0.74 TBq (20 Ci) ^{60}Co source, was involved in a motor vehicle accident in a rural area 20 km away from city X. The truck collided with another vehicle travelling in the opposite direction and overturned. The truck driver was found unconscious and seriously injured. The radiographer's right leg was broken and therefore could not leave the scene of the emergency. To make matters worse, the two passengers from the other vehicle were also seriously injured. The radiographer was forced to ask a person who came to their aid for the detector. Considering the dose rate measured, the radiographer arrived at the conclusion that at least one of the two and possibly even both of the sources were unshielded. He immediately recognised the danger of the situation, which could give rise, in the case of loss of the source or damage of the container, to a radiological over-exposure of the emergency victims and the members of the public. The radiographer then asked that police and medical personnel immediately be informed of the possible dangers. He also emphasised that people surrounding the scene should be moved away from the vehicles and that police should call for urgent radiological emergency response assistance. He also mentioned where police could find response procedures.

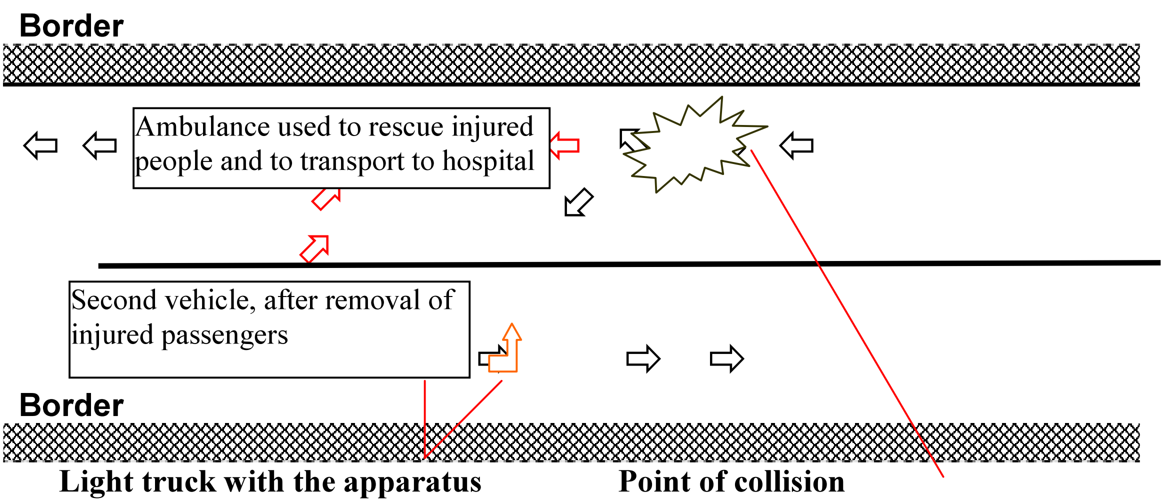


FIG. VII-1. The accident scenario at the collision, 22:00 hours; vehicles in opposite direction.

Sequence of events

- T_o Time of accident, 22:00 h.
- $T_o + 0.02$ Time when group of persons came near the car to help injured people.
- $T_o + 0.10$ Time when authorities were informed.
- $T_o + 0.20$ Time when National Regulatory Authority (NRA) was informed.
- $T_o + 0.30$ Time when Police, Fire Brigade and Ambulance arrived.
- $T_o + 0.40$ Time when, after radiographer's information, the Fire Brigade and Medical care started to respond.
- $T_o + 1.00$ Rescue of passengers.
- $T_o + 1.05$ Rescue of driver.
- $T_o + 3.00$ Recovery of the sources.

Shipment information

Facility: ABXYW, Ltd
Address: to be completed

Other exercise data

National Regulatory Authority - NRA
Occurrence Register ORN- 123-AA User License No: AC-08765
The NRA is available for assistance if requested.
The NRA Public Communication Department is prepared to handle any media inquiries
Emergency Contacts: to be completed

Possible challenges

- Crowd control.
- Control of large traffic volume.
- No fire fighting equipment readily available.
- Emergency response teams get to the scene after a large number of vehicles and persons have gone through, which could have resulted in a spread of contamination.
- Suppose that the survey meter was damaged in the collision and no survey can be made.
- Assume that the driver was alone in the vehicle, and is unconscious.
- Assume that the truck did not carry a radioactive material placard.

General Scenarios

Scenario 1: Package exhibiting high radiation readings

A 5-meters tractor-trailer arrives at International Airport X with a radioactive materials package containing Iridium-192. When the workers at the unloading dock open the door of the trailer, they observed that the contents of the radioactive materials package had fallen out of the 23 litres drum and were scattered on the floor of the vehicle. One of the workers then picked up all the contents, including the Iridium-192 source wire, and placed them back on a pallet with other cargo. Interviews with that worker revealed that he handled the source wire from a position located approximately 30 centimetres from the actual Iridium-192 sealed source, and he only held the wire for a few seconds.

The pallet containing the package and other cargo is then removed from the truck using a forklift and is taken to an area used by customs agents to inspect foreign shipments. When customs agents arrive to the site, their alarming dosimeters activate. They immediately secure the area and call for assistance.

This scenario tests the response to a loss of shielding combined with over-exposure of personnel.

Scenario 2: Radioactive substance found in an apartment block

A box containing ^{137}Cs- was found in an unoccupied cellar of an apartment building by the caretaker. The box was marked with the words “Cesium 137, radioactive” in a foreign language and was correctly sealed. The police were called and started tracking the man they believed may have abandoned the substance. The officials opened an investigation and a search was launched to find the former tenant of the apartment to which the cellar is connected. Authorities wanted to question the man about why he was in unauthorised possession of the substance. The effects on the health of the residents of the apartment block were deemed negligible. Tests show that the substance was not manufactured in the country where it was found. It was an industrial product, mainly used for measuring processes and for calibrating instruments.

This scenario is interesting for testing the national response to an emergency that combines health, security, media and trans-boundary issues. It is best conducted in the form of a tabletop.

Scenario 3: Transportation emergency involving a radioactive device

In a railway station, a locomotive strikes a luggage trolley and destroys a Type A package containing an approximately 37 GBq ^{99m}Tc generator. There are 291 persons on the train that may have come into contact with the affected area. At the time the exercise starts, the 291 people are still on the train.

This scenario challenges the ability of the response organization to deal with the need for a fast assessment and the control of a crowd that may have been contaminated and may react very negatively to the fear brought on by the idea of radiation.

Scenario 4: Transportation emergency with pharmaceutical products

A vehicle transporting radioactive pharmaceuticals skids on the wet pavement of a major highway. The radioactive cargo consists of four packages each containing eight lead cylinders with 5.5×10^5 Bq of technetium and thallium. One of the packages breaks open and the contents of a lead cylinder spills on the road. The driver is unconscious behind the wheel.

This scenario introduces a number of challenges in addition to the "standard" spill response, including:

- the *real emergency* of having to deal with a traffic interruption on a major highway;
- the potential that contamination may have been spread by the traffic before it was stopped;
- the need to deal with a casualty in a contaminated environment; and
- the media interest that such an emergency may introduce.

Scenario 5: Emergency at sea

A cargo ship carrying 30 cylinders, each containing 12 tonnes of uranium hexafluoride (less than 1% enriched), collides with a car ferry boat. The cylinders appear intact but fall to the sea. There is no contamination.

This scenario challenges the ability of the response teams to respond in an environment in which they generally have little practice. It forces cooperation between naval and radiological response teams. It also tests the ability of the response teams to assess the potential impact of water borne contamination and to implement monitoring measures over a wide area. In addition, if the sea is rough, it tests the ability of the response teams to recover packages in a hostile environment.

This scenario has a safety implication in that the exercise should not put the response team in undue risk.

Scenario 6: Empty container

A hospital notices that the shielded package containing ^{99}Mo it just received from an isotope production facility is empty. They phone the supplier, who assures the hospital that all the paper work is in order. A search for the missing source is initiated. After an extensive search, it is found that the supplier made an error and the source is indeed still at the facility.

This scenario involves a possible lost source, potential contamination, and the possibility that administrative procedures were not properly followed.

Scenario 7: Loss of a moisture-density gauge

A gauge containing 1.5×10^9 Bq ^{241}Am and 3×10^8 Bq of ^{137}Cs is loaded into a pickup truck for transport. The truck's tailgate falls open and the source is lost. The loss is discovered several kilometres from the originating point.

This exercise is a typical loss of source exercise, except that the source is lost in the open. This scenario can enable search strategies to be tested, including aerial surveys and particularly land searches where security and radiation personnel would be called upon to cooperate. In such an exercise, a real source can be used in a controlled area to realistically test the ability of the survey personnel to find the source. The affected public could be simulated.

Possible additional challenges

Adding individual events that are not necessarily essential for the conduct of the exercise but that potentially increase realism can enhance the value of the exercise. The following are examples of exercise challenges.

- The person who is knowledgeable with respect to radiological issues or the contents of a shipment, speaks a language that is not understood by the response team(s).
- Monitoring equipment malfunction. This could serve two purposes, the first of which is to observe whether or not the team recognises the malfunction and the second of which is to see how the team overcomes the obstacle.
- Survey equipment gets contaminated.
- Certain members who have little or no experience (as long as this does not compromise safety) replace some of the members of the experienced response team. This would simulate the case where pre-designated responders are not available and back-up personnel with less experience must be introduced.
- Outdoor work is carried out under adverse weather conditions, e.g. extreme heat, extreme cold, rain or snow, etc. This introduces a realistic test of the range of use of the equipment, the tolerance of the response team and the suitability of the personnel protection equipment under such conditions.
- Media interference.

APPENDIX VIII: EXAMPLES OF SCENARIOS FOR CATEGORY V PRACTICES

DETAILED SCENARIO

Introduction

Scenarios for category V events can vary greatly depending on the specific national situation and the proximity of extra-territorial nuclear power plants. Hence, it is not possible to provide a generic scenario that is suitable for all countries.

Generally, a scenario for a category V type exercise is quite simple. The complexity of the exercise and the challenges introduced are primarily based on the national assessment response, and on the peripheral events that are introduced in the exercise to make it more realistic.

The following is one of the many examples of a typical category V exercise. It is followed by a section of potential challenges that could be part of the exercise. The challenges introduced will depend on the objectives of the exercise. It is those challenges that will make a category V exercise useful.

Narrative

At 06:00 h, an emergency occurs at the Nuckie Power Plant in country Y, 100 km away from the country X border. The Nuckie power plant is a 1000 MWe PWR. A release through a leaking outlet damper starts at 10:00 h. It is estimated that 20% of the core has melted. Sprays are inoperative. The release rate from the containment is 10% per hour.

Country X is notified by country Y at 07:00 h, and by the IAEA at 09:00 h.

The wind is blowing toward country X at 13 m/s.

Country X depends heavily on country Y for the import of meat, cereal and wine. There are several farms located around the Nuckie power plant.

Event sequences:

Time	Event
06:00	LOCA with loss of emergency core injection at the Nuckie power plant.
07:00	Notification from country Y received by country X.
09:00	Notification from the IAEA received by country Y.
10:00	First media report of the emergency.
11:00	Country X is informed by country Y that a release has started and is expected to go on for hours.
13:00	Radiation detected at the border with country Y.
14:00	Country X is informed by country Y that an evacuation of 8 km around the station is under way.
15:00	Country Y requests assistance from country X for the survey of the 100 × 20 km area extending between the plant and the border with country X.

Time	Event
16:00	Country Y informs country X that the release has decreased and is expected to be under control within 2 hours.
18:00	Country Y informs country X that the release has stopped.
19:00	Winds shift.
20:00	Radiation readings at the border with country Y start decreasing.

Potential challenges

The following considerations can be introduced in the category V scenario to make the exercise more realistic and to allow the achievement of exercise objectives:

- Key members of the organization are missing and must be replaced by their alternates.
- Requests for information by members of the public regarding the safety of country X residents who are in country Y.
- A large volume of requests from the media.
- The media report incorrect facts, e.g. that people in country Y who live near the country X border are preparing for an evacuation.
- Requests for full briefings by ministers.
- Meat and wine merchants report that they will stop importing products from country Y.
- Border forces refuse to let people from country Y come into country X.
- Airport workers refuse to service airplanes from country Y.
- All flights to country Y cancelled by the airlines.
- Anti-nuclear groups call for a stop of all nuclear research and use of radiation in country X.
- Unconfirmed reports of a secondary explosion at the Nuckie power plant.
- Telephone main switchboards crash under the large number of calls to emergency services.
- Roadblocks around the affected power plant in the neighbouring country have stopped all major traffic of goods into country X.

GENERAL SCENARIOS

General scenario 1: Incineration of a ^{60}Co source in a smelter

A source of several TBq of ^{60}Co mixed in with scrap metal is burned in a smelter in country X. The plant does not have a gate monitor capable of preventing the ingress of radioactive sources. Monitoring stations downwind of the plant promptly detect an increase in ambient radiation levels, but do not immediately recognise the source. The wind is blowing towards neighbouring country Y. Country X notifies country Y.

This scenario is an interesting alternate to a nuclear power plant emergency in the far field. It also leads to low-level trans-boundary impacts, and requires both countries to cooperate to estimate the level of risk and the protective actions, if any, that may have to be adopted. Until the nature of the airborne contamination and the source of the release are known, authorities will have to make decisions on the basis of very few data.

Scenario 2: Emergency involving a nuclear powered vessel

A nuclear powered vessel moving outside territorial waters of country X is the scene of a reactor emergency that leads to a short release of radioactive material to the atmosphere. The vessel surfaces and is waiting for assistance from the country of origin. The winds are blowing toward country X.

This scenario presents challenges and a degree of complexity that are different from those encountered when dealing with land-based reactors. There may not be bilateral agreement between the country of origin and country X. There are no fixed monitoring stations over the water. It may be difficult to obtain detailed information on the events from the ship. This forces the national authorities of country X to make decisions based on very little information and to focus their attention on the monitoring data. It may also test their ability to develop an appropriate monitoring strategy (e.g. aerial surveys) to make the best use of the information available.

Possible additional challenges

Adding individual events that are not necessarily essential for the conduct of the exercise but that potentially increase realism can enhance the value of the exercise. The following are examples of exercise challenges.

- Have participants decide which special non-government groups need to be considered, and what their specific concerns and needs are.
- Have the players identify and correct/monitor unsubstantiated information that has made its way into the public domain.
- Have media sources introduce conflicting information and observe how players attempt to prevent public confusion.
- Have players deal with the potential impact of differing environmental and food monitoring standards on public perception and trust.

APPENDIX IX: EXAMPLES OF SCENARIOS FOR RESPONSE EXERCISES TO EMERGENCIES RESULTING FROM A MALICIOUS ACT

Scenario 1: Threat against a nuclear facility

Start state

Regulatory authority received a fax saying that there will be an attack on a major nuclear facility within the next 5 days. No details are provided on the nature of the attack or the facility. The fax says that this attack against the "establishment" will demonstrate its weakness and moral ineptitude.

Evolution

The following events occur during the course of the exercise:

- When contacted, a nuclear research facility (or other) and a nuclear power plant independently report that people posing as journalists have been roaming around over three days one week ago.
- An army base (far from the facility) reports the theft of a large quantity of explosives.

Notes

This exercise contains two phases. The first one is the search to identify the potentially affected facilities and attempt to determine the likely mode of attack. The second is to determine a pre-emptive plan that considers physical protection, liaison with off-site authorities and the possible implementation of part of the emergency plan. Ideally, this exercise is conducted with the participation of the facility and off-site local organizations.

Scenario 2: Threat against a water reservoir

Start state

A truck carrying a large quantity of low- and medium-level radioactive waste destined for disposal is stolen. The media report the event in the first page of national newspapers. The police have been unable to locate the vehicle. Public speculations abound about RDDs or the contamination of food or water supplies.

Evolution

Radio stations receive an email notice from an unknown source, which says in cryptic words that people should watch what they drink, making a clear reference to a recent crisis in a remote community where several people got sick and died after the water treatment plant, mismanaged, became infected with Escherichia coli.

Intelligence services report that word is floating about the deliberate contamination of water supplies in a major city. They consider the threat serious.

Notes

This is a good example for a tabletop exercise. Its purpose is to bring people from different organizations together to formulate solutions to a potentially very complex problem. The network and working relationships developed will benefit emergency preparedness for all types of malicious acts.

Scenario 3: Deliberate exposure of people

Start state

The police receive a call from an unknown person telling them that there are powerful radioactive sources located in a very busy shopping mall. They provide the exact location. They then explain that there are other sources located throughout the city.

Evolution

Depending on the police capabilities, either they send their own survey team or call appropriate authorities to verify. When they do, a cesium source of 10^{13} Bq is found between the liner and the shell of a garbage bin, next to a seat in the central mall area. Dose rates are close to 1 Sv/h at 1 m.

Notes

This scenario will require a search for other sources and a search for the people who may have been exposed. This is a very complex scenario as many actions need to take place on many levels and in several areas, including media, medical and radiological. It is best to conduct this scenario in stages. The first could be a workshop with organizations that would be involved. The second could be a tabletop. The third could be a full field exercise.

Scenario 4: Deliberate contamination of water supplies

Start state

The start state begins with scenario 2 above. Then the stolen truck is found in the vicinity of a water treatment plant in a major city, on the next early morning. Surveyors sent to the location detect the presence of contamination near the main treatment basins.

Inside help is suspected.

There are no radiation monitors at the facility and no automatic shutdown systems in case of radioactive contamination of the water.

Evolution

The barrels are found, along with the manifest that describes the exact composition of the waste. Videos from cameras located on the periphery of the plant are seized. Viewing shows that the truck arrived at about 02:00 h. The plant was isolated from the water distribution system at 07:00 h.

Notes

This scenario is best suited for tabletops. Although health hazard to the public is small, to qualify it will require a careful analysis of the health hazard based on water consumption rates and distribution parameters for the area. Local parameters should be used to customize the exercise data.

Scenario 5: Explosive radiological dispersion device

Start state

Call to emergency services of an explosion downtown in a major city. The explosion appeared to originate from the sewer system. A gas leak is suspected. In fact, it is a powerful explosive device placed in the sewer. The explosion damaged several cars. No death, but there are several serious injuries. The contamination is cesium and strontium. It extends over 50 m from the source of the explosion and 100 m downwind, down the street.

Evolution

First responders arrive at the scene and realize that there is no fire; therefore, it is not a gas leak.

Electronic dosimeter alarms go off.

Notes

This scenario is best suited for field exercises. The degree of complexity can be adapted by changing the number of victims, the strength of the explosive, the nature of the radioactive substance(s) and the possible presence of a secondary threat.

Scenario 6: Confirmed bomb threat against a nuclear power plant

Start state

Bomb threat call to the security agents at a nuclear power plant. The fence alarm system on the water side is found to be defective. An inspection of the fence reveals a hole on the water side. Earlier, someone noticed a pleasure craft approaching the plant. An insider job is suspected.

Evolution

A backpack-size explosive device is found near the hydrogen cooling system of the main generator. The trigger mechanism is unknown. Someone suspects that the trigger may be a change in vibration level.

Notes

This scenario can be used for a tabletop or an on-site exercise. Outside law-enforcement and explosive ordinance units will need to be involved. One of the questions will be: shut down or not? Shutting down the turbine may trigger the explosion and cause a major fire, possible steam main failure and possible station blackout.

APPENDIX X: EXAMPLE OF MASTER EVENTS LIST

The master events list contains all the events, messages, etc., in a sequential order. Each event shows which controller must introduce it, and who the recipient is. It is intended for use by the lead controller only, and is used to keep track of the overall progress of the exercise.

It is very useful to generate this list in a database. This can help the management of events during scenario development and can be used to produce lists of events organized by controller.

Table X-1 is an example of a master events list for a threat category V type exercise.

TABLE X-1: MASTER EVENTS LIST FOR EXERCISE IN COUNTRY “R”

MASTER EVENTS LIST				
Country R Time	**Country A Time**	**Event**	**Simulator Actions**	**Remarks**
Initiating Event: A fire and explosion, caused by turbine damage occurs at a nuclear power plant (NPP) in country A. This causes the partial activation of country R’s national nuclear emergency plan (NNEP) organization. The event happened approximately nine hours ago.				
09:15	15:15	**STARTEX**	**Input 1.** Provide all information received from external sources, concerning the event. The PIC and TSC participants will be **separated** for the first input. They will work separately to develop their assessment of the information available. The NNEP National Coordinator will be separated from both groups.	This input initiates the exercise. Information received either directly from the country A or through the IAEA should be available. If nothing has been received, inputs generated by the exercise control group will be provided. Provide time for participants to assimilate and assess available information to determine impact to country R. **Exercise Evaluator** will be with PIC to take notes and direct the discussion. **Exercise Recorder** will be with TSC to take notes. **Exercise Simulator** will be with the TSC to direct the discussion. **Exercise Director** will accompany country R’s Health Authority.
09:35	15:35	The NNEP National Coordinator requests an initial assessment briefing.	**Input 2.** Briefing is requested in person by the NNEP National Coordinator for ASAP but not later than 09:45. The PIC and TSC will be brought together and will remain together until after lunch.	The purpose of this input is to help focus the participants on the task at hand. **Controller 2** will be the primary recorder.
09:45	15:45	The NNEP National Coordinator is briefed.	**Input 3.** Assemble for the briefing.	The briefing is simulated and questions asked.

MASTER EVENTS LIST

Country R Time	Country A Time	Event	Simulator Actions	Remarks
10:00	16:00	Multiple requests for information are received from concerned family members of country R's Armed Forces' personnel and the media.	**Input 4A.** Television stations are requesting information for early morning news programs and one of them is requesting an interview with the Minister of the Environment. **Input 4B.** Concerned family members have called country R's National Defence inquiring about the safety of country R's Forces personnel in country A. The Acting Lead of Defence Staff has asked the Lead of Medical Services to respond to inquiries. He/she in turn has asked the Health Authority for any information it may have.	The purpose of this input is to sensitise participants to the potential for requests for information from a wide variety of sources entering the system at a number of points. This input is given to the Atmospheric Environments Services (AES) representative. This input is given to a Health Authority TSC representative.
10:15	16:15	The President of the Atomic Energy Regulatory Authority requests *Question Period Notes* for the Minister responsible for the Atomic Energy Regulatory Authority	**Input 5.** This input will be given to the Atomic Energy Regulatory Authority PIC representative. The *Question Period Notes* are to be in the possession of the Atomic Energy Regulatory Authority.	The purpose of this input is to remind the participants of one of their primary functions- to inform the government. This input is given to the Atomic Energy Regulatory Authority PIC representative.

MASTER EVENTS LIST				
Country R Time	**Country A Time**	**Event**	**Simulator Actions**	**Remarks**
10:30	16:30	The media reports on various issues concerning air travel to and from country A's continent.		This input will require participants to react to actions by various groups, which are based on misinformation or an incomplete understanding of the information.
			Input 6A. Country R's X airlines announce that they are re-routing all flights that might fly over country A. **Input 6B.** Country R's Y airlines have announced the cancellation of all flights to and from the nearest city to the emergency site. **Input 6C.** Y airlines Pilots' Association issues a statement that they have informed their members to refuse to make flights through the plume and have suggested that travellers with destinations to country A reconsider their travel plans. **Input 6D.** The union representing the ground handling crews at one of country R's International Airports have advised their members not to handle flights that originated or stopped over in country A. **Note: Inputs 6A - 6D are intended to be video inputs. A hard copy of the media report is also available for use if necessary.**	**Exercise Simulator** will look after video input. This is **Video Input 1**.
			Input 6E. Alliance of country R's Travel Associations request for information to support members.	**Exercise Director** will provide this input to External Affairs (EA) PIC representative.

MASTER EVENTS LIST				
Country R Time	**Country A Time**	**Event**	**Simulator Actions**	**Remarks**
10:45	16:45	The environmental group "Greenpeace" has issued a statement suggesting that "a similar emergency could easily occur at a country R nuclear generating station since country A's reactor is similar to those of country R's and it is operated and maintained to its safety standards. In addition, current and projected country R electrical power requirements do not warrant putting the public safety in such grave jeopardy."	**Input 7.** This input is a fax from an environmental group's office in country R's capital and will be given to the assembled participants.	The purpose of this input is to require the participants to look at the issues involved in dealing with special interest and/or expert groups. This includes the problem of dealing with inaccurate information presented as fact by such groups. This input is given to the Atomic Energy Regulatory Authority TSC representative.
11:00	17:00	Country R's media are clamouring for interviews with government officials (Ministers, President of Atomic Energy Regulatory Authority, etc.) for their mid-day news programs.	**Input 8.** Multiple inputs from various media, primarily TV and radio, but also the printed press, to government departments.	This input is intended to require participants to assess or reassess the requirements of the media and how best to deal with them. The inputs will be given to the PIC participants from the Health Authority, EA and the Atomic Energy Regulatory Authority.

MASTER EVENTS LIST

Country R Time	Country A Time	Event	Simulator Actions	Remarks
11:25	17:25	Unconfirmed report of a second, more serious, explosion at the country A's NPP.	**Input 9.** This input will be taken from the Internet by the media. **Note: This input is intended to be a video input. A hard copy of the media report is also available for use if necessary.**	This report is in fact false and is intended to present the problem of dealing with rumour. **Exercise Simulator** will look after the video. This is **Video Input 2.**
11:35	17:35	"Greenpeace" issues another statement to the effect that "if the report of a second, more serious, explosion at the NPP is true, this would create a catastrophe of biblical proportions."	**Input 10.** This is as a result of the input above. It will once again be a fax from the environmental group.	The purpose of this input is to require the participants to deal with inflammatory rhetoric rather than statements of substance. This input will be provided to a Health Authority PIC and TSC representative.
11:50	17:50	Citizen action groups are demanding that the licences for similar NPPs not be renewed. They point to the recent safety history of the facilities and to the age of one of them.	**Input 11.** This will be a televised news broadcast concerning picketing at the facilities. **Note: This input is intended to be a video input. A hard copy of the media report is also available for use if necessary.**	The purpose of this input is to require the participants to deal with current country R nuclear issues. **Exercise Simulator** will look after the video. This is **Video Input 3.**

MASTER EVENTS LIST				
Country R Time	**Country A Time**	**Event**	**Simulator Actions**	**Remarks**
12:20	18:20	A TV news station reports in its 12:00 edition that a spokesperson for country A's continent nations has stated that six nations are testing milk for deadly radioactive contamination. There is additional coverage of related country R news including citizen action groups in various parts of country R questioning the need for testing of country R milk.	**Input 12A.** A TV news station 12:00 edition reports that a country R neighbour TV station has stated that several country A continent nations will test milk for Iodine-131. There is an unconfirmed report from the neighbouring country that an unnamed government source has stated that they are considering testing milk but have not yet made a final decision. **Input 12B.** The Cheese Producers of country R have been called for a ban on the importation of cheese products from country A. **Input 12C.** The Wine Growers have called for a ban on importation of this year's wines from countries surrounding country A. **Note: Inputs 12A - 12C are intended to be video inputs. A hard copy of the media report is also available for use is necessary.**	The purpose of this input is to require participants to acknowledge the existence of other influential special interest groups and to deal effectively with the issues they raise. **Exercise Simulator** will look after the video. This is **Video Input 4**.
			Input 12D. The Department of Agriculture reports that there have been numerous calls to regional offices, from individual concerned citizens and consumer action groups demanding to know what food products are being/will be affected.	This input will be given to the Department of Agriculture TSC representative.

MASTER EVENTS LIST

Country R Time	Country A Time	Event	Simulator Actions	Remarks
12:30	18:30	The situation at country A's NPP has become a little clearer. There was **not** a second, more serious, explosion.	**Input 13.** This input will be a fax from the IAEA.	This input acknowledges the participants' efforts to seek accurate information. This will be provided to the Atomic Energy Regulatory Authority TSC representative.
12:45	18:45	Misinformation, rumour and conflicting information have heightened the public's perception of the perceived risk as compared to the real risk. Concerned citizens and advocate groups are flooding switchboards with demands for information on the impact of the nuclear emergency for country R citizens. In addition, a member of a scientific organization has provided expert opinion to at least one media source.	**Input 14A.** This input is intended to be provided to various participants to represent the information coming from a variety of sources. Each input will contain a sample of the questions being asked by the public. **Input 14B.** This input is intended to be a media interview with Dr. Z of country R's Institute of Radiation Safety. It introduces potential conflicting and/or misinformation. **Note: Input 14B is intended to be a video input. A hard copy of the media interview is also available for use if necessary.**	This input is intended to sensitise the participants to the real probability that the public's perception of the risk will be considerably different from the real risk to their health and wellbeing. The **Exercise Director** will provide this input to a representative of each department. **Exercise Simulator** will look after the video. This is **Video Input 5.**

MASTER EVENTS LIST				
Country R Time	**Country A Time**	**Event**	**Simulator Actions**	**Remarks**
13:15	19:15	The NNEP National Coordinator requests an update briefing.	**Input 15.** This input will be made in person by the NNEP National Coordinator who will be segregated from the process of developing the briefing. The PIC and TSC participants will be separated so that they will be required to physically seek out information.	This input emulates the process that would be in place if the NNEP were fully activated. It will require the participants to develop the briefing package. **Exercise Director** will accompany country R’s Health Authority. **Exercise Evaluator** will be with the PIC to take notes and direct the discussion. **Exercise Recorder** will be with TSC to take notes. **Exercise Simulator** will be with the TSC to direct the discussion.
14:00	20:00	The briefing is presented.	**Input 16.** Assemble for the briefing.	The briefing is presented and questions asked.
14:20	20:20	There is an unconfirmed report of a serious loss of coolant emergency at one of country R’s NPP.	**Input 17.** The apparent cause of the LOCA was a badly corroded header in a steam generator.	This input will be given to the Atomic Energy Regulatory Authority TSC.
14:30	20:30	**ENDEX**	**Input 18.** Participants are to be reminded of the time and place for the debriefing.	

APPENDIX XI: EXAMPLE OF RADIOLOGICAL DATA IN A FACILITY

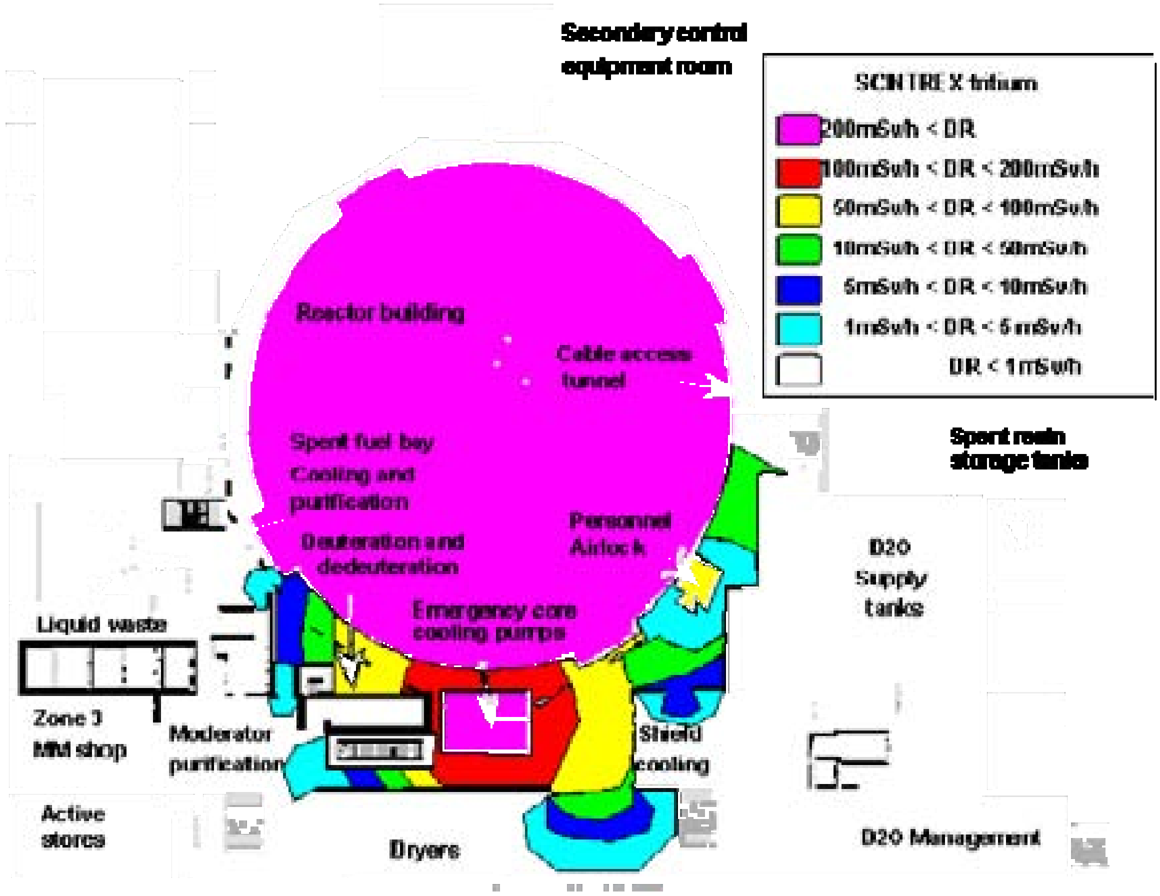


FIG. XI-1. Radiological plant data.

TABLE XI-1. RADIOLOGICAL DATA FOR NOBLE GAS SAMPLE (^{133}Xe)

Time	t[a]	Activity (TBq)	Gamma dose rate (Sv/h)		Beta dose rate (Gy/h)	
			Contact	30 cm	Contact	30 cm
11:00	345	370	30	0.21	82.5	0.58
1:00	525	170	13.5	0.09	37.2	0.26
15:00	585	84	0.7	0.05	18.6	0.13
16:00	645	7.8	0.32	0.02	9.1	0.06

[a] t = time in minutes from start of exercise.

TABLE XI-2. RADIOLOGICAL DATA FOR IODINE SAMPLE (SILVER ZEOLITE)

Time	**t**[a]	**Activity (TBq)**	**Gamma dose rate (Sv/h)**		**Beta dose rate (Gy/h)**	
			Contact	30 cm	Contact	30 cm
11:00	345	0.41	56	0.39	69	0.48
1:00	525	0.18	25	0.18	31	0.22
15:00	585	0.09	12.5	0.09	16	0.11
16:00	645	0.04	6.2	0.04	7.8	0.05

[a] t = time in minutes from start of exercise.

TABLE XI-3. REACTOR BUILDING RADIOLOGICAL DATA[a]

Elevation	**Dose rate, mSv/h**	
	Inside building	**Outside building**[b]
7.5 m		
North	32	0.032
East	36	0.037
South	130	0.13
West	29	0.029
15.5 m		
North	32	
East	30	
South	14	
West	14	0.014
23 m		
North	90	
East	36	
South	82	
West	18	0.018
30 m		
North	12	
East	150	
South	70	
West	20	

[a] Reactor building air activity 4.9×10^6 Bq/m^3
Dose rate on filters (contact):0.69 Sv/h γ
0.84 Sv/h β+ γ
Dose rate from filters (at 30 cm): 0.005 Sv/h γ
0.006 Sv/h β + γ

[b] Where the dose rate is not given, report the background level.

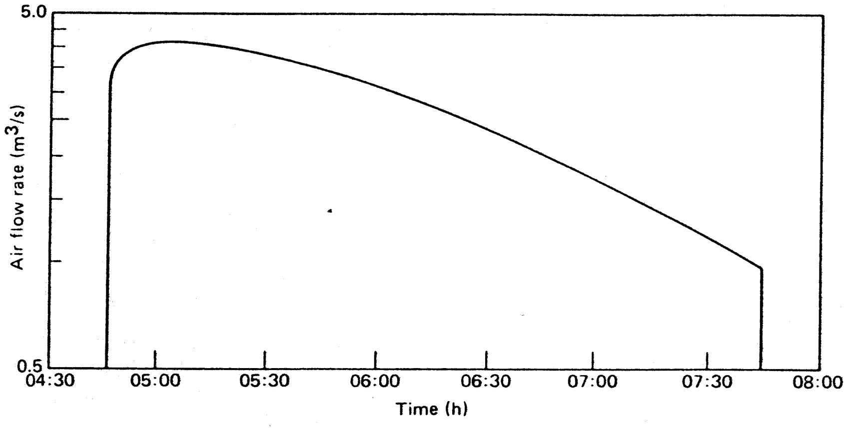


FIG. XI-2. Containment purge flow rate versus time.

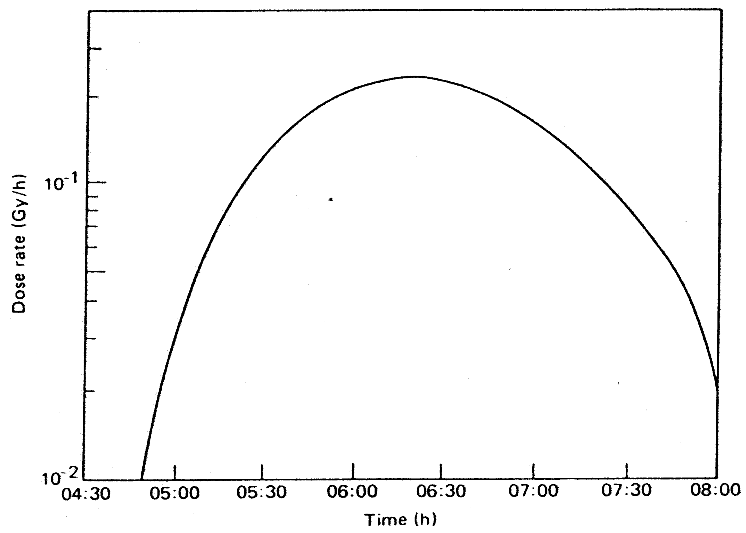


FIG. XI-3. Containment radiation monitor dose rate versus time.

APPENDIX XII: EXAMPLES OF ENVIRONMENTAL DATA FOR A RADIOACTIVE PLUME

TABLE XII-1. TIMES OF CLOUD PASSAGE IN RELATION TO TIME OF EMERGENCY START

Status of cloud passage	**Distance from stack**				
	400 m	1 000 m	2 000 m	5 000 m	10 000 m
	Time elapsed				
Start of passage of cloud	1 min 20 s	3 min 20 s	6 min 40 s	16 min 40 s	33 min 20 s
End of passage of cloud	21 min 20 s	23 min 20 s	26 min 40 s	36 min 40 s	53 min 20 s

APPENDIX XIII: EXAMPLES OF METEOROLOGICAL DATA

TABLE XIII-1. METEOROLOGICAL PRINTER LISTING

Month/day/year:		Time:			
Level (m)	**Wind direction (degrees)**	**ΣA (degrees)**	**Wind speed (m/s)**	**Temperature (°C)**	**ΔT (°C/min)**
10	155	-	6.7	11	-
46	-	-	-	-	0.02
76	155	-	6.7	12.3	0.02
	Distance (km)		**χ/Q (s/m^3)**	**Σy (m)**	
	0.80		0.801×10^{-4}	29.0	
	1.00		0.636×10^{-4}	35.7	
	2.00		0.273×10^{-4}	67.5	
	4.00		0.112×10^{-4}	125.6	
	6.00		0.671×10^{-5}	179.9	
	8.00		0.469×10^{-5}	232.0	
	10.00		0.357×10^{-5}	282.0	
	25.00		0.125×10^{-5}	611.5	
	50.00		0.577×10^{-6}	1082.0	
	100.00		0.268×10^{-6}	1900.0	
	Mixing height: 500 m				

TABLE XIII-2. EXERCISE INFORMATION - METEOROLOGICAL DATA

Time		Wind direction		Wind speed	Temperature
	t [a]	From	To	m/s	difference [b] Δ T (°C)
05:15	0	22 NNE	202 SSW	0.36	-1.7
06:00	45	18 NNE	198 SSW	0.45	-1.7
06:30	75	14 NNE	194 SSW	0.82	-1.7
07:30	135	12 NNE	192 SSW	1.00	-1.7
08:30	195	10 N	190 S	1.10	-1.7
08:45	210	348 NNW	168 SSE	1.10	-1.7
09:00	225	341 NNW	161 SSE	1.20	-1.8
09:15	240	332 NNW	152 SSE	1.30	-1.8
09:30	255	327 NNW	147 SSE	1.30	-1.8
09:45	270	328 NNW	148 SSE	0.86	-1.8
10:00	285	330 NNW	150 SSE	0.91	-1.8
10:15	300	327 NNW	147 SSE	0.91	-1.8
10:30	315	315 NW	135 SSE	1.00	-1.9
To termination	-	315 NW	135 SE	1.00	-1.9

[a] t = time in minutes from commencement of exercise.
[b] Temperature difference between 10 m and 100 m altitude.

APPENDIX XIV: EXAMPLE OF OFF-SITE RADIOLOGICAL DATA IN DIFFERENT FORMATS

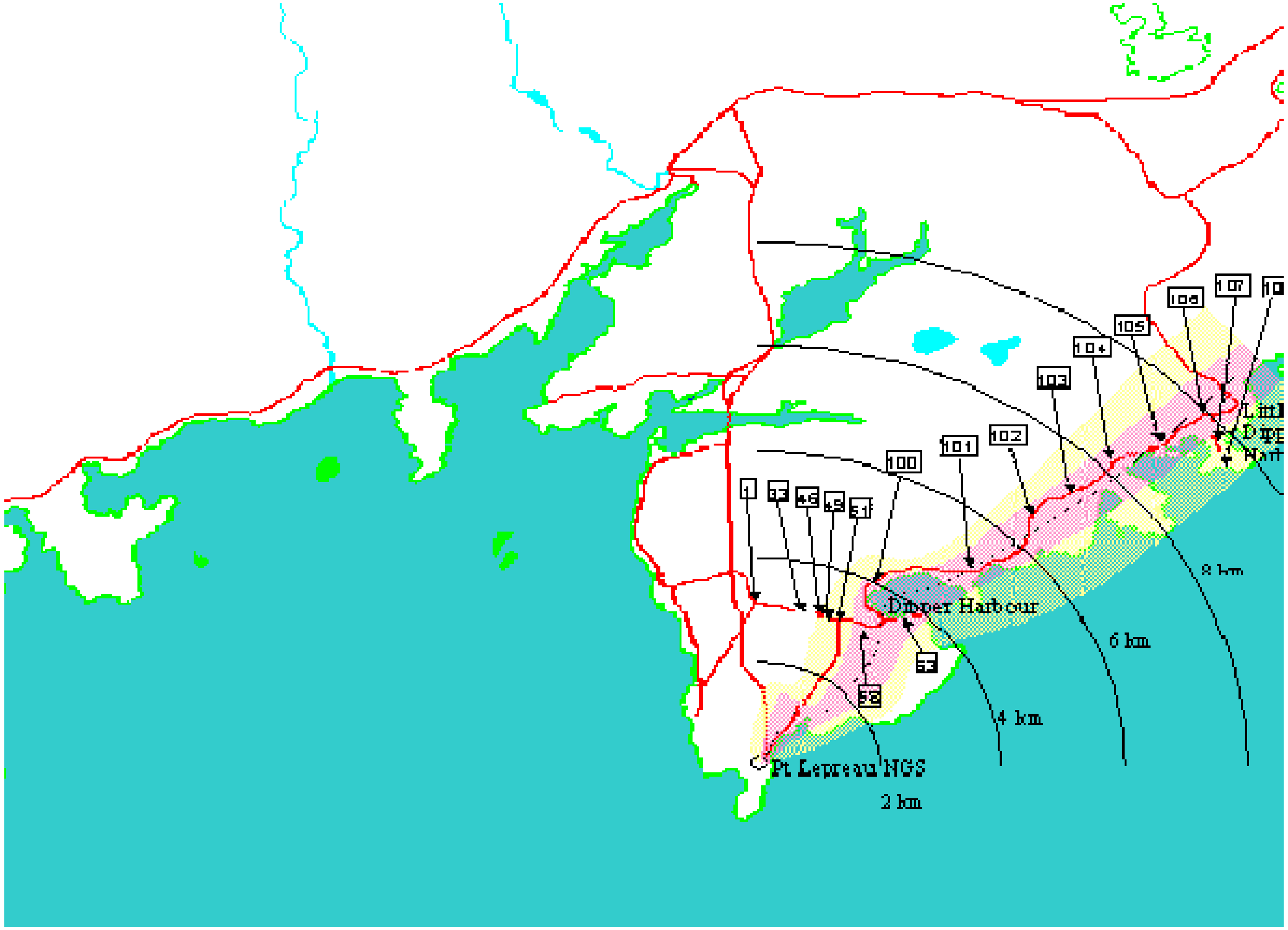


FIG.XIV-1. Example of off-site radiological data in graphical format.

TABLE XIV-1, EXAMPLE OF OFF-SITE RADIOLOGICAL DATA IN MATRIX FORMAT

Reference	**Dose rate (µSv/h) vs time**												
	6:30	**6:35**	**6:40**	**6:45**	**6:50**	**6:55**	**7:00**	**7:05**	**7:10**	**7:15**	**7:20**	**7:25**	**7:30**
Zone 1	0.1	0.1	0.1	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.2	0.1	0.1
Zone 2	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.3	0.2	0.1	0.2
Zone 3	0.3	0.2	0.1	0.1	0.2	0.1	0.2	0.2	0.1	0.1	0.2	0.3	0.2
Pole 46	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Pole 49	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Pole 51	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Pole 58	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Pole 63	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Pole 100	0.2	0.2	0.1	0.2	0.3	0.2	0.1	0.2	0.2	0.1	0.1	0.2	0.1
Pole 101	0.2	0.2	0.1	0.2	0.1	0.2	0.2	0.1	0.2	0.1	0.3	0.2	0.1
Pole 102	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Pole 103	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1
Pole 104	0.2	0.2	0.1	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.1
Pole 105	0.2	0.1	0.2	0.2	0.3	0.2	0.2	0.1	0.2	0.1	0.2	0.1	0.1
Pole 106	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.2
Pole 107	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Pole 108	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
South Musquash	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

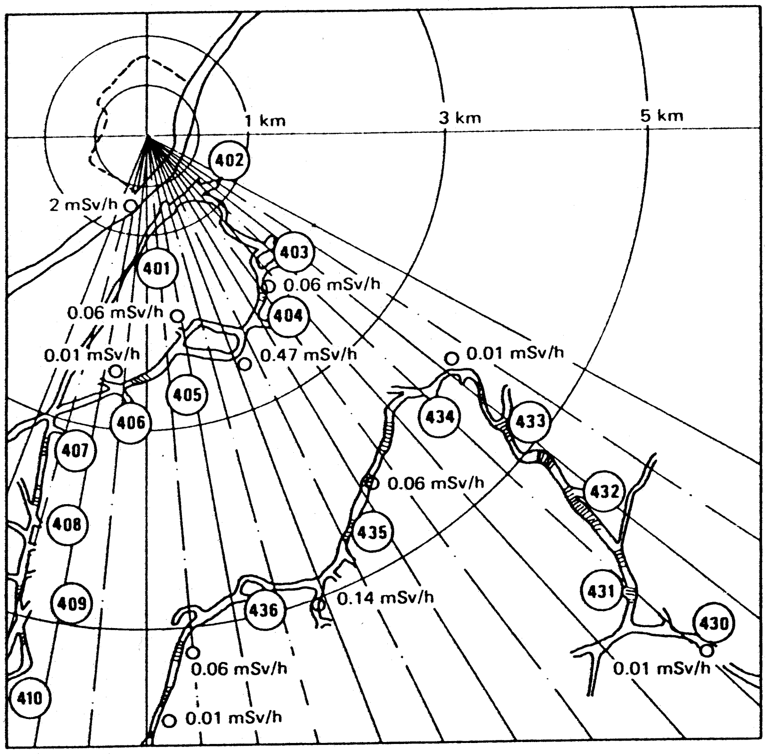


FIG.XIV-2. Dose rate measurements during passage of cloud.

Methods of providing radiological field data

Using tables to represent the plume

A spreadsheet tool is developed to provide readings along the centre line at various distances as a function of time. This is dependent on the release profile, i.e. readings vary according to plume travel and the release fraction in the time interval considered. To do this, the release can be divided in several time intervals, each with an assumed release fraction of the total release. The doses were scaled according to that release fraction. The dose rates can be obtained by dividing the dose by the time interval, and introducing a time correction factor that accounts for plume travel time at the given wind speed.

A map showing the plume centre line is used to indicate the plume travel path. In this example, a Gaussian dispersion model can be used to generate integrated dose results and plume location. This map shows the plume centre line and the lateral extent of the plume, where it is assumed, in this case, that the values are 10% of the plume centre line values. This is arbitrary. Between the plume centre line and the 10% line, the readings are assumed to vary linearly.

The controller must choose the data from the table at the right distance and time. If the survey is off the centre line, the controller introduces a “fudge” factor to reduce the value of the reading in the table.

Conversely, data can be tabulated at fixed points and pre-calculated to take into account the distance off the centre line. This is effective especially when procedures call for surveys at pre-established monitoring locations, or when fixed monitors are used.

A similar table of locations and times can also be used to shown the simulated readings in the facility or at the emergency site.

The disadvantage of this method is that it is difficult to model variations in wind direction, and hot spots. The main advantage is that only one map is required for all data types (e.g. dose rate, air samples). One table is used for each data type. Remember to tabulate the data values as they would be read off the appropriate instrument (e.g. cpm or mSv/h).

Using graphs to represent the plume

Survey data can be conveyed through pictures of zones within which selected readings would be obtained if surveyed. Several pictures can be used to account for time variations. A separate set of pictures is required for each data type, including for example plume dose rates, ground shine, air contamination, surface contamination, etc.

Surface contamination

There are two basic methods of providing the exercise participants with off-site surface contamination data needed for input purposes.

In the simpler method, controllers provide the radiological survey teams with gamma or beta-gamma dose rates or other relevant radiological readings at each survey point. The controller concerned will usually be stationed with the survey team or at the location from which the surveyors are dispatched. Similarly, dosimeters, samples of water, vegetation, etc. sent to environmental assessment laboratories are assigned pre-calculated readings which are divulged by a controller at the laboratory, preferably after the actual sample analysis has been completed. Alternatively, an appropriate delay could be included to take into account the time taken to dispatch the sample to the laboratory, the workload at the laboratory and the estimated counting and analysis time. This method suffers from the minor disadvantage that the laboratory staff are not fully exercised, although this is largely overcome if some work in sample preparation and analysis is carried out.

The second method, which entails considerably more work, involves the preparation of sources and samples containing radioactive material in appropriate amounts which will give predetermined readings on field survey instruments or in the environmental assessment laboratory. Generally speaking, laboratory staff may be adequately exercised in handling radioactive samples during routine operations or spills, so that the complication of introducing radioactive samples into large exercises may be unnecessary. This may not, however, provide staff with experience in handling large numbers of active samples or dealing with the inherent problem of sample segregation to prevent cross-contamination. However, environmental survey laboratories are dependent upon their ability to maintain low background levels of radiation, and it may not be prudent, as part of an exercise, to introduce large quantities of highly radioactive samples into this type of laboratory, with the concomitant potential for contamination and increased levels of background radiation. Field survey teams can also be adequately drilled using spiked samples in a classroom setting, although it may be desirable to see how they and their instruments perform in adverse weather conditions.

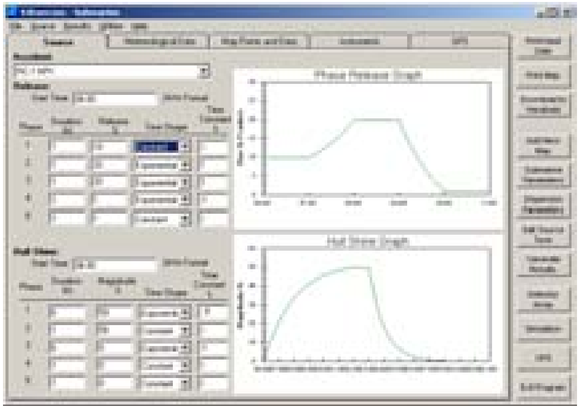
These two basic methods may be combined by allowing survey teams and laboratories to perform measurements on samples that may or may not be radioactive and then substituting appropriate values based on the scenario's detailed event description. The use of pre-irradiated dosimeters to simulate received radiation doses should also be considered, as these can easily be prepared in advance of the exercise.

APPENDIX XV: EXAMPLE OF EXERCISE SOFTWARE TO SIMULATE FIELD MEASUREMENTS AND DOSE

There are a few programs that can be used to generate and simulate field measurements. The following is an example of one such software.

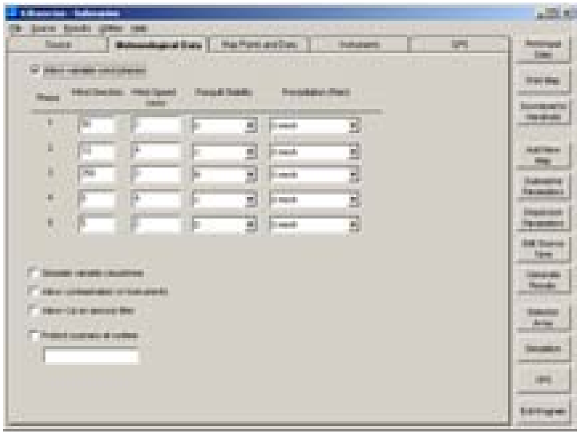
Source parameters

Some programs allow selection from pre-defined emergencies or allow the user to enter customized source term data. In the example below, the simulation of gamma shine from a submarine, radioactive container or unshielded source is possible. This software also allows the simulation of various phases for the release and the gamma shine.



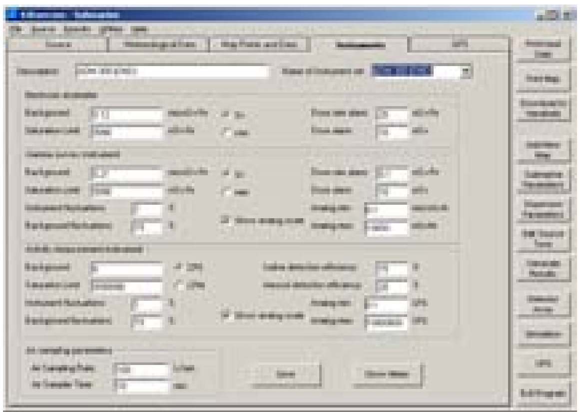
Meteorological data

Such software allows the user to define a weather profile for several release phases. This allows the simulation of changing wind conditions through the exercise. Wind meander, the physical form of iodine and instrument contamination can also be simulated.



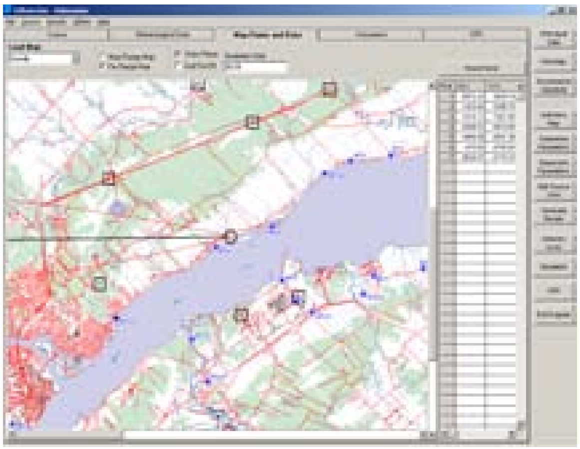
Instruments

Instrument technical specifications can also be defined so that the readings reflect the realistic behaviour of the field instruments used.



Map

Such software usually allows the user to define the source location by clicking on a geo-referenced map. Fixed survey points and monitoring stations can also be defined in the same manner.



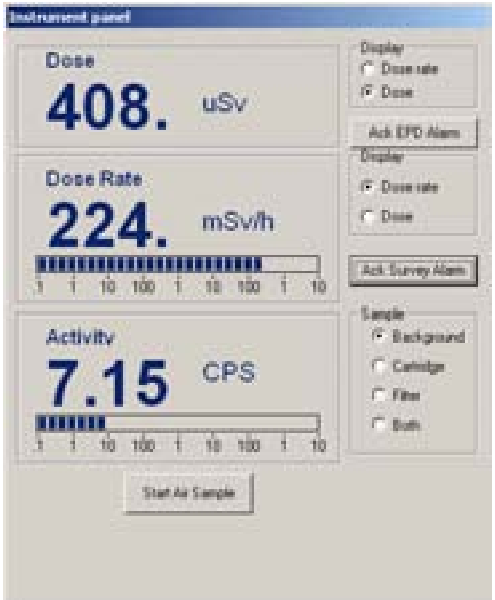
Modes of operation

Exercise software can often be used in three modes:

Real-time GPS mode. In this mode, the software displays simulated instrument readings based on location and scenario time. The software also continuously integrates dose rates to provide an accurate reading of the dose received by the surveyor. This is the only way to accurately simulate the dose received during an exercise.

Real-time monitoring station mode. In this mode, the software continuously displays the readings from the monitoring stations defined on the map.

Simulation mode. In this mode, the user simulates the location of a survey team by moving a cursor on the map.



APPENDIX XVI: EXAMPLE OF EXERCISE CONTAMINATION DATA

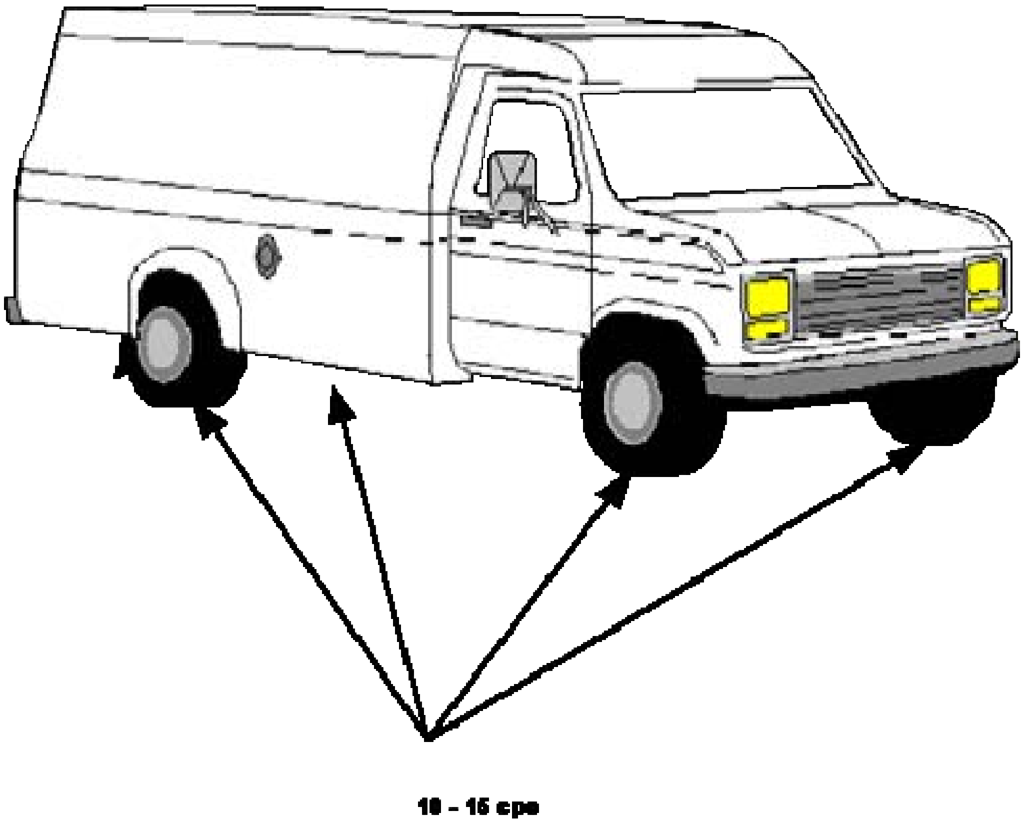


FIG. XVI-1. Example of vehicle contamination survey.

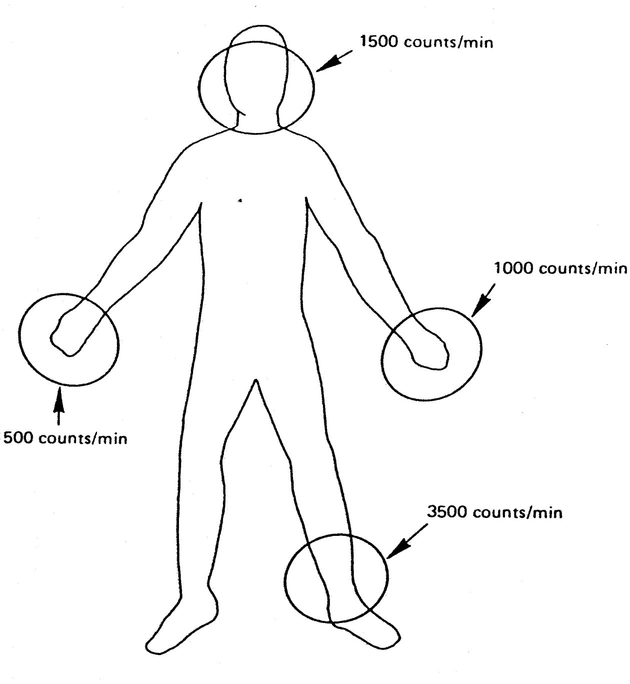


FIG. XVI-2. Example of individual contamination data.

APPENDIX XVII: EXAMPLES OF EXERCISE MESSAGES

1) EXERCISE CONTROL MESSAGE

Time:	06:00
Issue to:	Shift engineer from controller
Caution:	This is an exercise. Emphasise in communications that this is an
exercise.	DO NOT alter actual unit operation for purposes of the exercise.
Message:	Plant Status Update

- Unit no.2 is normal
- Unit no.1 has a primary system leak of 3.5 L/s as indicated by an imbalance between charging and letdown flow
- Unit no. 1: plant status is as follows:

(1) Containment radiation level: 10 Gy/h.
(2) Containment pressure: Depressurised.
(3) Reactor pressure: 1.54×10^7 Pa.
(4) Pressurizer level: 33%.
(5) Containment temperature: 27°C.
(6) Containment humidity: 40%.
(7) Raw water storage tank level: normal.
(8) Re-circulation sump level: 0.
(9) Meteorological data: Wind from SSE (158°) at 4.4 m/s; T = -1°C/100 m.

2) SIMULATED MESSAGES

These messages will be recorded in full in the following manner:

Date:	Time:
Name of person called:	
Telephone no.:	
Message that would have been sent:	

3) CONTROL INFORMATION MESSAGE

Valid Time Period:	10:45-12:45
Title:	In-plant dose rates.
Issue to:	Health Physics teams making in-plant surveys.
Message:	Report actual readings for all in-plant areas except for the following:

(1) Containment purge system room. Post this as a high radiation area - no admittance.

(2) Roof of containment purge system room (elevation 196 m).

(a) For Area A on the floor plan, which is directly above the purge exhaust directing, there are localised 'hot spots' of 5×10^{-4} Sv/h to 5×10^{-3} Sv/h - restrict admittance.

(b) For Area B on the floor plan, which is the probable staging area for a repair effort, there is an average dose field of about 3×10^{-4} to 4×10^{-4} Sv/h due to containment shine, with the 4×10^{-4} Sv/h value occurring at the closest point of approach to the containment.

(c) For Area C on the floor plan, which is the location of the access hatch to the purge exhaust valve area (about 1.5 m above the valve, there is a local dose field of 2.4×10^{-2} Sv/h).

(3) Vicinity of containment purge exhaust valve (elevation 163 m).

The dose field in the vicinity of the purge exhaust valve can be summarised as follows:

Dose rate at 0.3 m: 3.63×10^{-1} Sv/h
Dose rate at 1.5 m: 9.4×10^{-2} Sv/h
Dose rate at 3.0 m: 3.3×10^{-2} Sv/h

These doses take into account contributions from the purge line itself as well as the containment.

Note: **There is no airborne iodine in any of these areas.**

4) CONTROL INFORMATION MESSAGE

Valid time period:	06:00-10:45 and 12:45-16:00
Issue to:	In-plant health physics from in-plant team controller

Provide this information to the health physics teams as they survey the in-plant area.

- Normal radiation fields are in effect.
- Report actual readings in all areas except as noted below.
- During the simulated sampling of reactor coolant and containment air after 09:15, use the following contact dose rate information:

containment air sample (unshielded):	3×10^{-4} Sv/h
containment air sample (shielded):	1×10^{-5} Sv/h
reactor coolant sample (unshielded):	7×10^{-5} Sv/h
reactor coolant sample (shielded):	1×10^{-5} Sv/h

5) CONTROL INFORMATION MESSAGE

Valid Time Period:	06:00-10:45
Title:	Containment integrity
Issue to:	Technical Support Centre - Site Emergency Director or Control Room Shift Engineer

Message:

– If discussion arises concerning containment integrity, allow it to reach a conclusion.

– If decision is that integrity is impaired, inform Site Emergency Director that while the decision may be justified, for the progress of the exercise all containment isolation systems are currently intact and there are no indications that containment integrity is impaired.

APPENDIX XVIII: EXAMPLE GUIDE FOR CONTROLLERS

INSTRUCTIONS

1. INTRODUCTION

The exercise will be conducted from the Puff NPP simulator for reactor plant data. The off-site simulation and control centre will be established at location X to simulate off-site activities. There will be field controllers at the traffic control point(s), the EOF/ICP and the Relocation/Reception Centre.

The pace and direction of the exercise will be controlled by the lead on-site and off-site controllers from the EOF/ICP. They will control the master events list and coordinate the exercise inputs. Each controller will receive a detailed "controllers package" at the briefing on 2 September. The controller's package will contain the required inputs and communications instructions.

2. EXERCISE TEAM

2.1. ORGANIZATION CHART

The exercise team organization is shown in Figure XVIII-1.

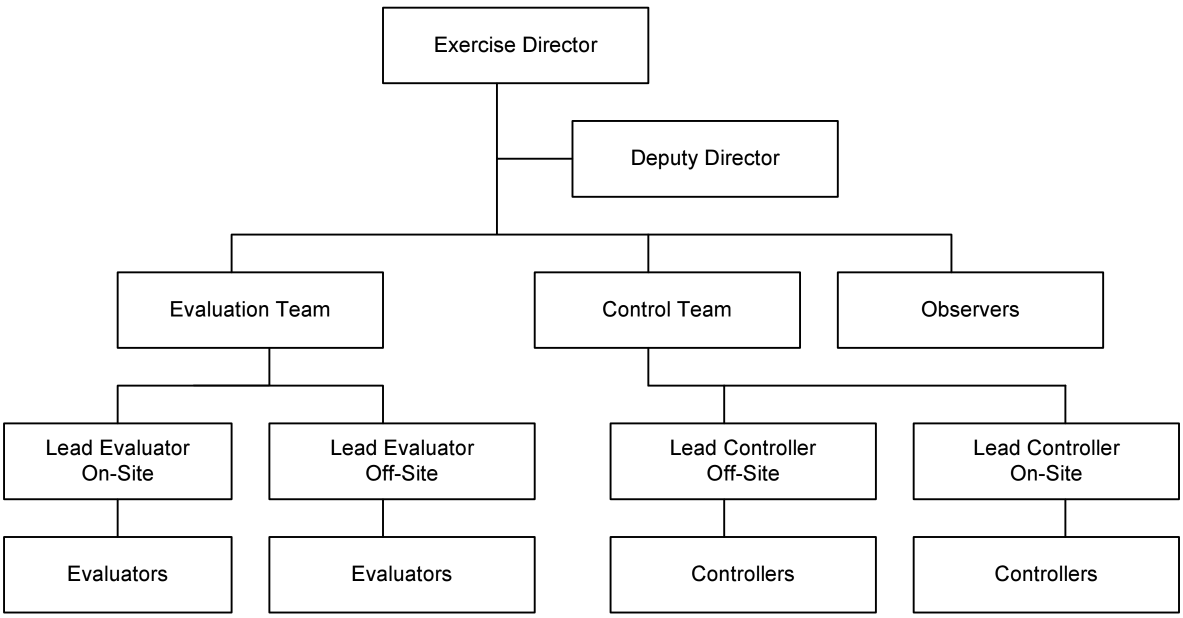


FIG. XVIII-1. Organization of the exercise team.

2.2. ROLES AND RESPONSIBILITIES

Exercise Director

The Exercise Director is responsible for the overall exercise. His responsibilities include:

- deciding when the exercise starts;
- stopping the exercise for safety reasons, if required;
- resolving conflicts between the on-site and off-site controllers, if required; and
- stopping the overall exercise.

Deputy Director

The Deputy Exercise Director assists the exercise directors and acts as exercise director if the latter becomes unavailable.

Lead Controllers

The On-site and Off-site Lead Controllers are responsible for the conduct of the on-site and off-site portions of the exercise, respectively. Their responsibilities include:

- starting their respective portion of the exercise;
- ensuring the good conduct and coordination of all aspects of their respective portion of the exercise;
- coordinating, together, the on-site and off-site aspects of the exercise;
- resolving issues related to timings and ensuring that all controllers are informed of any change in timelines;
- stopping their respective portion of the exercise for safety reasons, if required; and
- informing the exercise director of the progress and issues related to the exercise on an on-going basis.

Controllers

Controllers are responsible for the proper conduct of their assigned portion of the exercise. Their responsibilities include:

- providing the required exercise input;
- ensuring that actions are carried out in a safe manner;
- stopping their portion of the scenario for safety reasons, as required;
- immediately informing the lead controllers when the time line is compromised;
- immediately informing the lead controllers when safety is compromised; and
- ensuring that their work place is left in a safe state when the exercise is over.

Lead Evaluators

The On-site and Off-site Lead Evaluators are responsible for coordinating the evaluation of their respective portion of the exercise. Lead Evaluator responsibilities include:

- instructing their evaluators on the evaluation schedule, method and criteria;
- ensuring consistency in the evaluators notes;
- instructing the evaluators on the format and schedule for their evaluation report;

- gathering all evaluators notes and reports; and
- producing the final evaluation report for their respective portion of the exercise.

Evaluators

Evaluators are responsible for taking notes during the exercise and participating in the production of the final evaluation reports, as instructed by their respective lead evaluator.

2.3. ALLOCATION OF RESPONSIBILITIES

Table XVIII-1 lists the persons allocated to each exercise team position, their location during the exercise, and their contact number during the exercise. Contact numbers are intentionally left blank at this time. An updated list with exercise contact numbers provided will be distributed the day before the exercise.

TABLE XVIII-1: EXERCISE TEAM BACKGROUND INFORMATION

Exercise position	Name and organization	Location	Contact number during the exercise
Exercise Director			
Deputy Exercise Director			
EVALUATORS			
On-site			
Lead Evaluator		Simulator	
Control Room		Simulator	
EOF/ICP		EOF/ICP Number:	
Emergency Response Team		Initially in the control room. Follow the ERT	
Off-site Survey Team 1		Initially in the simulator. Follow the first survey team.	
Off-site Survey Team 2		Initially in the simulator. Follow the second survey team, as required.	
TSC		TSC assembly point.	
Hospital		Hospital	
Health Physics Laboratory		Health Physics Lab	
Chemistry Laboratory		Chemistry Lab	
Off-site			
Lead Evaluator		EOF/ICP	
Nuclear Control Group		EOF/ICP	
TSC		EOF/ICP	
CONTROLLERS			
On-site			
Lead Controller		EOF/ICP	
Control Room		Control room	
EOF/ICP		EOF/ICP	
Emergency Response Team 1		Initially in the control room. Follow ERT.	
Emergency Response Team 2		Where required in the station to direct local initiating events such as the fire and the casualties.	
Off-site Survey Team 1		Initially in the simulator. Follow the first survey team.	
Off-site Survey Team 2		Initially in the simulator. Follow the second survey team.	
TSC		TSC assembly point.	
Hospital		Casualty treatment area.	
In-station security gate		In-station security gate.	

Laboratories		Health physics or chemistry lab, as required by input.	
Roamer		Simulator. Follow directions of the control room controller.	
Off-site			
Lead Controller		EOF/ICP	
Simulation cell leader		Simulation cell at the EOF/ICP	
National Department and agencies		Simulation cell at the EOF/ICP	
Power Corporation		Simulation cell at the EOF/ICP	
Media		Simulation cell at the EOF/ICP	
Non participating departments/agencies		Simulation cell at the EOF/ICP	
Traffic Control/ radiation monitoring point		Initially at the EOF/ICP. Move to the traffic control point, when directed by the lead off-site controller.	
All others		Simulation cell at the EOF/ICP.	

3. EXERCISE SCHEDULE

The following general timings are to be used for planning purposes:

Serial	Day	Time	Event	Location
1	2005-09-02	10:00 am	Exercise Team briefing	Puff NPP
2	2005-09-03	6:00 am	Startex	
3	2005-09-03	9:00 am	Volunteers (evacuees) assemble	
4	2005-09-03	10:00 am	Volunteer briefing	
5	2005-09-03	3:00 am	Endex	
6	2005-09-03	3:00 pm	Participants debriefing	Puff NPP Reception Centre
7	2005-09-03	4:00 pm	Exercise debriefing	All sites Teleconference From Puff NPP
8	2005-09-04	10:00 am	Exercise Team debriefing	Puff NPP
9	TBA	TBA	Exercise report debriefing	Puff NPP

The following briefings will be held:

A. Exercise Team briefing – 10:00 am, 2005-09-02 at the following locations:
- on-site group at the Puff NPP; and
- off-site group at EOF/ICP

B. Participants debriefing (hot wash) – 3:00 pm, 2005-09-03 at the following locations:
   - EOF/ICP
   - Reception Relocation Centre; and
   - Puff NPP.

C. Exercise debriefing – 4:00 pm, 2005-09-03 via teleconference from the EOF/ICP; and

D. Exercise report debriefing at time and place to be determined by the lead evaluator.

4. INSTRUCTIONS FOR CONTROLLERS

The points listed below are provided to assist controllers in carrying out their tasks as members of the exercise team. The direction and pace of the exercise rests with controllers.

Controllers shall:

Before the exercise:

- ensure that they are thoroughly familiar with the overall exercise scenario and evaluation objectives, and their particular roles and responsibilities.

During the exercise:

- clearly identify themselves as controllers to the organization being exercised at the start of the exercise;
- identify a telephone that can be used to reach the lead controller, if necessary;
- perform communications check with lead controller;
- always confirm they have reached an exercise participant before starting any message;
- always start each message with "FOR EXERCISE" and the name of the organization/individual being simulated (e.g. "FOR EXERCISE, this is the emergency coordinator");
- follow the instructions in the master events list;
- if the scenario or master events list gets off track, immediately report the problem to the lead controller;
- **not** provide additional information unless requested by the organization being evaluated, and then, only within the limits of the scenario;
- **not** accelerate the exercise by providing information ahead of schedule;
- within their sphere of influence, immediately terminate the affected activity when a real emergency or an unsafe situation occurs and report to the lead controller;
- monitor exercise play and make adjustments only when necessary to keep the exercise on track or to maintain a safe environment; and
- suspend local play for safety reasons and, if necessary, recommend to the exercise director the suspension of the whole exercise; and

After the exercise:

- ensure that the work place is left in a safe state at Endex.
- attend meeting held by the lead controller to identify control issues that may have affected the performance of participants.
- the lead controller will discuss with the lead evaluator the general conduct of the exercise and identify control issues that may have an impact on the evaluation.

APPENDIX XIX: EXAMPLE GUIDE FOR EVALUATORS

1. BACKGROUND

On 27-28 April 2005, country N will be holding a combined national and international nuclear emergency response exercise. The exercise will involve the Alpha NPP, the Omega emergency measures organization (OEMO), the national nuclear emergency plan (NNEP), the International Atomic Energy Agency (IAEA), the Nuclear Energy Agency (NEA) and over 20 countries. The Hydro company and the regional authority are the main drivers for this exercise. The national and international dimensions are built upon the regional components.

At the national level, the aim of this exercise is to:

- verify the ability of the NNEP organization to respond to a nuclear emergency in country N; and
- verify the international coordination mechanisms for the exchange of information.

REX Inc. has been tasked to lead the evaluation of the NNEP component.

2. AIM

The aim of this guide is to provide instructions for the REX-led evaluation team.

3. SCOPE

The scope is limited to the national support centre groups within NNEP, i.e.:

(a) the National Coordinator;
(b) the Operations Section;
(c) the TSC;
(d) the National Coordination Officer and liaison team in the operations centre; and
(e) the National Public Information Officer at the PIC.

4. ORGANIZATION

4.1. GENERAL

The NNEP national support centre evaluation team constitutes only part of the overall evaluation team and is shown in detail in Figure XIX-1.

Emergency Preparedness centre of country N provides the lead evaluator for the entire team. His role is to coordinate the overall evaluation and consolidate the evaluation reports by the various evaluation team leaders into a single evaluation report.

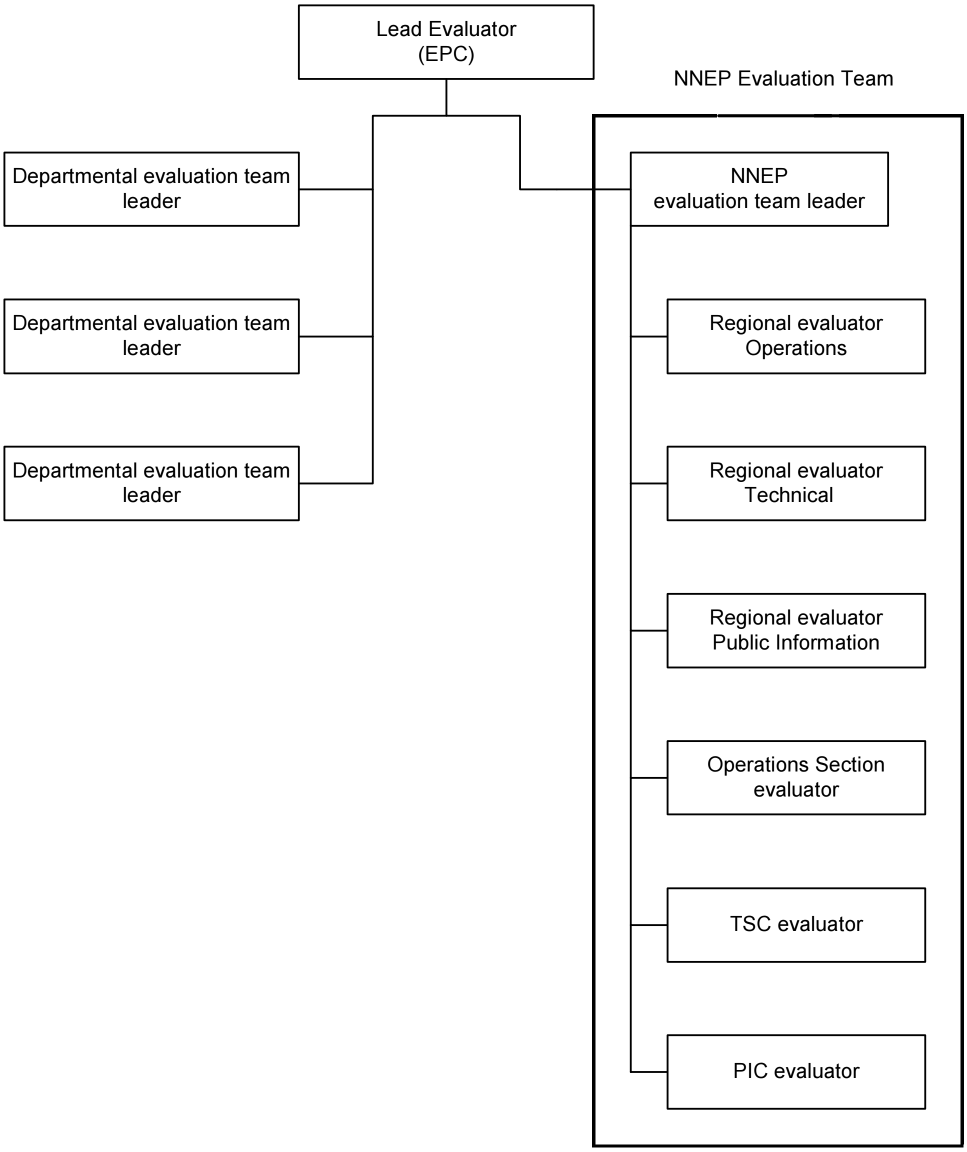


FIG.XIX-1. Evaluation team and overall national evaluation organization.

4.2. PERSONNEL

Personnel assigned to the evaluation team and primary locations are shown in Table XIX-1.

TABLE XIX-1. NNEP EVALUATION TEAM PERSONNEL

Position	Name	Primary location
NNEP evaluation team leader		
Operations Section evaluator		
TSC evaluator		
PIC evaluator		
Regional evaluator – Operations		
Regional evaluator – Technical		
Regional evaluator - Public Information		

4.3. RESPONSIBILITIES

4.3.1. NNEP evaluation team leader

- Coordinate the NNEP evaluation team instructions and logistics.
- Evaluate the National Coordinator.
- Provide instructions to the NNEP evaluation team staff.
- Consolidate the evaluations and produce the NNEP evaluation report.

4.3.2. Operation Section, TSC and PIC evaluators

- Evaluate respective groups.
- Produce evaluation report for respective group in accordance with the evaluation objectives.

4.3.3. Regional evaluator – Operations

- Lead the regional evaluators.
- Evaluate the work of the National Coordination Officer and of the National Operations Liaison Officers.
- Evaluate the operational interface between the national team and the regional team at the operations centre.

4.3.4. Regional evaluator – Technical

- Evaluate the work of the National Technical Liaison Officer at the regional operations centre.
- Evaluate the technical interface between the national team and the regional team at the regional operations centre.

4.3.5. Regional evaluator – Public Information

- Evaluate the work of the National Public Information Officer at the PIC.
- Evaluate the interface between the national team and the regional team at the PIC.

4.4. EVALUATION INSTRUCTIONS

Exercise evaluations are often based on compliance with procedures or checklists. While this is appropriate for the evaluation of complex operating actions (e.g. power plant operations), it does not always provide an adequate assessment of groups involved in emergency management, assessment and decision-making. For this type of evaluation, it is better to measure performance, or the achievement of well defined goals.

A performance-based exercise evaluation is based on defined emergency response functional elements and objectives. This approach does not use evaluation checklists, and there are no procedures to “tick off” during the exercise. Instead, a performance-based exercise evaluation requires that the evaluators have a good knowledge of the evaluation objectives and evaluation criteria that apply to the group being evaluated, and that they keep detailed and accurate records of the pertinent group’s actions.

The actual evaluation takes place after the exercise, when all evaluators share their observations on specific emergency functions and objectives.

This evaluation is to be ***performance-based***.

4.4.1. Guidance for evaluators

The role of evaluators is to observe the exercise and make note of their observations for later analysis and evaluation. They do not interact with the players and should route questions through a controller where possible. The evaluators must be able to recognise deficiencies and make recommendations; however, this does not mean evaluators should constantly be on the lookout for small errors. Only those deficiencies that affect the overall effectiveness need to be investigated thoroughly. Keep note of all deficiencies and quote examples to reinforce comments, to assist the Team Leader during the post-exercise evaluation and debriefing.

Evaluators should:

Prior to the exercise:

a. review the scenario timeline and response objectives applicable to their area; and
b. become very familiar with the applicable response objectives and evaluation criteria.

During the exercise:

a. arrive at the assigned location at least 20 minutes prior to the beginning of the exercise;
b. clearly identify themselves as evaluators to the organization being evaluated at the start of the exercise;
c. position themselves to maximise their effectiveness in evaluating, and be passive observers (i.e. DO NOT interfere with exercise play);
d. record facts, not impressions. Identify specific occurrences with time, date, location and organization involved. Record occurrence of repetitive actions;
e. record the time of major scenario events and actions;
f. ensure that each item is relevant to the role of the person/organization being evaluated;
g. note strengths as well as weaknesses;
h. ask questions only for clarification, if absolutely necessary. Do not become involved in discussions with players or other evaluators or controllers;
i. listen to all communications that affect their particular area of evaluation;
j. observe but not correct; and
k. not change the scenario or provide data.

Following the exercise:

a. review their notes;
b. prepare a written report using the list of evaluation objectives and criteria as a guide;
c. attend the evaluation briefing and assist in the production of the consolidated evaluation report.

5. SCHEDULE

For planning purposes, the schedule for NNEP evaluation team members will be as shown in Table XIX-2. This schedule may change slightly as time draws nearer to the evaluation.

TABLE XIX-2. NNEP EVALUATION TEAM SCHEDULE

Event	Time and location	Comment
NNEP exercise staff briefing	21 April, 09:00 h, *[Address]*	All evaluation team members to attend. Exercise scenario notes will be provided at this time.
Regional exercise staff briefing	26 April, 15:00 h, *Superior Room*, *[Address]*	Meeting directed by the control staff. All regional evaluators to attend. This will be followed by a meet and greet.
Pre-exercise check	26 April, 17:00-18:00	All evaluators to report by telephone to the evaluation team leader, for last instructions and final questions.
Exercise	27-28 April.	Evaluators report to the ______at 08:30 h. Regional evaluators report to the ____at 06:45 h. Regional evaluator at the PIC report to the PIC at 08:30 h.
Post-exercise evaluation meeting.	30 April, 09:00 h, *[Address]*	Evaluator written reports to be completed prior to this meeting.

6. LOGISTICS

All evaluators are requested to make their own travel arrangements. Hotel reservations have been booked as follows:

Evaluator	Date	Location

If alternate arrangements are required, evaluators are requested to notify the exercise organizer no later than 19 April, 17:00 h.

7. COMMUNICATIONS

Regional evaluators are requested to provide a cellular phone number to the exercise organizer for use during the exercise no later than 21 April. Reservations can be arranged provided that the exercise organizer is informed of the need for rental phones no later than 21 April. If rental phones are used, the exercise organizer is to be informed of the appropriate phone number immediately upon rental.

Communication with TSC and PIC evaluators will be done through the team leader.

TABLE XIX-3. TELEPHONE LIST

Evaluator	Contact number

APPENDIX XX: EXAMPLE OF EVALUATORS WORKSHEET AND NOTES

EXAMPLE OF EVALUATOR NOTES

The following is part of a typical time/action log of the operation of the TSC as compiled by an evaluator during the course of an emergency exercise for a gas-cooled reactor power station. It illustrates, particularly in the initial stages of the exercise, the rapid sequence of events that sometimes run concurrently. Note that personnel accountability is particularly important at nuclear power plants where large quantities of potentially lethal materials (carbon dioxide, liquid sodium, etc.) may be present.

(1) Check of TSC before the exercise begins.

(a) Contents of the emergency protection equipment cupboard were verified against the inventory sheet in the emergency plan.
(b) Wall maps and site plan for plotting health physics data were available.
(c) Wall mounted plan and elevation drawings of the reactor were available.
[Note: These showed the main gas circuit structure, but did not provide the circuit section or subsection identification numbers.]
(d) The off-site radiological survey whiteboard display was available.
(e) The adjacent communications room used by the radio operator, health physics analysts and data plotters did not appear to contain any emergency protective equipment.

(2) Sequence of events in the TSC.

09:15 Siren sounded (1 min). Clearly audible in reception hall area of administration building.
09:16 Health physicist plus two health physics assistants and a typist arrive in the TSC.
Potassium iodide tablets issued to incoming TSC staff. Administration officer arrived at TSC.
09:17 Site Emergency Director (SED) arrived in TSC.
[Note: TSC staff wear no identification of their duty role. This could be confusing for non-site personnel during liaison duties with TSC staff.]
09:21 TSC wind anemometer reading taken.
09:22 SED obtained initial state of plant from Shift Engineer in Plant Control Room (PCR).
Information included: no.8 gas circuit duct ruptured, no.8 circulator stopped.
09:26 CO_2 pressure less than 3.5×10^4 Pa, blowers 5 and 7 at rest, N. 8 gas duct valve stuck, CO_2 ring main out of use, reactor shut down, all emergency shutdown devices (16 in total) in, Electrical Grid Control and Station Gatekeeper informed of Emergency Standby by PCR.
09:22 Inhalation hazard assessment vehicles VEC 52 and 53 sent to off-site locations 48 and 51 respectively.
09:26 SED requested Administration Officer to complete notification of outside organizations.
Notice sent out of Emergency Alert (Exercise). [Note: Electrical Grid Control not notified of change of emergency status.]
09:29 Calculated plume path and 10% isopleths marked on district survey wall maps. TSC staff having some difficulty in finding telephone numbers for external notifications.
[Note: These should be on readily accessible lists.]
09:32 PCR to SED - PCR is habitable.

09:35 Inhalation hazard assessment vehicle, VEC 54, sent to site 52.
09:36 Preliminary forecast obtained from meteorological office (simulated).
09:37 First roll call indicated two people from station A not accounted for (Jones and Brown). One person at station B (Harris) not accounted for.
09:39 Report of a fire outside loading bay. SED seeking information.
09:40 Data being entered on emergency status whiteboard.
09:42 Potential plume direction being marked on site plan.
09:42 SED checking that notifications have been made to outside organizations.
[Note: There are indications of radio problems during the period 09:20 to 09:40 with fire attendants using the radio and thus preventing the reception of health physics data.]
09:45 District survey vehicle VEC 51 directed to ring road 1.
09:47 Administration Officer unable to notify Nuclear Regulatory Inspectorate (NRI) owing to telephone difficulties (number unobtainable, etc.).
09:49 SED notified county council of Emergency Alert (Exercise).
09:50 SED notified nearest nuclear power station (NPS) of Emergency Alert (Exercise).
09:51 Three persons verified missing in PCR roll call.
09:52 Emergency Controller assumes total of three people missing.
09:55 *[Note: site survey forms arriving in TSC not always completed with time, date and serial number.]*
09:55 Message to NPS that no immediate assistance required.
10:00 Two missing persons now reported found.
10:02 SED conferred with health physicist re: site conditions. Advised that the $C0_2$ is dispersing. No off-site information available as of yet.
10:03 Third missing person reported last seen in vicinity of reactor 2 building, cleaning and sweeping staircase and landing.
10:05 Reactor Physicist discussed plant assessment with SED. No reactivity problem.
10:10 Gatehouse notified TSC that senior police staff had arrived and were on way to TSC.
10:10 Initial district survey results in. VEC 52 results taken at 09:45 at site 48. No time of receipt recorded on form. VEC 53 result taken at 09:55 at site 5 1.

EXAMPLE OF EVALUATOR'S EVALUATION WORKSHEET

Example 1

Table XX-1 provides an example of a typical evaluator's assessment criteria check sheet for evaluating the performance of a first aid team. The evaluator should indicate the appropriate level of performance for each applicable item. Items that are not applicable to a specific case should be identified as such.

TABLE XX-1. ASSESSMENT OF FIRST AID TEAM PERFORMANCE

NN	**Main actions and assessment criteria**	**Evaluation**			
		Excellent	**Marginal**	**Satis-factory**	**Unsatis-factory**
1	Prompt removal from risk of further injury and radiation exposure, if practicable.				
2	Reassurance given; calm manner adopted.				
3	Mitigation of risk, if immediate removal not practicable.				
4	Promptness of assessing condition/injuries: overall and priorities.				
5	Ambulance called.				
6	Clear instructions given on location of casualties (see N.15).				
7	Knowledge of availability of first aid supplies (see N.9).				
8	Overdue reliance on 'correct' equipment/ facilities versus degree of improvisation.				
9	Ability in use of first aid facilities provided.				
10	Evidence of not doing too much.				
11	Care to protect non-serious casualty from inhalation or ingestion risk due to: (a) radioactive materials; (b) toxic materials.				
12	Consideration of possibility of radioactive or toxic substances on skin.				
13	Monitoring for radioactive/toxic materials on clothes and exposed skin.				
14	Information on serious casualties ambulance cases passed to SED.				
15	Care taken to give clear briefing, but to avoid alarming ambulance crew unduly, on radiological aspects.				
16	Additional comments				
17	Overall evaluation				

Example 2

The example shown below is of a completed evaluation form for an exercise that involved a facility with a small reactor.

TABLE XX-2. COMPLETED EVALUATION FORM

DETECTION AND CONFIRMATION		
To detect and confirm a situation, which could lead to an emergency, within the time required.		
Criteria	**Comments**	**Rating**
Initial detection by the in situ system is immediately picked up. Confirmation by hand-held meter within 5 minutes.	Time: 08:47 Time: 08:56 Confirmation within 9 minutes. This is reasonable considering the need to suit up and the time it takes to drive to the emergency site. Red leader did not have a survey meter. Meter was provided by survey leader. Plan calls for them to go top high but they did not. The need to go top high to confirm should be reviewed. Response speed can be improved without jeopardising safety if survey done on approach and confirmation taken as first high reading.	satisfactory
CLASSIFICATION		
To correctly classify the emergency in the time required.		
Criteria	**Comments**	**Rating**
An emergency is declared within 15 minutes of detection. The level is updated within a few minutes of new, significant information being available.	Time: 08:57 One minute from confirmation, ten minutes from detection. General Emergency declared on basis of off-site readings at 09:36. They knew there was a release at 09:15. They could have declared a General Emergency at that time in accordance with the plan. The timing was acceptable but the assessment process that led to this delay was not. This will be discussed later in the assessment section.	marginal

IMMEDIATE ACTIONS		
To take immediate protective actions in the immediate vicinity of the facility in the time required.		
Criteria	**Comments**	**Rating**
Evacuation out to 100 m is completed in 5 minutes from confirmation. Evacuation out to 250 m is completed in 15 minutes from confirmation. Access control is promptly established. A survey is conducted at the 100 m mark. The safety perimeter is adjusted if levels at 100 m are high. The radiation levels at the safety perimeter are constantly monitored.	Time: 09:06 The evacuation was completed within 10 minutes. This was due to unforeseen high activity on the 100m area. Time: 09:08 (12 minutes after confirmation) Red leader and team were not high. Access control established at lower main gate 09:00 and at their position at 09:13; water side 09:20. Access control was maintained throughout exercise. An initial survey at the 100 m line downwind was conducted by survey leader. No further survey was conducted. No survey at 250 m was conducted. Initial air sample at 09:15 and one subsequent air sample at 1000 taken at decon behind the building. Both air samples were positive. On-scene commander did not have a survey meter. First gamma survey at decon done after prompting. However, they were monitoring dose with their dosimeter. Plan should be amended to explicitly describe the procedure for “red leader to ensure safe distances” to include periodic surveys. They should have a survey meter in addition to the dosimeters when working in close proximity to the emergency site for added protection.	marginal

APPENDIX XXI: EXAMPLE GUIDE FOR PLAYERS

GENERAL INFORMATION

1. INTRODUCTION

The region of Splendid and Splendid Power are committed to excellence in nuclear emergency preparedness. Emergency preparedness involves many components including, but not limited to: hazard and risk analysis, planning, resourcing, training and audits. Exercises are an important component of the audit function. Exercises are used to validate response organizations, plans, procedures and training. Therefore, exercises are a cornerstone of an emergency preparedness programme.

Exercise Caprice is a joint Splendid Power / Splendid Emergency Measures Organization exercise involving a nuclear emergency at Lumina Generating Station. It will be conducted on September 23, 2005. The exercise will involve Splendid Power, national, regional and municipal resources, as well as private sector and volunteer groups.

2. AIM

The aim of this appendix is to provide players with the information they will need for the exercise Caprice and the exercise directing personnel for conducting and evaluating Exercise Caprice.

1.3. EXERCISE OBJECTIVES

The objectives of Exercise Caprice are as follows:

Objective 1: test the ability of the on-site emergency response organization to properly classify the emergency;

Objective 2: verify the time required for notification of off-site organizations by the on-site emergency response organization;

Objective 3: test the ability of the on-site emergency response organization to make appropriate decisions for mitigating the release of radioactive material to the environment;

Objective 4: test the ability of the on-site emergency response organization to make appropriate decisions regarding the protection of plant personnel;

Objective 5: test the ability of the on-site and off-site emergency response organizations to take appropriate actions to protect emergency personnel;

Objective 6: test the ability of on-site personnel to deal with contaminated and non-contaminated medical casualties;

Objective 7: test the effectiveness of the liaison between on-site and off-site authorities for sharing information and making decisions;

Objective 8: test the effectiveness of the coordination between Splendid Power and the off-site authorities for the preparation of media information;

Objective 9: verify the activation time for the off-site emergency organization;

Objective 10: test the effectiveness of the coordination of information between all off-site intervening organizations;

Objective 11: test the ability of the off-site emergency organization to make proper decisions regarding the need for urgent protective actions to protect the population;

Objective 12: test the ability of the off-site emergency response organization to complete the public alerting process in the required time;

Objective 13: test the ability of the off-site emergency organization to mobilise the resources required to evacuate and process the affected population through the relocation/reception centre and, by evacuating a limited number of people, test the effectiveness of these resources;

Objective 14: test the ability of the designated hospital to deal with a contaminated medical casualty; and

Objective 15: test the ability of the off-site emergency response organization to prepare timely and coordinated information for dissemination to the public.

3. PARTICIPATING ORGANIZATIONS AND OBSERVERS

The following organizations will participate in Exercise Caprice:

- Lumina Generating Station designated shift team and emergency response personnel;
- all Lumina Generating Station personnel;
- Splendid Power Corporate Headquarters;
- the Regional Nuclear Control Group;
- Communication Splendid;
- the Emergency Action Committee and the District Emergency Operations Centre;
- Off-site Emergency Centre staff;
- the Lumina Warden Service;
- the Regional Hospital; and
- the Fire Services.

Participating organizations may invite observers to attend their portion of Exercise Caprice, as long as their attendance does not compromise normal security requirements, safety and/or interfere with exercise play. Observer status with one organization does not automatically authorise access to other organizations. The participating organizations' normal access control procedures remain in effect. Observers must be on the access list of all organizations they wish to visit.

4. EXERCISE SCOPE

Exercise Caprice is a fully integrated on-site / off-site exercise:

- On-site refers to all activities that take place on Lumina property plus the Lumina off-site environmental monitoring.
- Off-site refers to all activities that take place off Lumina property by national and other resources as well as the Wardens, private sector and volunteer groups.
- The EOF/ICP, which is located 8 km from Lumina Generating Station, is a joint on-site / off-site centre which serves as a major interface between on-site and off-site operations staff.

Exercise Caprice will be a full-day exercise. The scope of participation is defined in Table XXI-1.

TABLE XXI-1. SCOPE OF PARTICIPATION

Organization	Participation	Comments
• Lumina Wardens • Lumina emergency response team • University of Splendid reception centre • Regional Hospital	One-day field exercise with fully simulated actions.	Wardens will conduct population alert drills within 20 km of the plant. Lumina emergency response team will respond to the simulated conditions. University of Splendid Reception Centre will set up and process approximately 60 volunteers.
Other participating organizations	One-day tabletop exercise.	All actions will be simulated. Communications Splendid media play will be limited to gathering information, conducting a simulated media briefing and news conferences and producing Public Safety Bulletins for the Communications Splendid website and appropriate addressees.
Lumina Generating Station non-emergency personnel	Accounting exercise.	All on-site personnel will participate in station accounting drills. On completion of the accounting drills, non-emergency personnel not involved in the exercise will return to their normal duties.

5. EXERCISE MANAGEMENT

The Exercise Director and Deputy Director are _______________ and ________________. All inquiries prior to the exercise should be directed to them.

6. SAFETY

Exercise participants are expected to follow all safety rules. In practice, this means that on-site personnel must follow access control procedures to the radiological zones and avoid making interventions that may jeopardise plant safety, or the safety of personnel. Off-site participants must follow health and safety regulations and practices. The exercise scenario should not require actions that are dangerous, but if the participants feel otherwise, they must discuss it immediately with an exercise controller.

The exercise will be conducted by designated and clearly identified exercise controllers. The exercise director can interrupt or terminate the exercise for safety reasons. Controllers can interrupt local play for safety reasons. During the exercise, all questions or information regarding safety or real emergencies must be directed to exercise control personnel.

In the event of a real emergency, the exercise will be terminated. A message will be broadcast and all personnel will return to their assigned emergency workstations.

7. SIMULATION

The simulator will be used as the control room during the exercise. Unless otherwise stipulated, all other applicable emergency locations will be used.

Unless specifically approved by a controller, non-participating organizations ARE NOT to be contacted during the exercise.

Except where safety is a concern, actual equipment and procedures are to be used.

8. COMMUNICATIONS

The exercise participants will use the actual emergency telecommunication systems identified in the applicable plan(s). Unless otherwise stipulated, phone numbers to be used are as per emergency procedures. A separate contact list detailing telephone numbers, e-mail addresses and radio frequencies for contacting simulated organizations will be provided at the exercise. Except for communications with the participating organizations all messages will be directed to the simulation and control centre. Normal security considerations and communications procedures will be used.

All messages, including telephone calls will be prefixed with " FOR EXERCISE". In the event of a real emergency the message will be prefixed with "THIS IS NOT A DRILL". If the Exercise Director determines that the exercise must be suspended or terminated early, he will announce "THIS IS NOT A DRILL, TERMINATE (OR SUSPEND) THE EXERCISE - THIS IS NOT A DRILL, TERMINATE (OR SUSPEND) THE EXERCISE."

9. MEDIA AND PUBLIC INFORMATION ARRANGEMENTS

There is always the possibility that environmental and anti-nuclear groups may use the exercise to further their agenda. There must be common media and public information arrangements in place to deal with such an eventually. Communications Splendid is responsible for developing a strategy to deal with media and public requests for information concerning Exercise Caprice. The draft strategy must be distributed to all participating organizations for comment by no later than 1 September, 2005. Organizations are requested to return their comments to Communications Splendid by 14 September, 2005.

Communications Splendid is requested to appoint a Splendid Government spokesperson for this exercise. Participating organizations are requested to appoint spokespersons to coordinate with and assist Communications Splendid.

During the exercise, all real media inquiries are to be referred by the participants to their respective media organization, and the exercise director is to be notified.

10. EXERCISE DEBRIEFING

As each organization terminates their portion of the exercise, the senior manager will debrief the participants. Evaluators and controllers will attend these debriefings to record findings and clarify issues. The senior manager from each organization will participate in the exercise debrief held at the _________in person or by conference call.

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DEFINITIONS

accident

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

arrangements (for emergency response)

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

controller

Controllers are accountable to the Lead Controller and are responsible for managing the scenario, providing simulated data to the participants and responding to participant requests. They ensure the continuity of the scenario and are the only ones allowed to change the events.

dangerous source

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

drill

An activity that develops a skill or capability or tests a single emergency procedure or task. The drill may test an individual's skill, the proficiency of a team, or the adequacy of procedures, equipment or facilities.

emergency

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

emergency class

A set of conditions that warrant a similar immediate emergency response. This is the term used for communicating to the response organizations and the public the level of response needed. The events that belong to a given emergency class are defined by criteria specific to the installation, source or practice, which if exceeded indicate classification at the prescribed level. For each emergency class, the initial actions of the response organizations are predefined.

emergency classification

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

emergency phase

The period of time from the detection of conditions warranting an emergency response until the completion of all the actions taken in anticipation of or in response to the radiological conditions expected in the first few months of the emergency. This phase typically ends when the situation is under control, the off-site radiological conditions have been characterized sufficiently well to identify where food restrictions and temporary relocation are required, and all required food restrictions and temporary relocations have been implemented.

emergency plan

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

emergency preparedness

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

emergency procedures

A set of instructions describing in detail the actions to be taken by response personnel in an emergency.

emergency response

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

emergency services

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

emergency worker

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

emergency zones

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

evaluation criteria

Measurable or observable actions or results that indicate that the response is achieving the exercise objectives.

Evaluator

An evaluator records and evaluates the performance of participants and the emergency response organization. An evaluator also records and evaluates the adequacy of facilities, equipment and supplies, and of the scenario during an emergency drill or exercise. Evaluators are assigned to key locations and activities during an exercise.

exercise

The term exercise designates any type of drill, trial, tabletop, partial, full-scale and field exercise.

Exercise Director

The Exercise Director is responsible for the overall coordination and conduct of the exercise, which includes, but is not limited to the exercise design, preparation and follow-up. This person may be a senior manager in the organization not otherwise involved in the exercise. For larger exercises, the Exercise Director may be supported by Assistant Exercise Directors.

exercise objective

Exercise objectives are a subset of response objectives that are to be verified through an exercise.

exposure

The act or condition of being subject to irradiation. Exposure can be either external exposure (due to a source outside the body) or internal exposure (due to a source within the body).

field exercise

An exercise involving the deployment of emergency response teams and personnel on or around the site.

full-scale exercise

A large-scale exercise involving most of the response organizations and field resources.

inputs

Information messages, data and/or problems given to the players by controllers to simulate exercise events.

Lead Controller

The Lead Controller is accountable to the Exercise Director and is responsible for managing the scenario, providing simulated data to the participants and controlling the pace of the exercise.

Lead Evaluator

The Lead Evaluator is accountable to the Exercise Director and is responsible for observing, assessing and reporting on the exercise. As part of the evaluation process the Lead Evaluator is responsible for validating the exercise.

longer term protective action

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

Master Events List

A chronological list of exercise events and inputs, normally for use by the Lead Controller.

nuclear or radiological emergency

An emergency in which there is, or is perceived to be, a hazard due to:

(a) the energy resulting from a nuclear chain reaction or from the decay of the products of a chain reaction; or
(b) radiation exposure.

Observer

A person who is authorised to witness the exercise but is neither a player nor a controller/evaluator.

off-site

Outside the site area.

on-site

Within the site area.

operational intervention level (OIL)

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

operator (or operating organization)

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

partial exercise

A partial exercise is like a full-scale exercise except that a smaller number of organizations participate. A partial exercise is normally designed to test coordination between specific organizations.

Player

People who are taking part in an exercise and respond to the simulated events.

precautionary action zone

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

protective action

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

real time

This term refers to using the actual passage of time when conducting an exercise.

response organization

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

scenario

A postulated or assumed set of conditions and/or events.

simulation

Responses or activities otherwise supposed to come from people or organizations that are not participating in the exercise are simulated by the controllers.

simulation cell

The group of controllers that is simulating non-participating persons and organizations with which the players need to interact.

site area

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

source

Anything that may cause radiation exposure — such as by emitting ionizing radiation or by releasing radioactive substances or materials — and can be treated as a single entity for protection and safety purposes. For example, materials emitting radon are sources in the environment; a sterilization gamma irradiation unit is a source for the practice of radiation preservation of food; an X ray unit may be a source for the practice of radiodiagnosis; a nuclear power plant is part of the practice of generating electricity by nuclear fission, and may be regarded as a source (e.g. with respect to discharges to the environment) or as a collection of sources (e.g. for occupational radiation protection purposes). A complex or multiple installation situated at one location or site may, as appropriate, be considered a single source for the purposes of application of international safety standards.

start state

The situation at the start of the exercise in terms of date/time, operational environment, and factors affecting the operational environment (weather, real-world events, regulatory compliance, radiological situation, etc.).

threat assessment

The process of analyzing systematically the hazards associated with facilities, activities or sources within or beyond the borders of a State in order to identify:

(a) those events and the associated areas for which protective actions may be required within the State;
(b) the actions that would be effective in mitigating the consequences of such events.

urgent protective action

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

urgent protective action planning zone

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

ABBREVIATIONS

ENDEX	end of the exercise
EOC	response organizations emergency operations centres
EOF	emergency operations facility
ICP	incident command post
MEL	master event list
OIL	operational intervention level
OSC	operation support centre
PAZ	precautionary action zone
PIC	public information centre
RDD	radiological dispersal device
RMAC	radiological monitoring and assessment centre
TSC	technical support centre
UPZ	urgent protective action planning zone

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McKenna, T.	International Atomic Energy Agency
Lafortune, J.	International Safety Research, Canada
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Consultancy Meetings

Vienna, Austria: 16–20 August 1999
Vienna, Austria: 8–12 May 2000

PILOT USE AND REVISION OF THE MANUAL

Regional Train-the-Trainers Courses on Exercise Preparation, Conduct and Evaluation
Vienna, Austria: 5–7 December 2001, 10–12 December 2001

Regional Train-the-Trainers Courses on Exercise Preparation, Conduct and Evaluation
Rio de Janeiro, Brazil: 29 September – 3 October 2003