IAEA Training Course for Research Reactor Emergency Response

Introduction to the Workshop

Emergencies at Research Reactors and Lessons Learned

Seminar

Block 2: Introduction to the Workshop
Module 1: Emergencies at Research Reactors and Lessons Learned

Learning objectives: Upon completion of this module, the participants will:

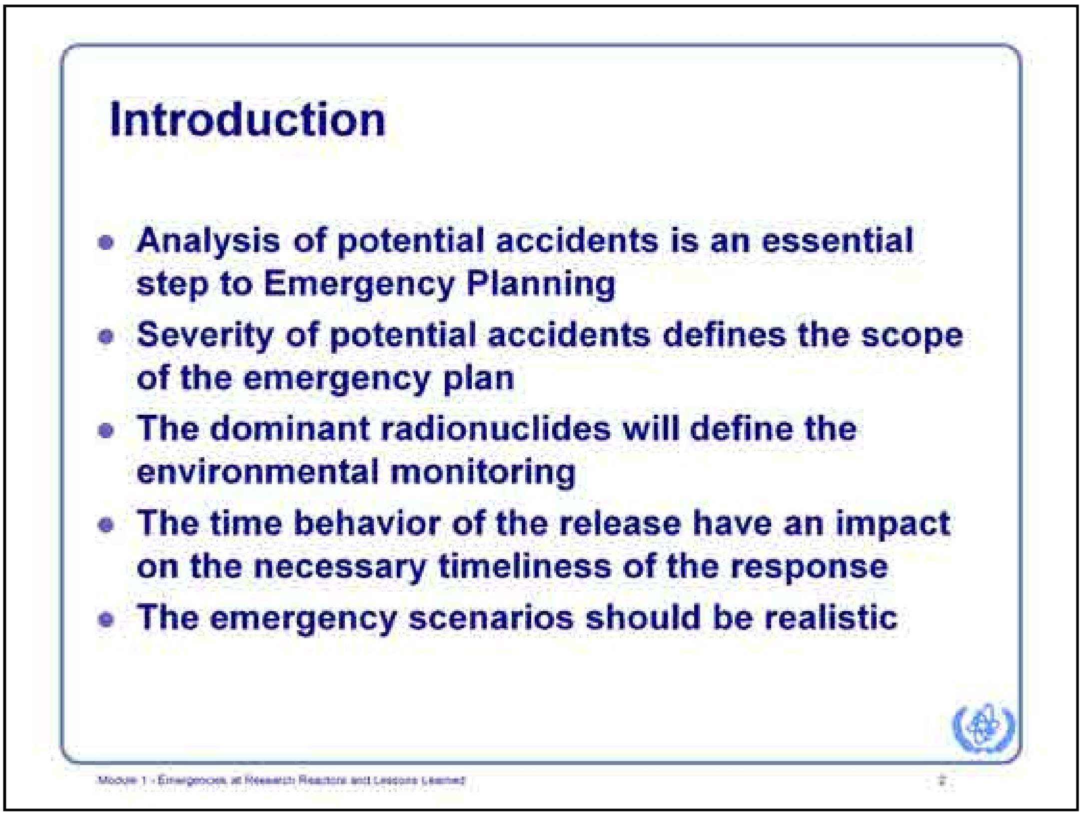
- be able to list types of potential radiological emergencies at research reactors, and know examples of reactor and facility set-ups that can give rise to such accident
- learn experiences from accidents at research reactors
- be able to list main consequences of these emergencies
- be able to list principle lessons learned

Activity: Seminar, questions and discussions
Duration: 1 hr

Materials and equipment needed: none

References:

1. INTERNATIONAL ATOMIC ENERGY AGENCY, Incident Reporting System for Research Reactors (IRSRR)
2. INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Reports Series No. 53, Derivation of the Source Term and Analysis of the Radiological Consequences of Research Reactor Accidents, Vienna (2008)
3. A review of criticality accidents, Stratton, W. R., Los Alamos, N.M. : Los Alamos Scientific Laboratory of the University of California
4. INTERNATIONAL ATOMIC ENERGY AGENCY, The Chernobyl Accident: Updating of INSAG-1, Safety Series No. 75-INSAG-7, IAEA, Vienna (1992)

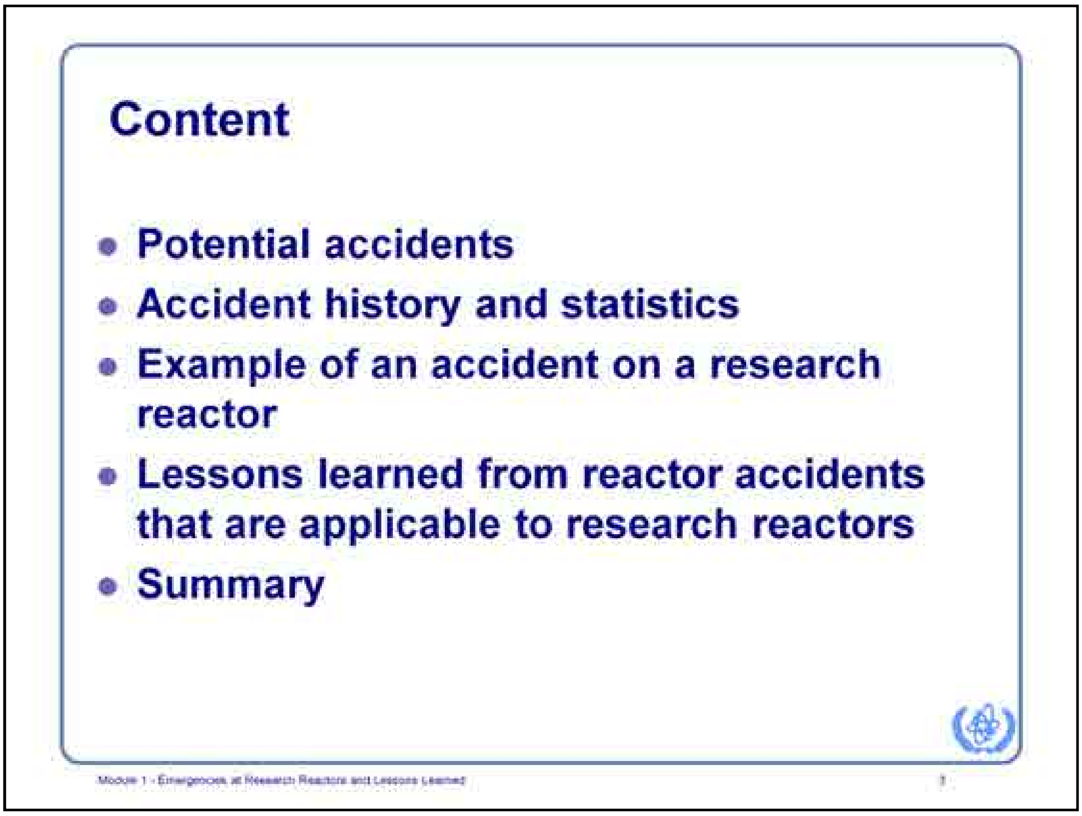


Lecture notes:

Awareness of the potential accidents is needed to be able to avoid them.

Certainly plan for an emergency response to the Design Basis Accident. Depending upon the severity of the consequences, accidents beyond design basis deserve consideration in the development of the emergency response planning and procedures.

If you can prevent the emergency from occurring, your emergency response procedures will never be needed. That is a better outcome than a perfect response!



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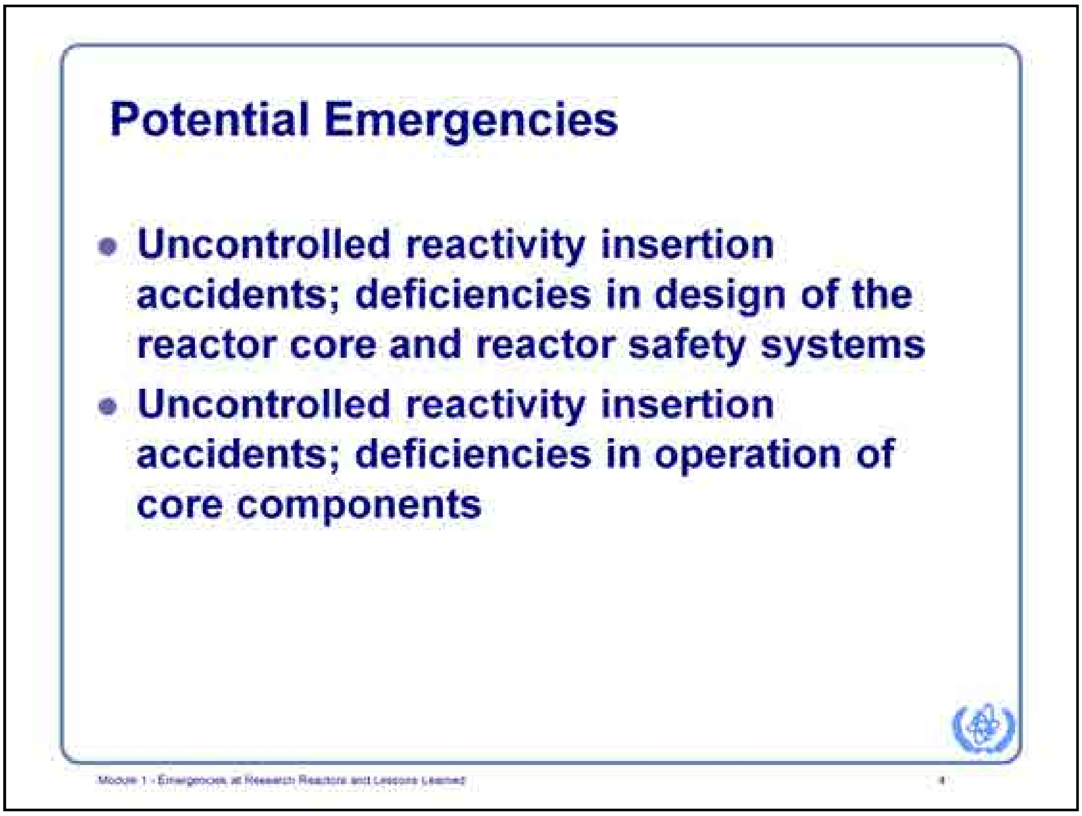
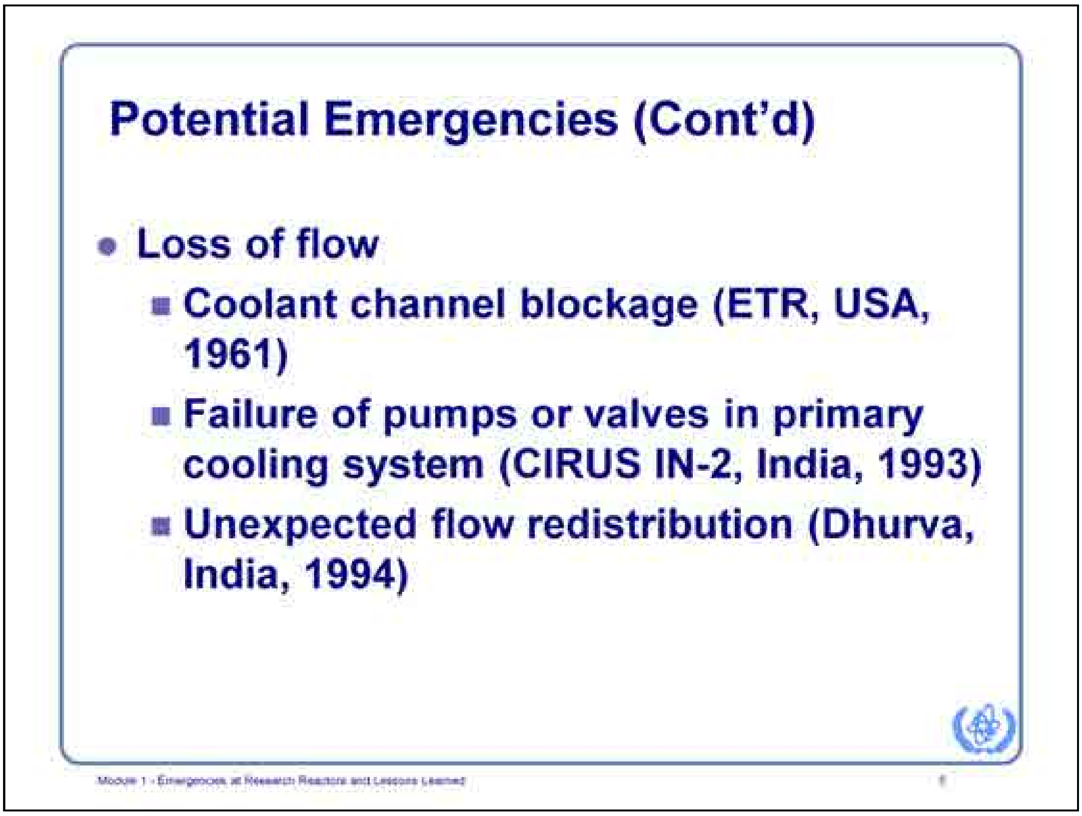


Lecture notes:

Inadvertent criticalities can cause significant damage to a research reactor.

Agree or Disagree – WHY?

Anticipated answers including potential for very high power levels relative to the design power level of the fuel elements.



Lecture notes:

Some research reactors are tolerant of loss of flow accidents.

Agree or disagree – WHY?

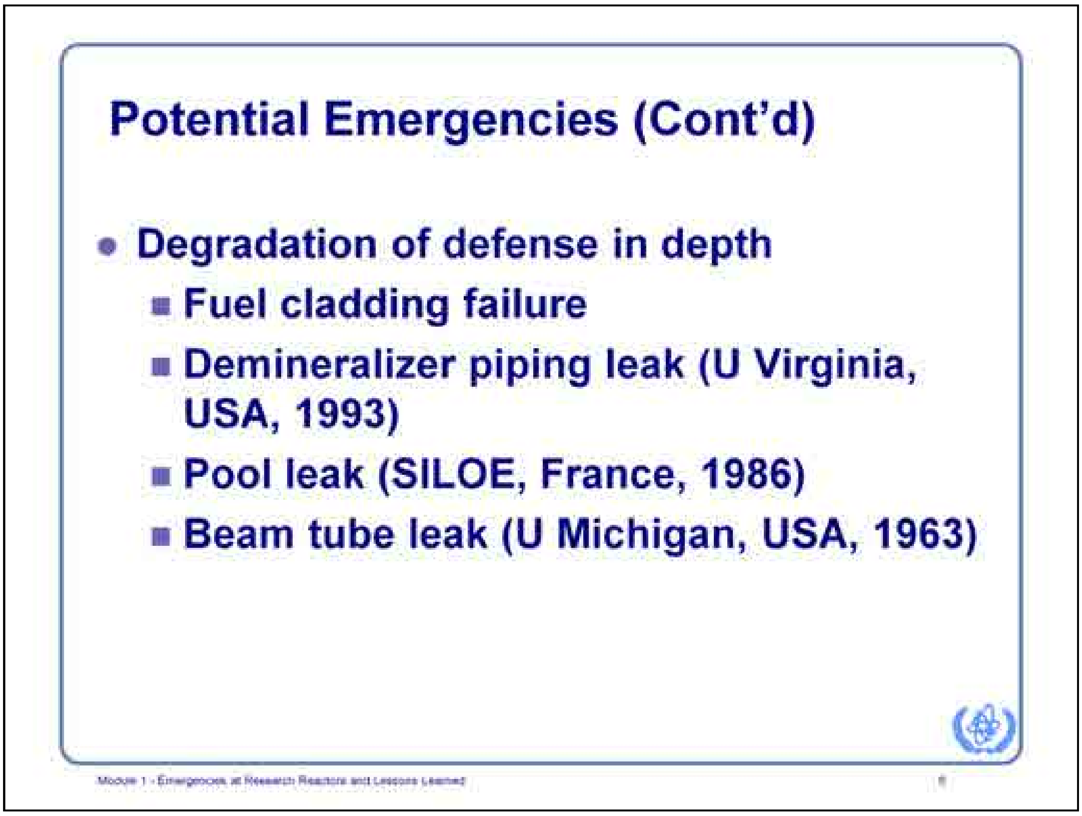
Anticipated answers include availability of natural circulation and low decay heat, depending on reactor design and operating power.

ETR – plastic sight box sank and blocked flow to parts of the core, portions of 6 fuel elements melted

CIRUS IN-2 – closed valve prevented cooling flow over a fuel element rod.

Dhurva – open interconnecting valve reduced core flow below the safety limit

These examples are from IAEA Safety Report Series No. 53, **Derivation of the source term and analysis of the radiological consequences of research reactor accidents**



Lecture notes:

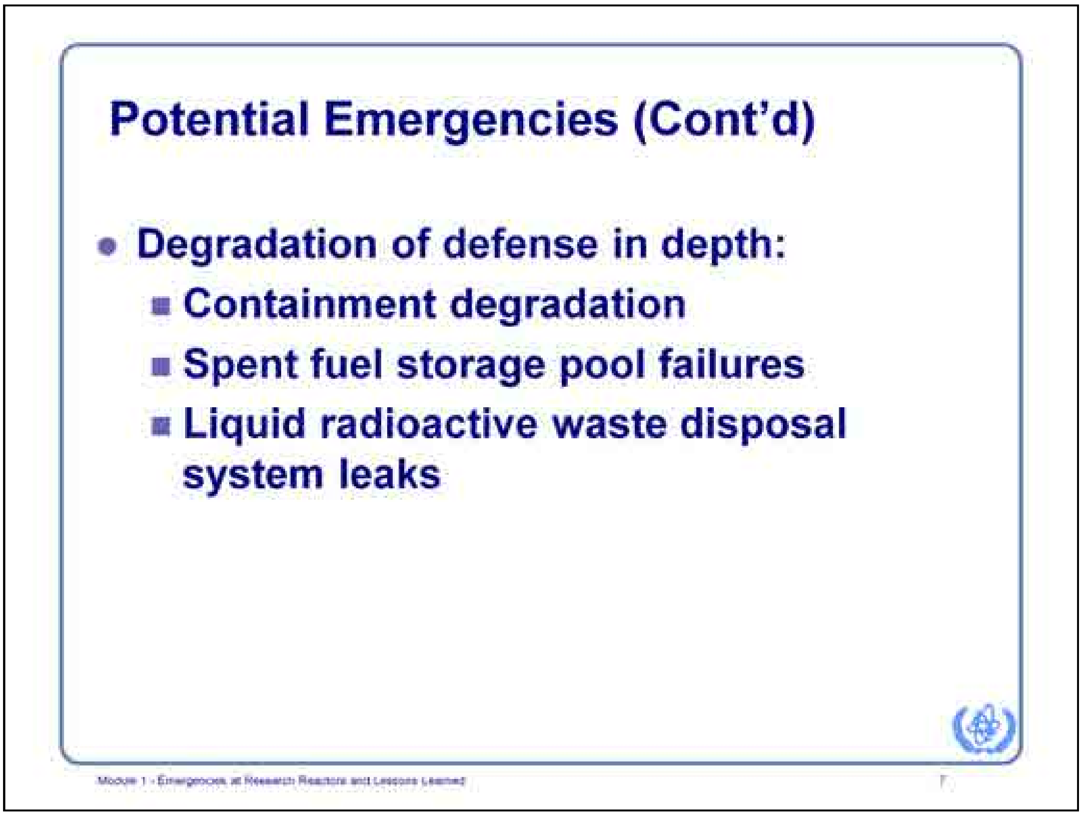
Avoiding a release of fission products relies on three barriers; fuel clad, piping that contains the coolant (and fission products if cladding fails) and an exterior containment or reactor hall that limits releases to the exterior. Many research reactors have little of this last protection barrier.

Failure of the systems that maintain the reactor fuel covered with water, even in the absence of cladding damage, is a reduction in safety since uncovered fuel causes potentially high radiation dose rates in the near the core.

U Virginia – pipe break in demineralizer piping

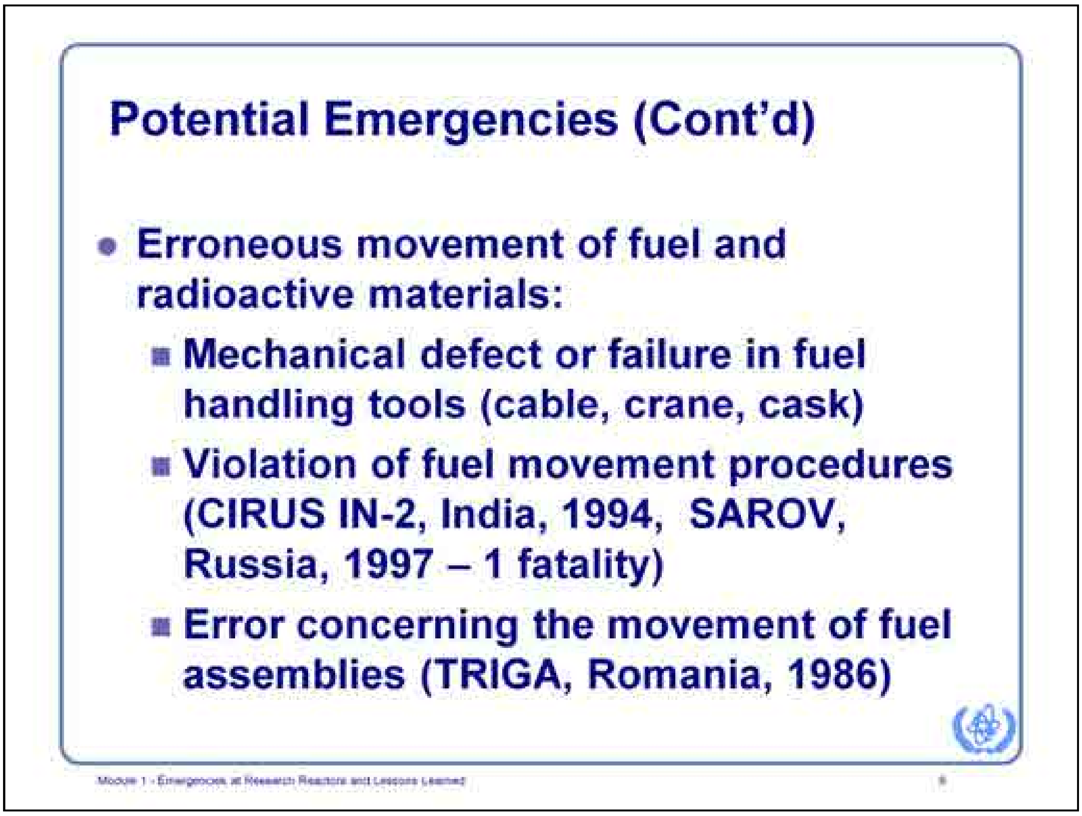
SILOE – water loss through bottom of pool contaminates groundwater with tritium

U Michigan – shield plug too long for beam tube inserted and ruptured the tube



Lecture notes:

Degraded containment is not readily detected until one measures containment integrity (periodic inspection and testing), or one needs the isolation.



Lecture notes:

Research reactors often relocate fuel assemblies, control rods, or other core components. The potential for an inadvertent criticality is present during these movements and detailed procedures are needed to make the movements in a safe manner. Damage to the components being moved is also a risk.

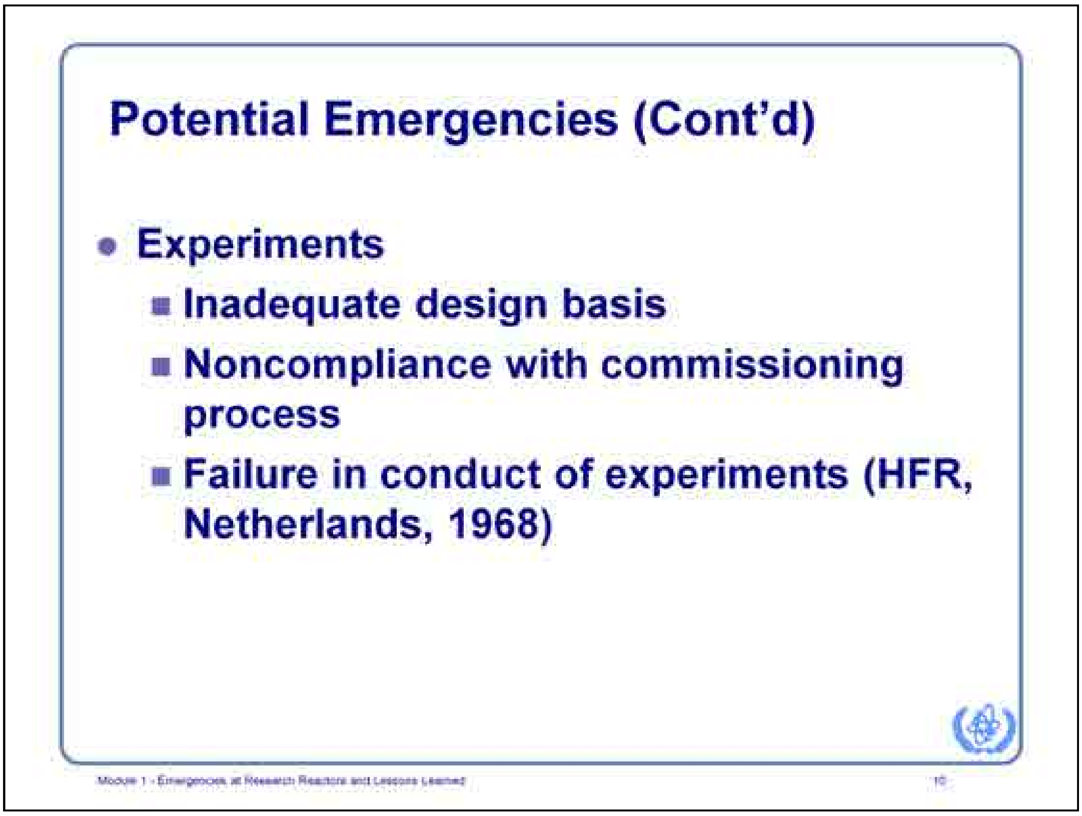
“THE CRITICALITY ACCIDENT IN SAROV” an IAEA accident evaluation report

CIRUS IN-2 – fuel rod placed in transfer cask without cooling water flow

TRIGA – power excursion to 21.5 Mw when two fuel assemblies were improperly positioned in the reactor grid sush that the control rods were ineffective to prevent criticality.

Lecture notes:

Failure to comply with operating limits, procedures performed during the commissioning process and requirements that prevent theft or misuse of fuel or other radioactive materials can cause physical damage to the reactor or injury to personnel. Incorrect settings for safety system activation or failure to perform required surveillance testing can also cause damage to the reactor.



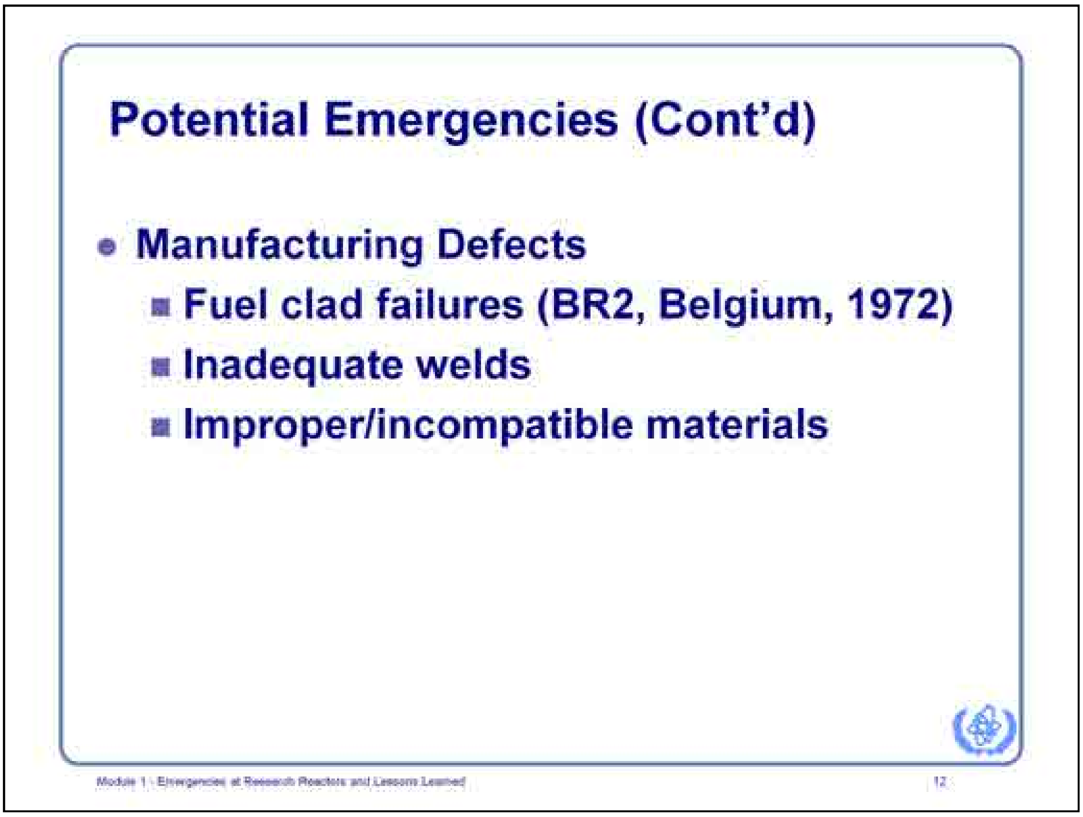
Lecture notes:

Experiment facilities need the same level of attention to safety as do reactor components. An inadequate design may fail and release radioactive material or cause damage to reactor components.

HFR – sample irradiated without instrumentation or cooling, 2.8 TBq noble gases released

Lecture notes:

EWA – Overfilled Xe container ruptures and releases 5 MBq I-125



Lecture notes:

BR2 – defective fuel element

Lecture notes:
NRX – core destroyed by erroneous control rod withdrawal
VINCA – power excursion, exposures of 2.0 to 4.3 Sv
SL-1 – power excursion due to design deficiency and operator error, 3 fatalities
RA-2 – Criticality due to operator error, 1 fatality
VENUS – power excursion due to design deficiency and operator error, 5 Sv to one worker

It can happen today!

AUG-29-2008

The medical LAB IRE at Fleurus Belgium was emitting for at least one week radioactive Iodine gas, contaminating the area long term, no peak but vegetables and fruits from garden banned from eating. Children should not walk in the green. 20 000 PEOPLE will turn to bottled water and prepare for long term impact.

The European Commission said Friday it had received an overnight alert from Belgium concerning a radioactive leak at the Institute National de Radio-elements (IRE) in Fleurus.

There had been a release of gaseous Iodine-131 from this facility, said the commission, the executive body of the European Union (EU).

The incident had been classified Level 3 on the seven-level International Nuclear Event Scale on Tuesday.

Belgian authorities have implemented protective action on the basis of environmental sample analyses, with restrictions imposed on the consumption of local food produce -- vegetables and milk --up to a distance of 5 km.

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Lecture notes:

Lecture notes:

The time period covered is 45 years. This IAEA publication is not making an attempt to list all accidents in that period, just some of the more significant ones.

Other is mix of human error and equipment failure. Most of the 35 total events had a human error as the primary cause, or as part of the cause of the event. These are just the event listed in the safety series report. Many others may be found in the literature

Example of an Actual Accident on Research Reactor

- Critical excursion on RA-2 Critical Assembly in Buenos Aires, Argentina, 23 September 1983
  - Operator's error during core configuration modification
  - Reactor became prompt critical
  - Peak power 300 MW, energy released 10 MJ, fission yield 3E17
  - The operator received a fatal absorbed dose: 21 Gy gamma and 22 Gy neutrons
  - Root cause – Procedure violation?

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Lecture notes:

One might wonder why the operator made such a serious mistake and was in violation of procedures when he caused the accident – what could be the real root cause?

Anticipate some answers such as:

poor safety culture,

this is how we really do the work

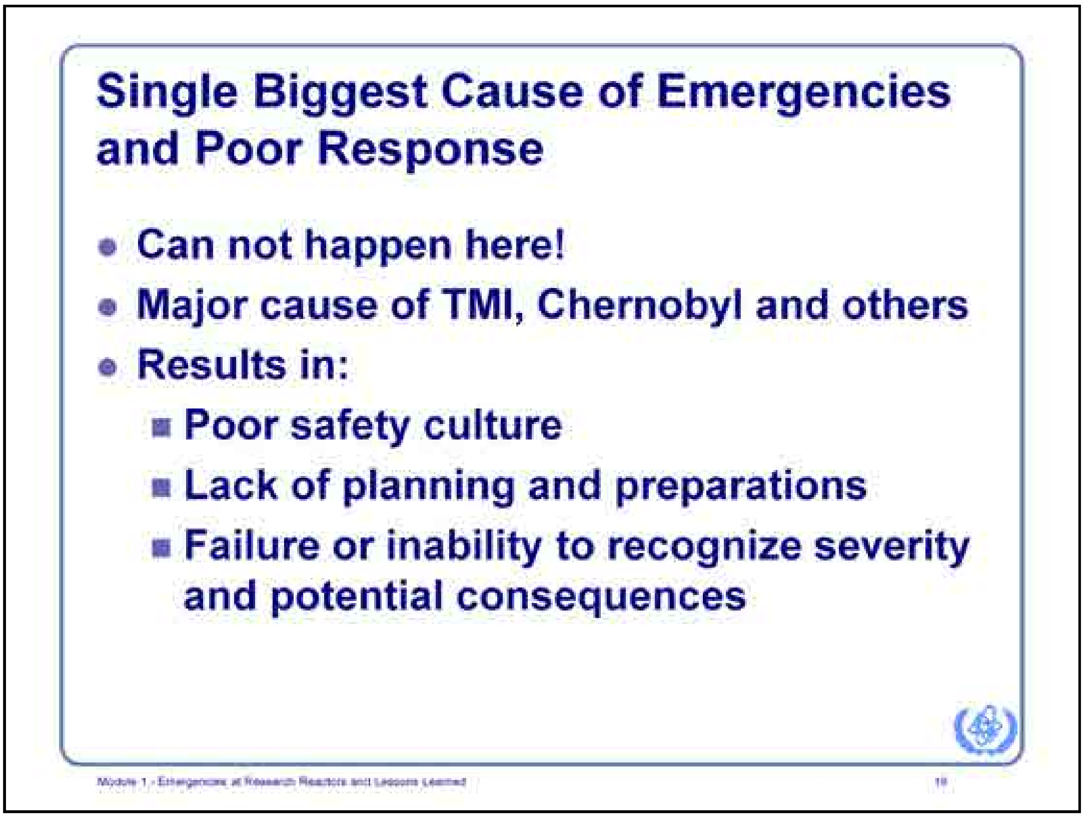
and similar.

Lecture notes:

“It can not happen here” is a sense of infallibility that reflects n unwillingness to learn from the mistakes of others. In fact, it can happen, perhaps not in exactly the same way, but due to similar lapses in judgement, or attention to detail, or lack of supervisory oversight, or any one of many additional lapses.

These problems are not limited to research reactors.

Lecture notes:

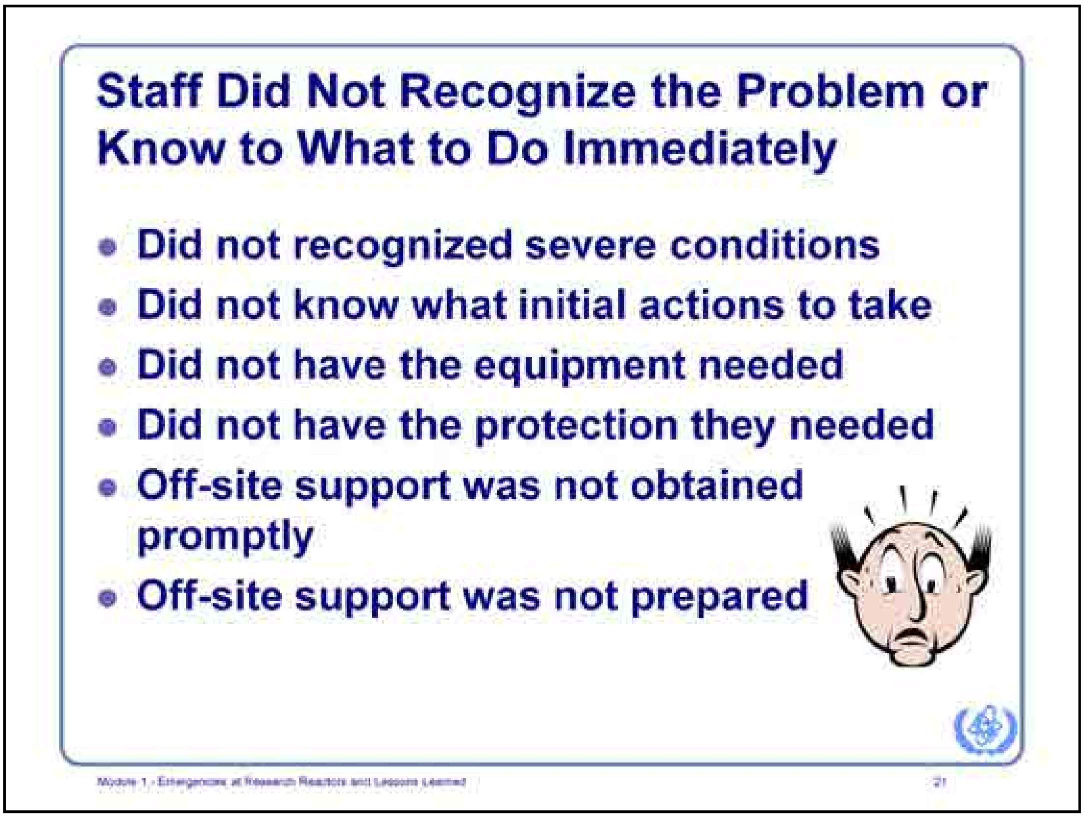


Lecture notes:

The single most important cause of the TMI and Chernobyl accidents was that all those involved from the regulatory body to the staff all believed that a severe accident could not happen. This resulted in 1) lack of care by the operators that contributed or even caused the accidents and 2) lack of preparation to deal with the accident and its consequences.

Lecture notes:

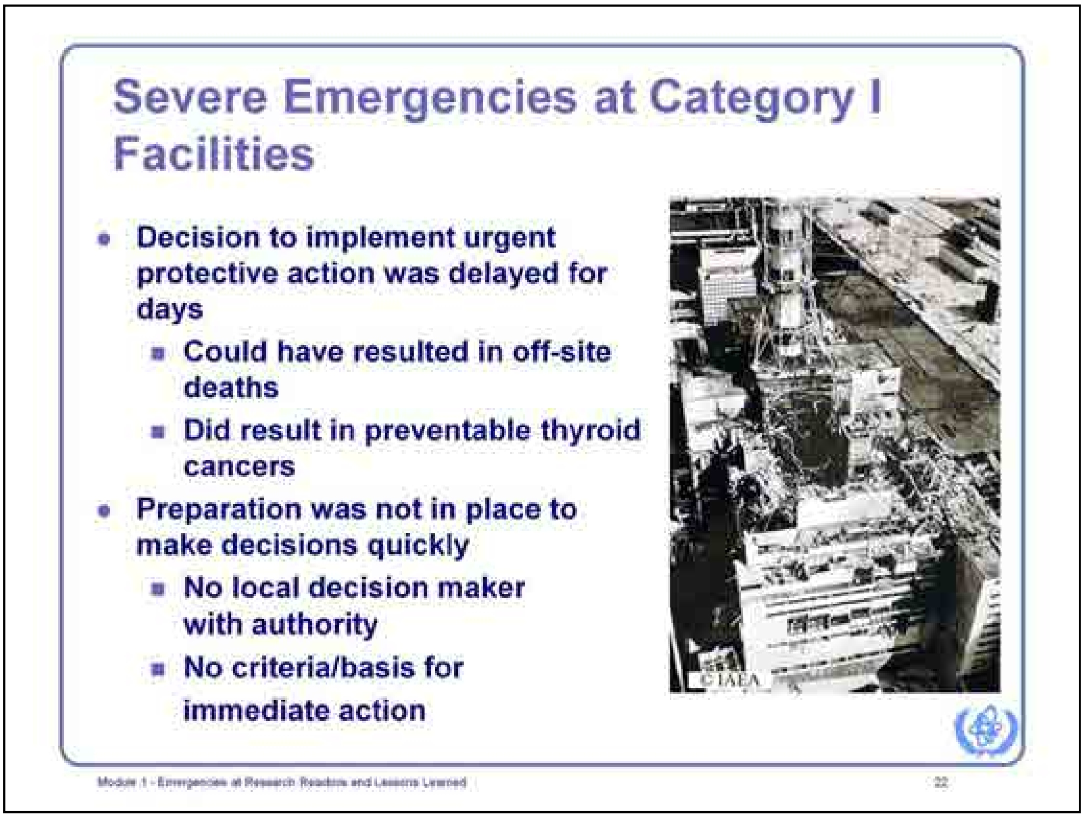
Many managers directing initial response were ineffective because they had not been trained under realistic emergency conditions. Also, the response system was not designed for severe emergencies. These managers were overwhelmed and confused (there were 80 people in the control room at one point), lacked telephone access because of jammed lines, and caused confusion by developing ad hoc plans. Ad hoc plans were developed because the managers were unaware of the plans and procedures that had already been established. This happened because senior managers did not participate in the training or exercises (they were too busy).



Lecture notes:

The severity of the most severe nuclear emergencies has not been initially recognized or comprehended by plant operators even when there are indisputable indications of event severity. At Chernobyl the staff was paralyzed, they did not know what to do. This occurred because there was neither criteria nor training on recognition severe accidents and the immediate action to take. Facilities should have an event classification system to indicate the level of threat, provide the basis for immediate notification, and initiate other actions to be taken on- and off-site. The classification system should address all potential nuclear and radiological emergencies that can occur at these facilities. The criteria (Emergency Action Levels or EALs) for classification should include conditions at the facility, radiological measurements and other observable conditions. This classification system should take into account the expected response of facility instrumentation and other systems during abnormal operations.

The reactor accident at Chernobyl occurred because an experiment was conducted without thought to the abnormal operating conditions and the potential risks. The reactor response was unanticipated and no operator response to those conditions had been planned.



Lecture notes:

For TMI and Chernobyl urgent protective actions that should have been taken immediately were not implemented for days.

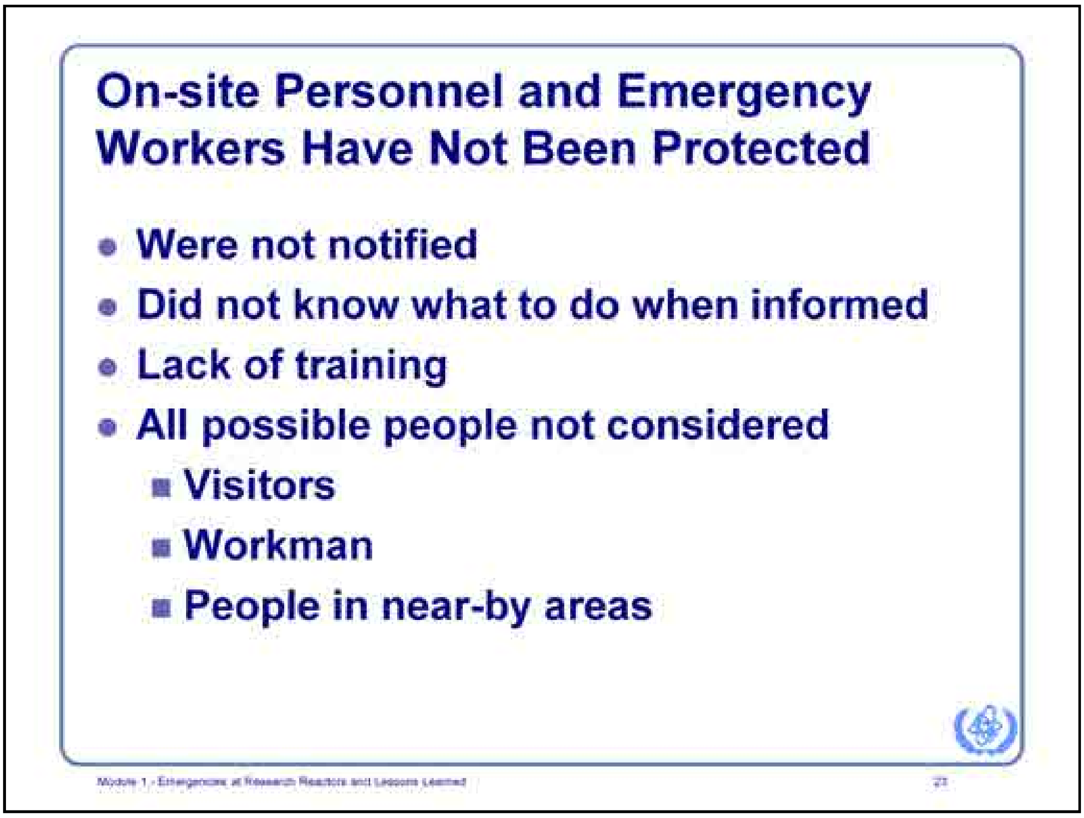
The Commission that examined the response to the TMI emergency found that the area near the facility should have been evacuated during the first few hours of the emergency because there was a vast amount of radioactive material in the containment. Only one barrier prevented a major release and the operator did not understand what was going on. However, the area near the facility was not evacuated.

During the Chernobyl emergency important protective actions were not taken for days or weeks. These delays could have resulted in many deaths off-site, except the plume impacted an uninhabited area. These delays also resulted in people off-site consuming milk and vegetables contaminated with radioiodine for several days because they were not aware of the hazard. This caused an increase in thyroid cancer, especially in children. This increase was seen at distances of more than 350 km from the site and could have been easily prevented if the population had been informed not to drink the local milk.

This occurred because the preparations needed to be able to made decisions quickly were not in place. This includes not having a local decision maker with the authority to act immediately and not having a basis for taking urgent action to include a classification system.

During some severe emergencies at threat category I and II facilities, it has taken many hours or days to determine and implement urgent protective actions for the public. Later analysis showed that, even with the delays, inappropriate protective action was implemented. This occurred because arrangements for making decisions promptly were not in place for these low probability emergencies.

Consequently, the Requirements [1] (para. 4.48) require that “For facilities in threat category I or II arrangements shall be made for effectively making and implementing decisions on urgent protective actions to be taken off the site. This capability shall make use of existing public infrastructure to limit the occurrence of severe deterministic effects and to avert doses, in accordance with international standards, for the full range of possible emergencies at those facilities.”



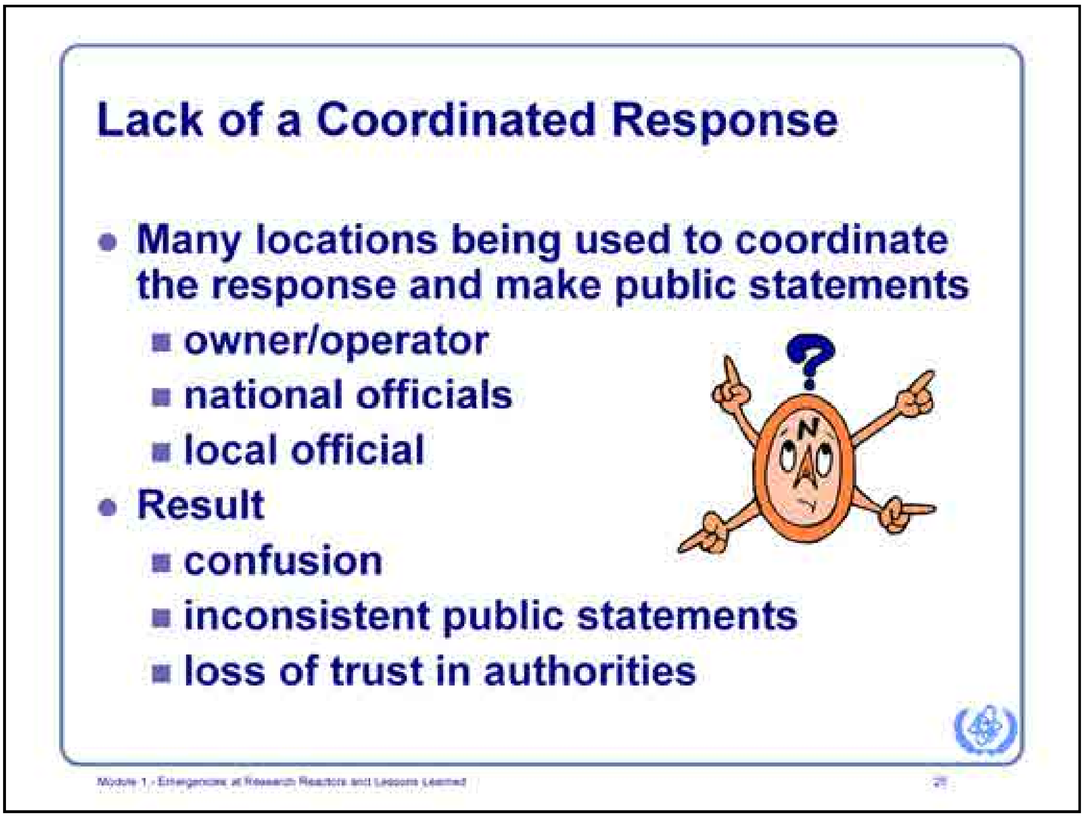
Lecture notes:

There have been cases where the on-site personnel and members of the public in facility-controlled areas (e.g., visitors, workers, people in nearby areas) were not informed of actions to take in the event of an emergency. Emergency Workers have not been informed of the threats in the area they must enter to respond and lacked the training to reduce their exposure.

During the Chernobyl emergency, many emergency workers, including members of the off-site fire brigade, received very high levels of radiation exposure, some fatal. This occurred because of inadequate equipment and training. Monitoring instruments went off-scale, no personal dosimeter were provided, and inadequate personal protective clothing contributed to severe beta radiation burns

Lecture notes:

During the response to the Goiânia and Chernobyl emergencies, it was impossible to establish justified criteria for the implementation of urgent and longer-term protective actions and other countermeasures (e.g. compensation schemes) because they were only being developed after the start of the emergency, i.e. during a period of heightened emotions and mistrust of officials and the scientific community.



Lecture notes:

During the response to several emergencies, national authorities, local officials, and owner of the facility had several independent organizations (centers, teams) providing public assessments and making inquires. This resulted in considerable confusion, release of conflicting information and unnecessary demands on other responders. This contributed to the mistrust of the government response in the public and media. The response greatly improved when a single emergency operation center for co-ordination of the national response and for providing information media was established close to the affected site.

Lecture notes:

In some cases the failure of the facility of local medical staff to gathered information needed to reconstruct the dose prevent the establishment of the optimal course of treatment.

Physicians have incorrectly assumed that radiation injuries requiring only conventional treatment or (ref Vietnam) can be treated locally and sometime did not consider the dose related prognosis for exposed tissue. Globally, only a few medical centers, have significant experience to provide the appropriate consolation or specialized treatment.

Failure to gather needed information and to obtain consultation from experts has lead to inappropriate treatments that greatly increased the suffering of the patients.

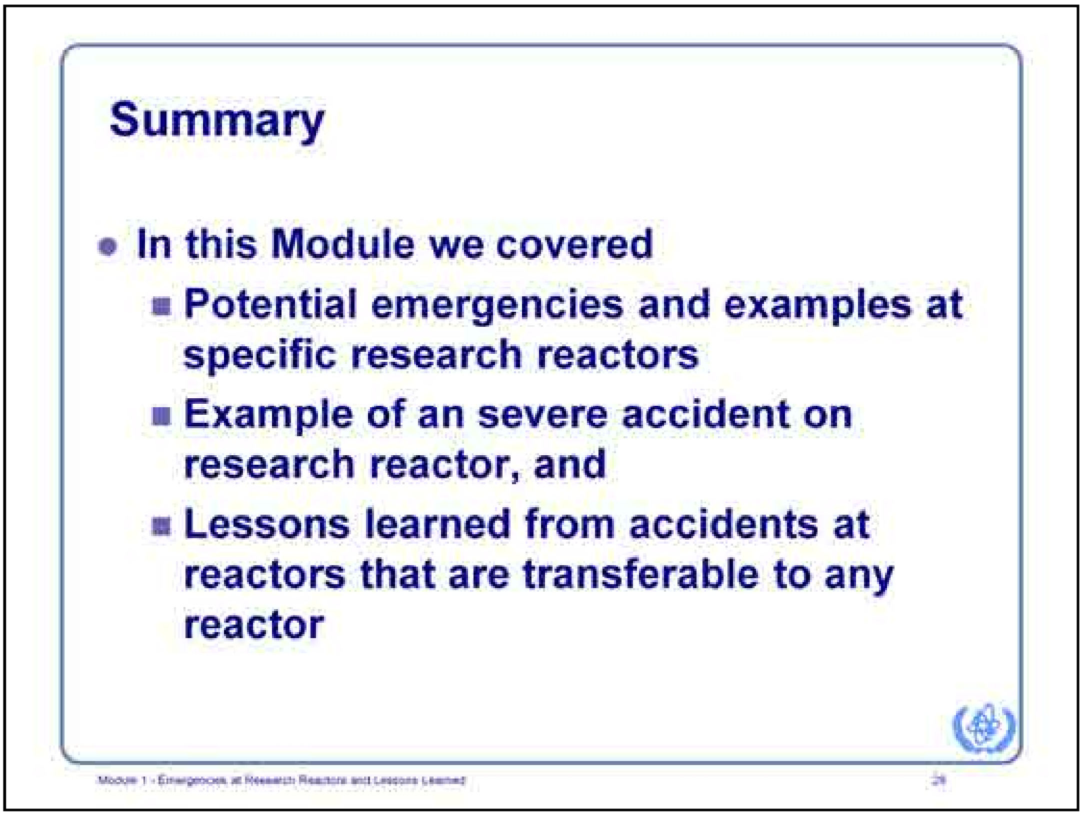
Lecture notes:

Overloading and sometimes the breakdown of public telephone systems (land lines and mobile systems) in the vicinity of an event (and in some cases on a broader scale) often happens shortly after the pubic becomes aware of an event perceived as significant. This prevented the regulatory body from maintaining communications with the site during the TMI emergency and hampered many other aspects of the official emergency response.

This occurred in the USA following the September 11th attack, earthquakes and the TMI emergency and in at least one case by people calling to trying to get tickets for a rock concert.

Once the emergency becomes known there will be media attention at the site, and at the national and at local levels within an hour or less.

Once the emergency becomes known there will be offers of help and calls with advice. During the first few days, the TMI control room received 4000 phone calls with advice. This greatly interfered with the response.



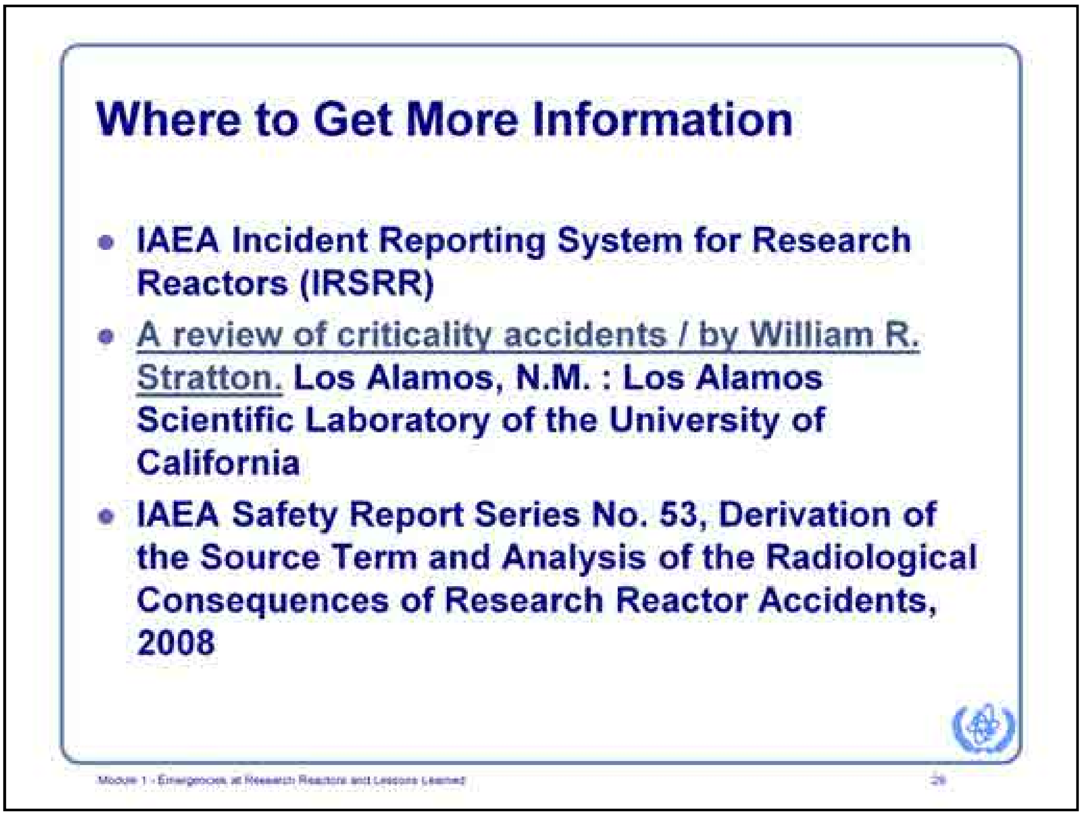
Lecture notes:

Let's summarize the main subjects we did cover in this session.

Some key points to make:

Facility must prepare for potential accidents by having a trained staff that promptly recognizes an emergency and the severity

Off-site must be aware of the facility emergency response plans, coordinate with the facility, and be ready to implement recommended protective actions



Questions:

While the IRSRR is intended to report incidents, these are precursor events. Enough unsafe circumstances and the minor incident could turn into a major accident. Keeping incidents low helps prevent accidents.

IAEA Training Course for Research Reactor Emergency Response

Introduction to the Workshop

Objectives, Concepts and Basic Principles of Emergency Response

Seminar – Part 1

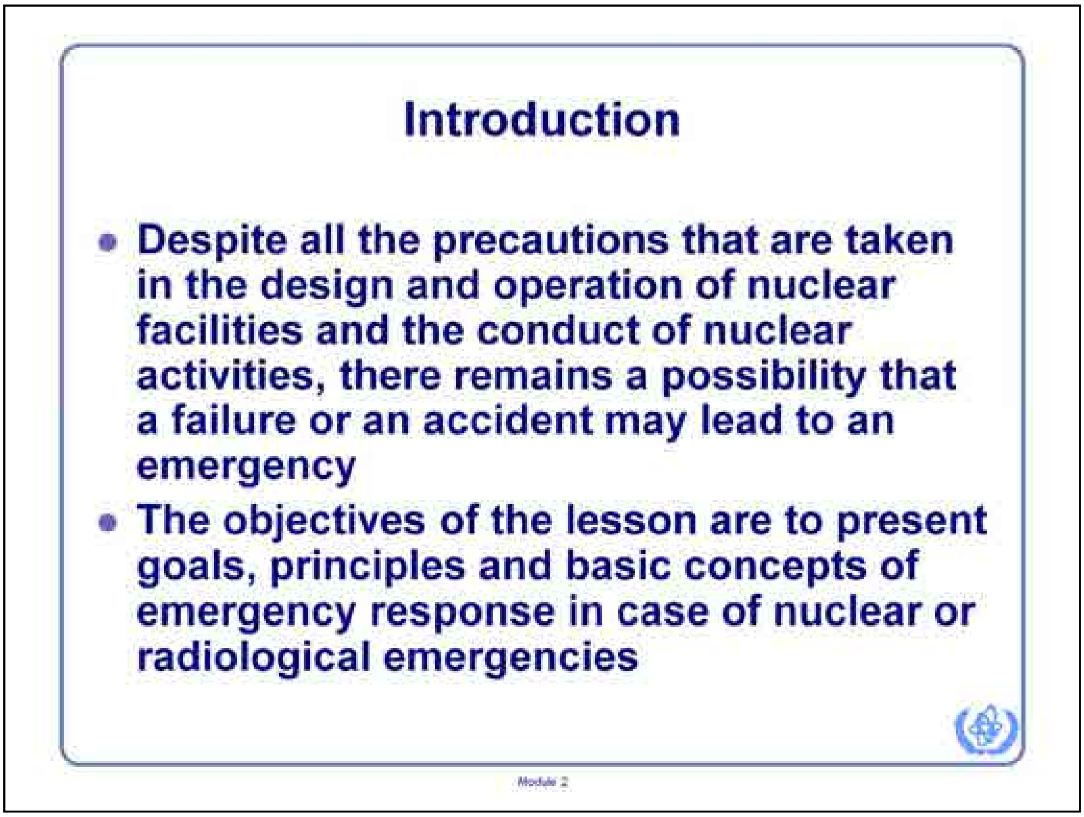
Block 2: Introduction to the Workshop
Module 2: Objectives, Concepts and Basic Principles of Emergency Response – Part 1

Learning objectives: Upon completion of this module, the participants will:

- understand the reasons for emergency planning (EP) and the scope of those plans
- be able to describe the intervention principles
- describe the emergency worker (EW) guidance exposure limits
- list the EP Objectives

Activity: Seminar, questions and discussion
Duration: 1 hr
Materials and equipment needed: none
References:

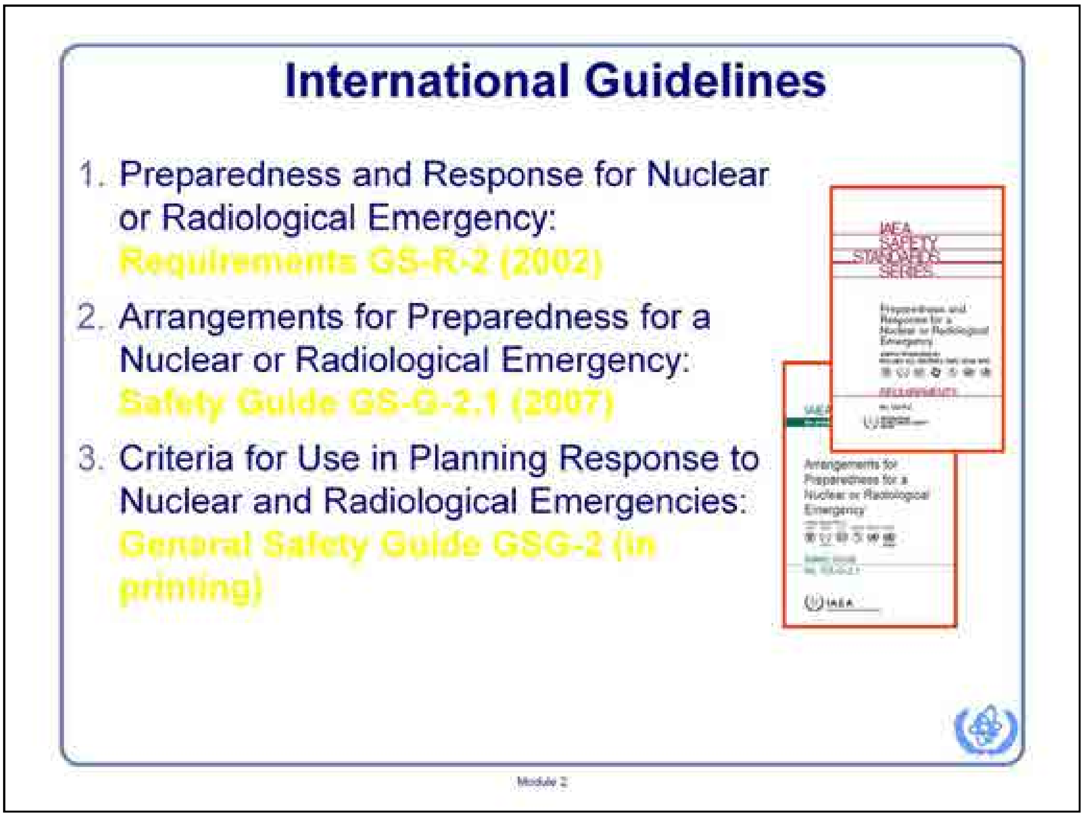
1. INTERNATIONAL ATOMIC ENERGY AGENCY, Arrangements for Preparedness for a Nuclear or Radiological Emergency, Safety Standards Series No. GS-G-2.1, IAEA, Vienna (2007)
2. INTERNATIONAL ATOMIC ENERGY AGENCY, Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency, EPR-METHOD 2003, IAEA, Vienna (2003)
3. INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct On the Safety of Research Reactors, IAEA, Vienna (2006)



Lecture notes:

Despite all the precautions that are taken in the design and operation of nuclear facilities and the conduct of nuclear activities, there remains a possibility that a failure or an accident may lead to an emergency. In some cases, an emergency may lead to the release of radioactive materials within facilities and/or into the public domain, which may necessitate emergency response actions(such emergencies may include transport accidents). That is why adequate preparations have to be established and maintained at local and national and, where agreed between countries, at the international level to respond to emergencies.

In this lesson we will therefore present and discuss goals, principles and basic concepts of emergency response in case of a nuclear or radiological emergency.



GS-R-2, Section 1, Objective:

1.5. This Safety Requirements publication establishes the requirements for an adequate level of preparedness and response for a nuclear or radiological emergency in any State. Their implementation is intended to minimize the consequences for people, property and the environment of any nuclear or radiological emergency.

1.6. The fulfilment of these requirements will also contribute to the harmonization of arrangements in the event of a transnational emergency.

1.7. These requirements are intended to be applied by authorities at the national level by means of adopting legislation, establishing regulations and assigning responsibilities.

GS-G-2.1, Section 1, Objectives:

1. To provide guidance on those selected elements of GS-R-2 for which guidance has been requested by Member States and for which there is an international consensus on the means to meet these requirements;

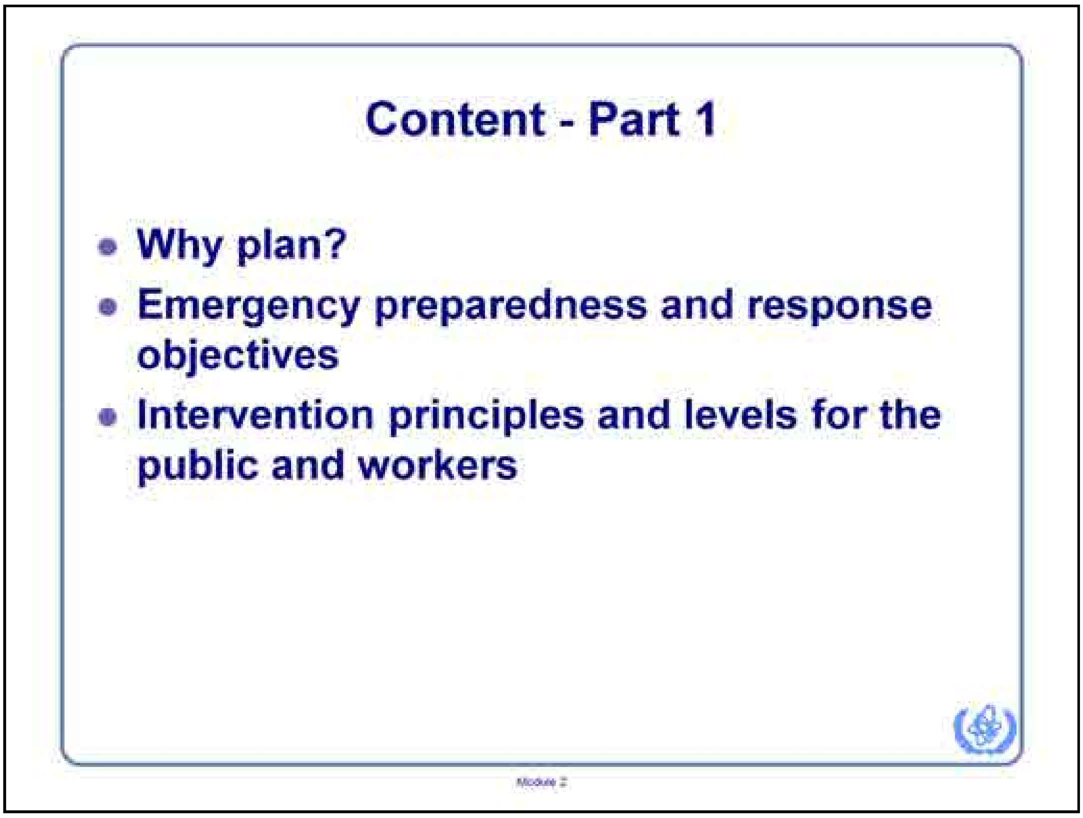
2. To describe appropriate responses to a range of emergencies;

3. To provide background information, where appropriate, on the past experience that provided a basis for the Requirements, thus helping the user to better implement arrangements that address the underlying issues.

GSG-2, Section 1, Objectives:

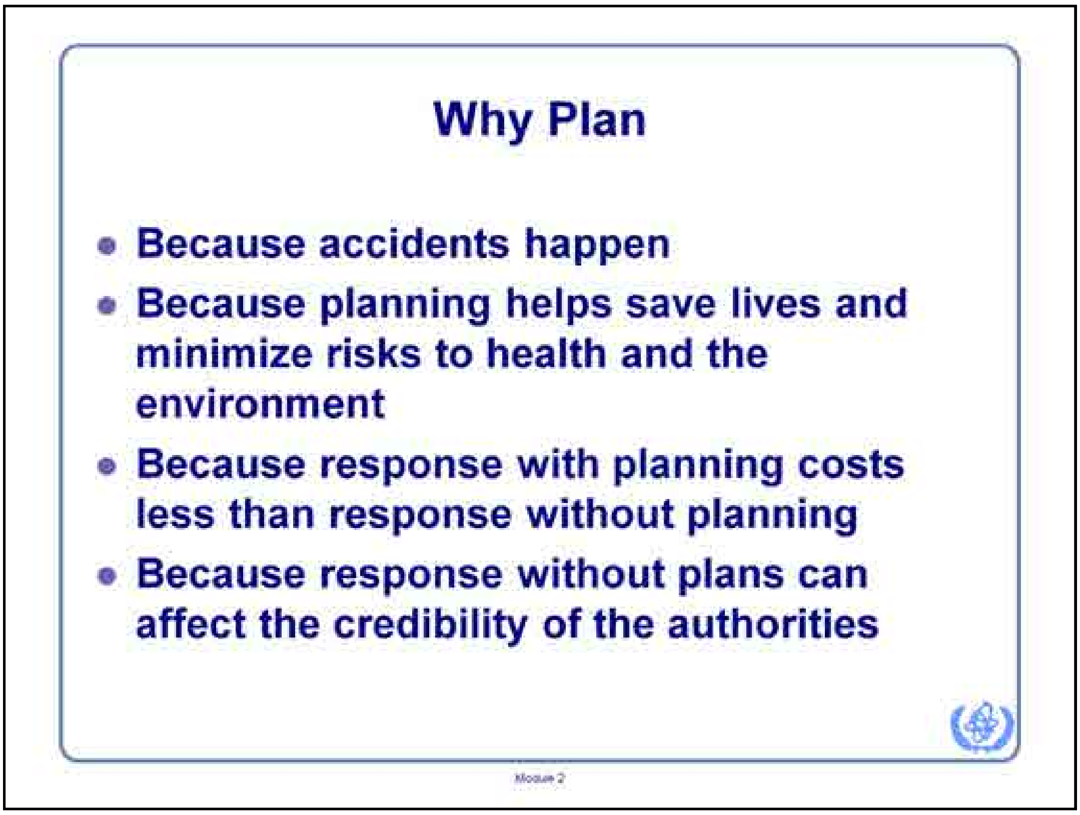
1. To present a coherent set of generic criteria (expressed numerically in terms of radiation dose) that form a basis for developing the operational levels needed for decision making concerning protective actions and other response actions necessary to meet the emergency response objectives.

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



Lecture notes:

This module is divided in two parts. In part I we examine the basic principles of planning, i.e why plan, how much planning is required, what are the objectives of planning and of response and what are the basic principles for intervention during a nuclear emergency.



Lecture notes:

The consequences of not having effective plans and arrangements before an emergency can be serious. It can cost lives, can have a significant impact on the credibility and confidence in public authorities and lead to a crisis. If the response is inefficient, it can also cost more money than if the organization had been prepared. The total cost of not being prepared is hard to estimate. But the consequences are often not ones that a government or agency is prepared to live with.

Lecture notes:

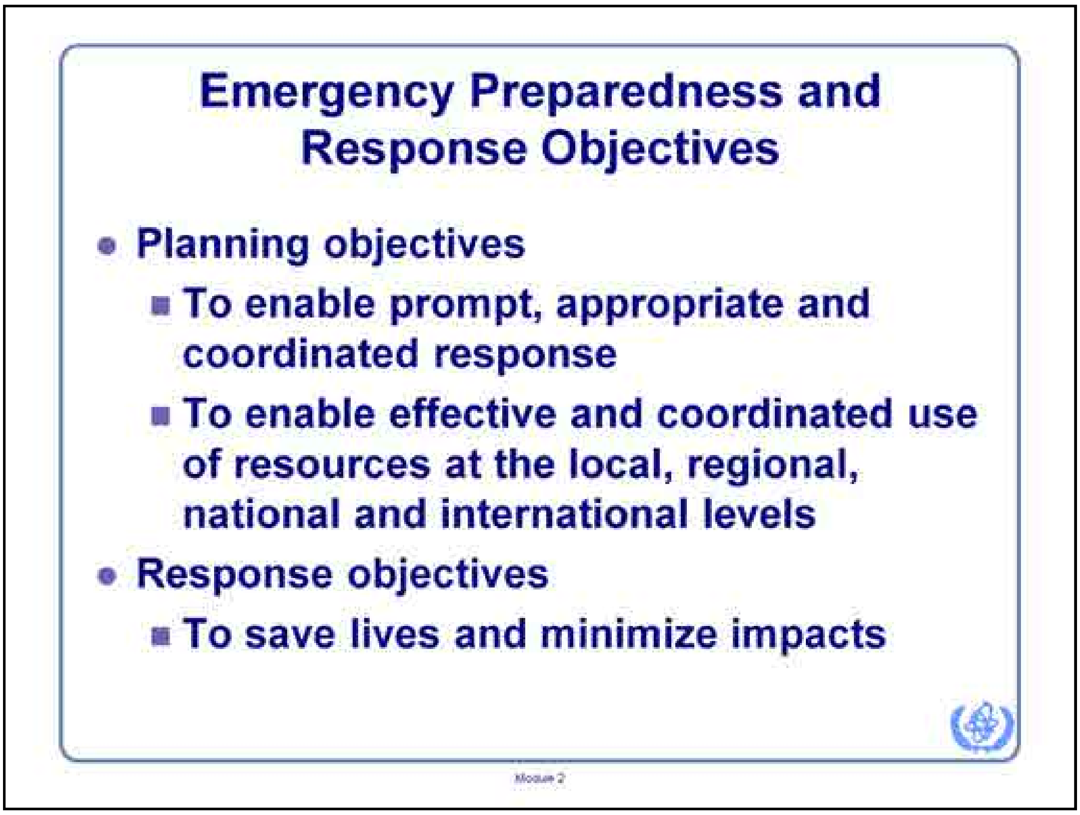
The recommendations of the ICRP were considered in the revisions to the Basic Safety Standards for Radiation Protection.

Here there are requirements that an integrated and coordinated emergency management system be established and that protection strategies be developed at the planning stage and a response to an emergency is undertaken through their timely implementation.

Lecture notes:

How much planning is required is the question we all must ask at the beginning of the planning process, as well as throughout the “life cycle” of the emergency preparedness programme. Remember that planning costs money and resources. In reality, there is no threshold for when planning is not required. Or rather, the threshold varies from individual to individual, and from government to government. The level of planning required depends on the priorities and resources available. And these change with time. It is therefore important to try to maintain a consistent and sustainable approach to planning.

The level of planning required will depend on the perceived priorities, on international pressures and on cost. In some cases, a conscious decision has to be made between being prepared or being responsive. In either case, there is a cost. The cost of emergency preparedness is the cost associated with planning. Being purely responsive involves no, or little preparatory cost. However, the benefit of being prepared is measured in terms of the savings realized by having an effective response should an accident occur. That benefit is measured both in terms of saved cost, in terms of lives saved, and in improving acceptance by the public.



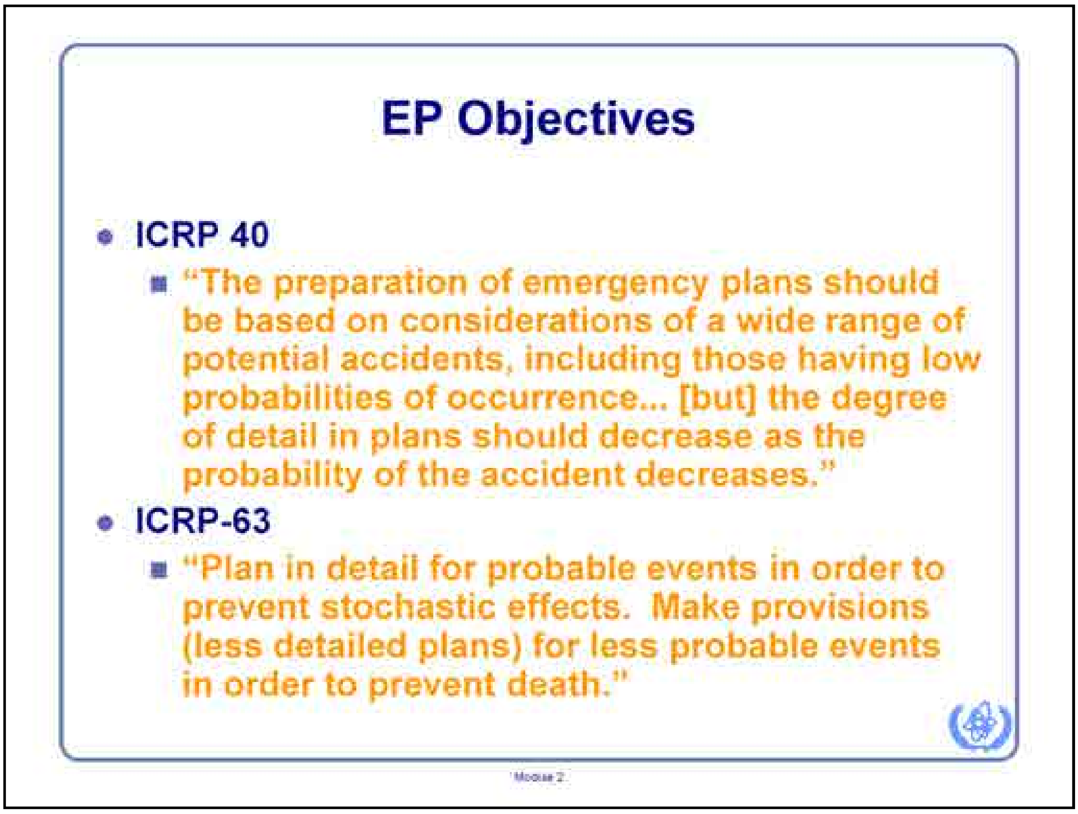
Lecture notes:

"Planning" and "response" are two different things. Plans are developed to ensure that the response will be coordinated and effective. Plans are designed on the basis of our expectations of what the accident consequences will be.

However, in practice, accidents rarely happen exactly as we predicted. Hence, during an actual emergency, the objective is to save lives and minimize stochastic health impacts, environmental impacts and psychosocial impacts. Adequate, well rehearsed plans are the only way to ensure that the response can be effective. Hence, the main goal of plans is to ensure that the response will happen quickly and effectively, unequivocally and in a coordinated way that will minimize the risk to individuals and the environment as a result of an accident.

It is important now to make a clear distinction between the concepts of "RESPONSE" and "PREPAREDNESS". **Response** is everything that is done during an actual emergency to 'take some action' to the situation. It always takes place under pressure of time with associated stress for the emergency responders. Emergency response has its own set of objectives and principles.

Preparedness, on the other hand, is "getting ready' to respond to an emergency. Developing and maintaining preparedness is part of the normal work of an emergency response capability - it does not have the pressure of time and stress associated with responding in an actual emergency. Preparedness has its own objectives and principles, and we shall discuss these later in this course.



Lecture notes:

When developing plans, it is important to realize that these plans have to be implemented. In other words, we have to have the resources to reach the degree of preparedness contained in the plans. Resources cost money and require time and people. Therefore, the details and level of planning done will to a great extent be limited by the resources available and by those we are willing to invest in the planning process. For example, everybody would like to have a $10,000,000 life insurance policy, but few people can afford it. Emergency planning is an insurance. To be practical and reasonable, we plan for what we feel are the greatest risks, and choose to live with other, less realistic risks.

This principle is reflected in the basic planning principles stated by the International Commission on Radiological Protection shown here.

Lecture notes:

The Safety Requirements (GS-R-2) of the FAO, IAEA, ILO, OECD/NEA, PAHO, UNOCHA and WHO provide emergency preparedness and response objectives.

These basic obligations can be expressed in terms of practical objectives for emergency response. These are shown on this slide.

Lecture notes:

The first practical objective of response is to 'mitigate the accident'. By this we mean to bring the radioactive source of the hazard under control. To do this we must reduce the risk of exposure either associated with the event itself or by reducing the risk or magnitude of a release to the environment.

This is achieved by having an accident management programme with predefined emergency procedures which responders follow in order to return to a safe mode of operation. In many radioactive situations a limited accident management plan should be followed to ensure that people are not exposed.

Over and above this, the facility operator and possibly external emergency services may be needed to perform damage control, such as fire-fighting.

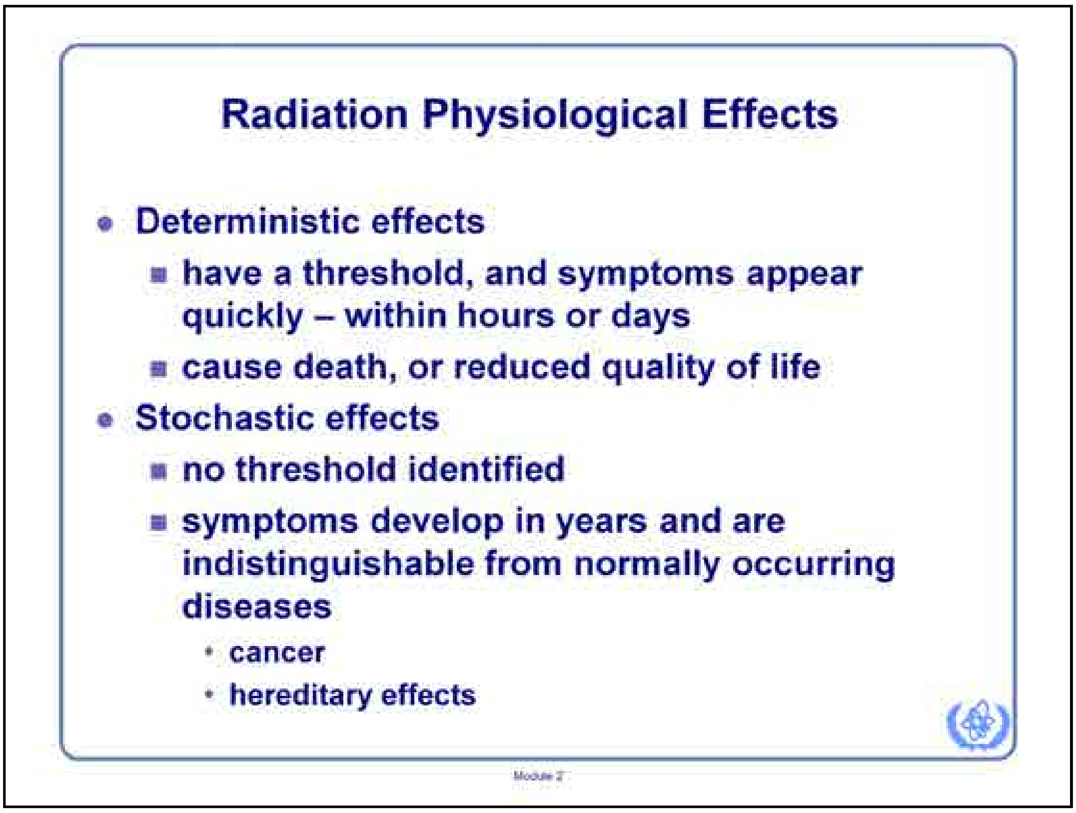
Technical assistance from experts should be made available to assist the facility operators, although this should be strictly controlled, since too much advice may be worse than too little!

Also within the scope of this objective is the need to address other conventional hazards that may be associated with the accident, such as earthquake, hurricane, flood or fire damage. The normal emergency response services would be involved but with the added complication of possibly working in a radiation environment which may be the least dangerous compared to the other elements of the accident.

Lecture notes:

Preparedness requires national guidelines for intervention with urgent protective actions to avoid deterministic health effects to the extent possible considering the projected dose, the radiological and non-radiological health risks and the costs and benefits of the intervention. Urgent protective actions are those that must be taken promptly, within hours or days, to be effective and delays markedly reduce the effectiveness. The protective actions may be modified as additional information is available and discontinued when no longer justified.

GSG-2 and BSS (under revision) establish thresholds for deterministic effects. See the next three slides.



Lecture notes:

The function of most organs and tissues of the body is unaffected by the loss of small numbers of cells, or sometimes even of substantial number. However, if the number of cells lost in a tissue is large enough and the cells are important enough, there will be observable harm, reflected in a loss of tissue function. The probability of causing such harm is zero at small doses of radiation, but above some level of dose (the threshold) it increases to unity (100%). Above the threshold, the severity of the harm also increases with dose. This type of effect is called deterministic, because it is sure to occur if the dose is large enough and is higher than threshold. If the loss of cells can be compensated by the repopulation, the effect will be relatively short-lived.

Examples of deterministic effects are radiation burns; induction of temporary or permanent sterility in the testes and ovaries; depression of the effectiveness of the blood forming system, leading to a decrease in the number of a blood cells; cataract. A special case of the deterministic effect is the acute radiation sickness resulting from acute whole body irradiation.

Photo

Two views of the right hand of a pioneer medical radiologist. The first injury to this radiologist was seen in 1899, namely 3 years after the discovery of X-rays was announced. The hand was amputated in 1932 and death from cancer occurred in 1933.

GENERIC CRITERIA FOR PROTECTIVE ACTIONS TO AVOID OR TO MINIMIZE DETERMINISTIC HEALTH EFFECTS

Acute external, local and contact exposure

Organ or tissue	RBE-weighted absorbed dose (<10 hr)
Red marrow	1 Gy
Foetus	0.1 Gy
Soft tissue	25 Gy at 0.5 cm
Skin derma	10 Gy to 100 cm^2

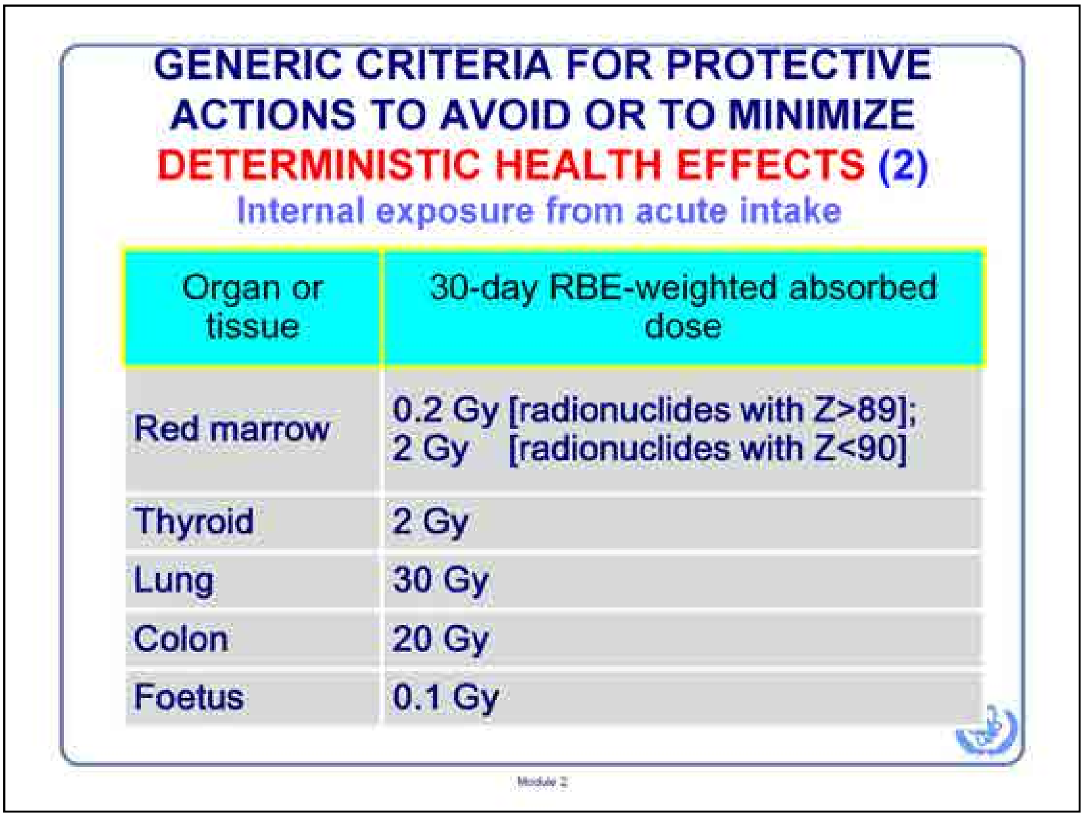
Module 2

Generic criteria for acute doses for which protective actions and other response actions are to be undertaken under any circumstances to avoid or to minimize deterministic health effects.

Dose in *Red marrow* represents the average RBE-weighted dose to internal organs (e.g., red marrow, lung, small intestine, gonads, thyroid, etc.) and lens of eye from irradiation in a uniform field of strongly penetrating radiation.

Dose in *soft tissue* reflects RBE-weighed dose delivered at the depth of 0.5 cm under the body surface in tissue due to close contact with a radioactive source (e.g. source carried in hand or pocket).

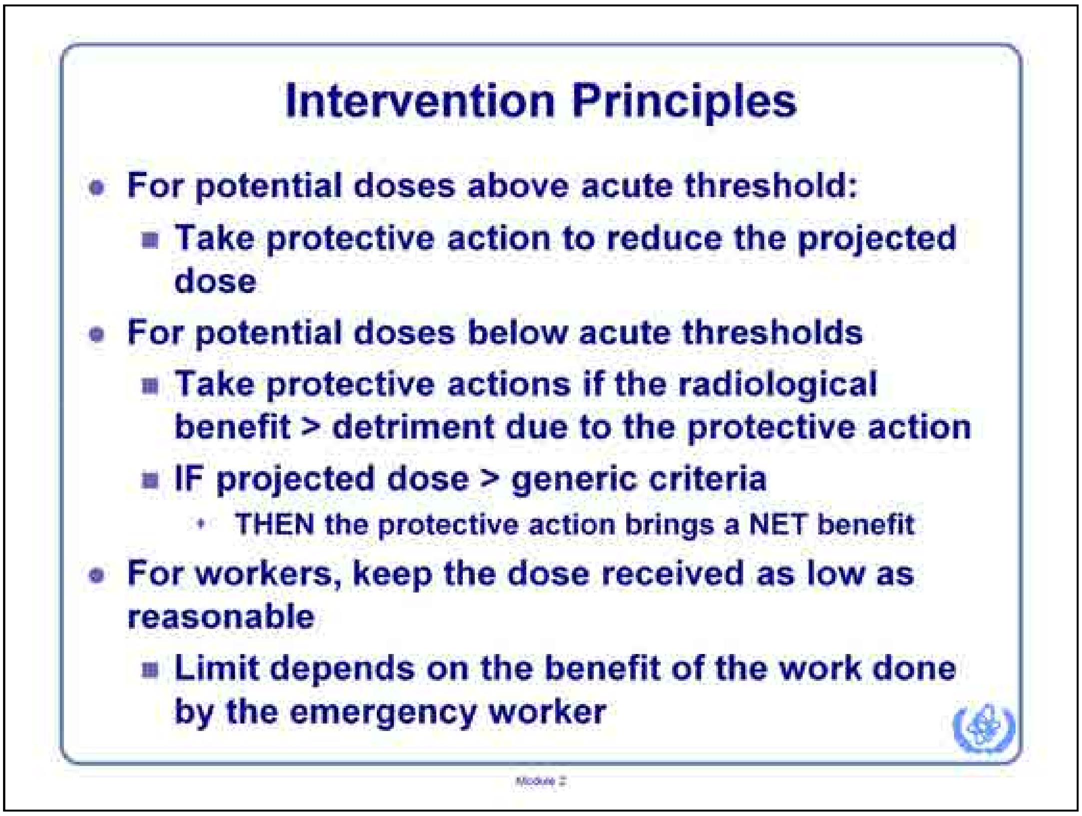
Dose in *skin* reflects RBE-weighed dose to an area of 100 cm^2 of derma (skin structures at a depth of 40 mg/cm^2 (or 0.4 mm) under the surface).



This slide summarizes generic criteria established at the level of doses which are approaching thresholds for severe deterministic health effects in case of intake of radionuclides.

30-day committed RBE-weighted dose is the RBE-weighted absorbed dose delivered over the period of 30 days by the intake that will result in a severe deterministic effects in 5% of exposed people.

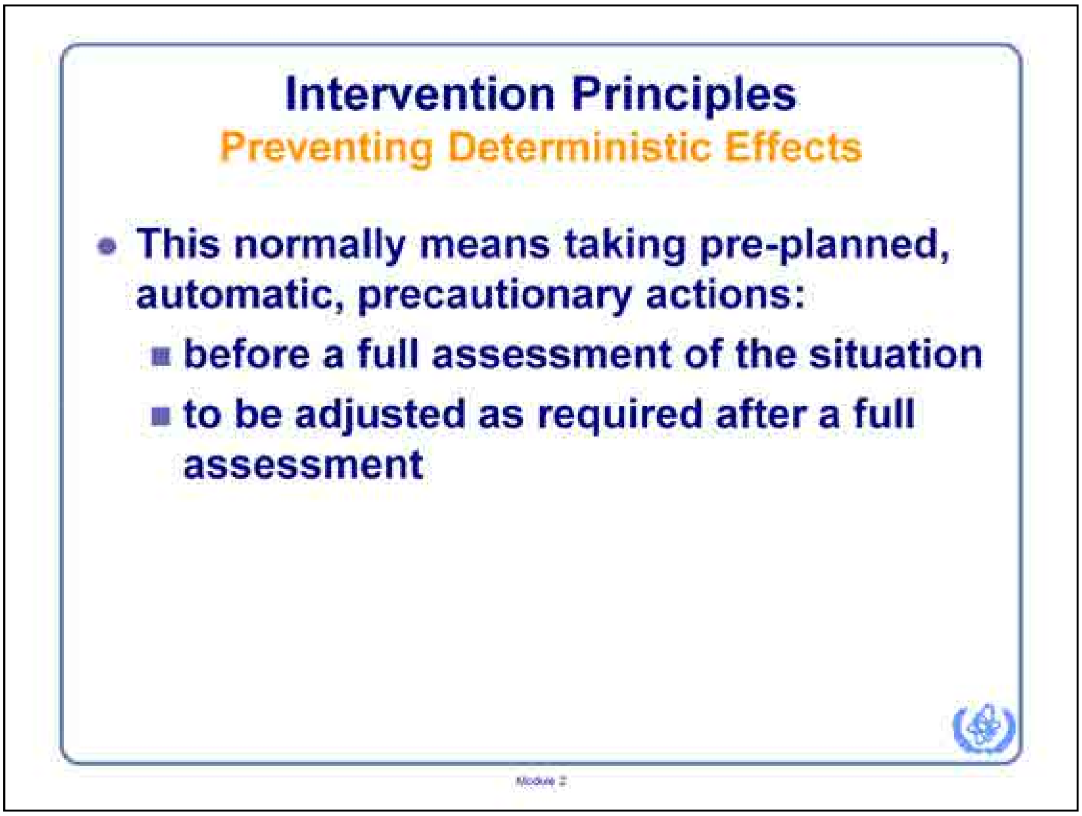
- In case of internal exposure of red marrow, different criteria are used to account for the significant difference in the radionuclide specific intake threshold values for the radionuclides in these groups.
- For purposes of GSG-2 "Lung" means the alveolar-interstitial region of the respiratory tract.
- For the case of exposure to the foetus, the committed RBE-weighted dose is defined for the period of *in utero* development.



Lecture notes:

The basic intervention principles are summarized on this slide. Note that the basis changes depending in the situation:

- A dose above deterministic thresholds is a direct threat to life and must be be allowed to be reached. In this case. Therefore, the goal is to limit the total dose.
- A dose below deterministic thresholds does not represent an immediate life threat. Any action aimed at reducing this dose introduces a cost in terms of health, disruption, stress and inconvenience. This cost must be balanced against the benefit of the measure. This benefit is measured in terms of the dose reduction that the action may lead to.
- Emergency workers, unlike the public, do not get exposed as a result of the accident except through their own actions, which are designed to protect the public. Their work is not to avert their own individual dose, but rather to get potentially exposed to help avert a dose to the public. But it should not be acceptable for an emergency worker to receive a dose above the normal yearly limit unless there is a very good reason to do so.



Lecture notes:

Nevertheless, precautionary actions aimed at preventing serious injuries must be taken as soon as possible when the threat warrants it. Therefore, early decisions may not wait for a careful assessment of the source term and they must be based on the plant conditions and on the classification level.

ER Objective III: Provide First Aid and Treat Injuries

- Give conventional First Aid
  - Life-saving first aid always has priority
- Triage injured patients
- Decontaminate
- Treat radiation injuries
- Obtain specialist assistance

Module 2

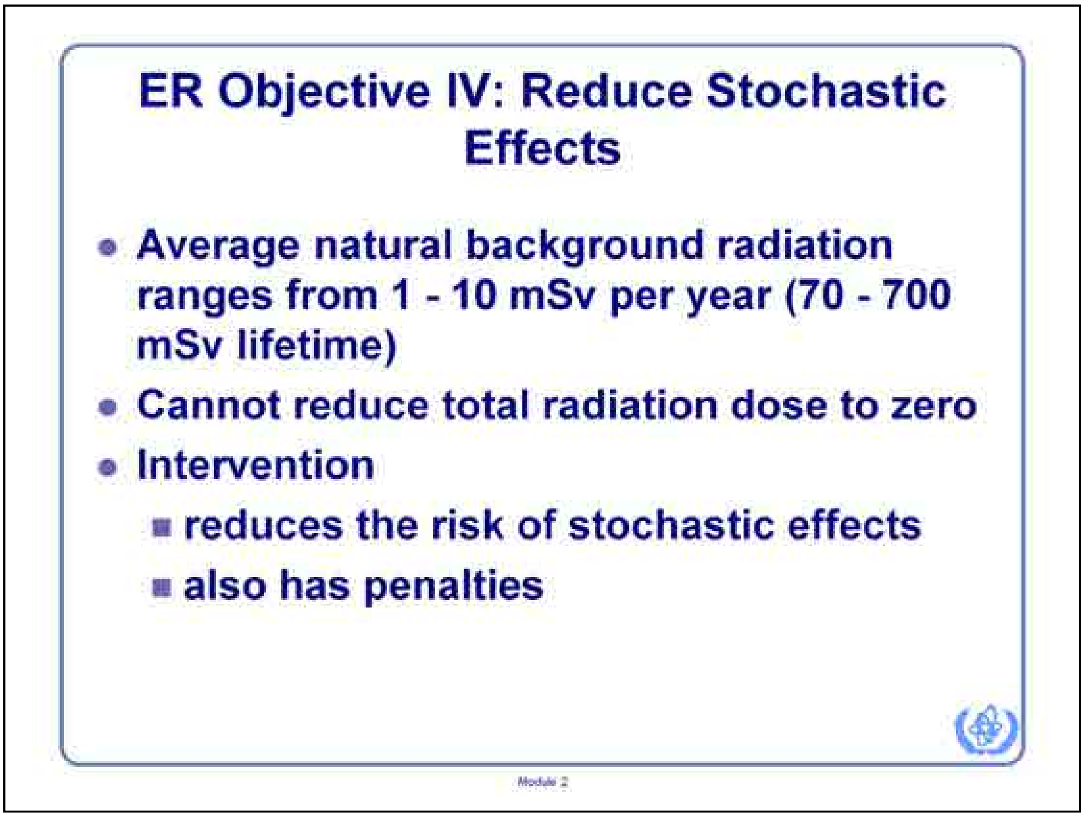
Lecture notes:

Unfortunately there may be accidents where people are exposed to significant doses of radiation before they are even aware that an accident has happened. For example, so-called ‘orphan’ sources (sources that were never under any form of institutional control) may have been found by patients presenting themselves to the local hospital with symptoms of skin or whole body irradiation. Some real life examples of these events were discussed earlier this morning.

In any case one of the primary practical goals of emergency response will be to treat injuries. Some of these injuries may be non-radiological, e.g.. thermal burns or injuries associated with the conventional aspects of a transport accident. Conventional First Aid to save life, reduce pain and aid recovery will be needed.

However because of the special nature of radiation accidents, there may be a need to treat contaminated patients. Because patients may not express symptoms of radiation exposure early on, there will be a need to sort and follow up potentially exposed individuals according to their assessed doses.

After the very initial emergency phase, the radiation injuries if they become manifest (usually within days or weeks, but sometimes hours) will need medical treatment and often special medical advice.

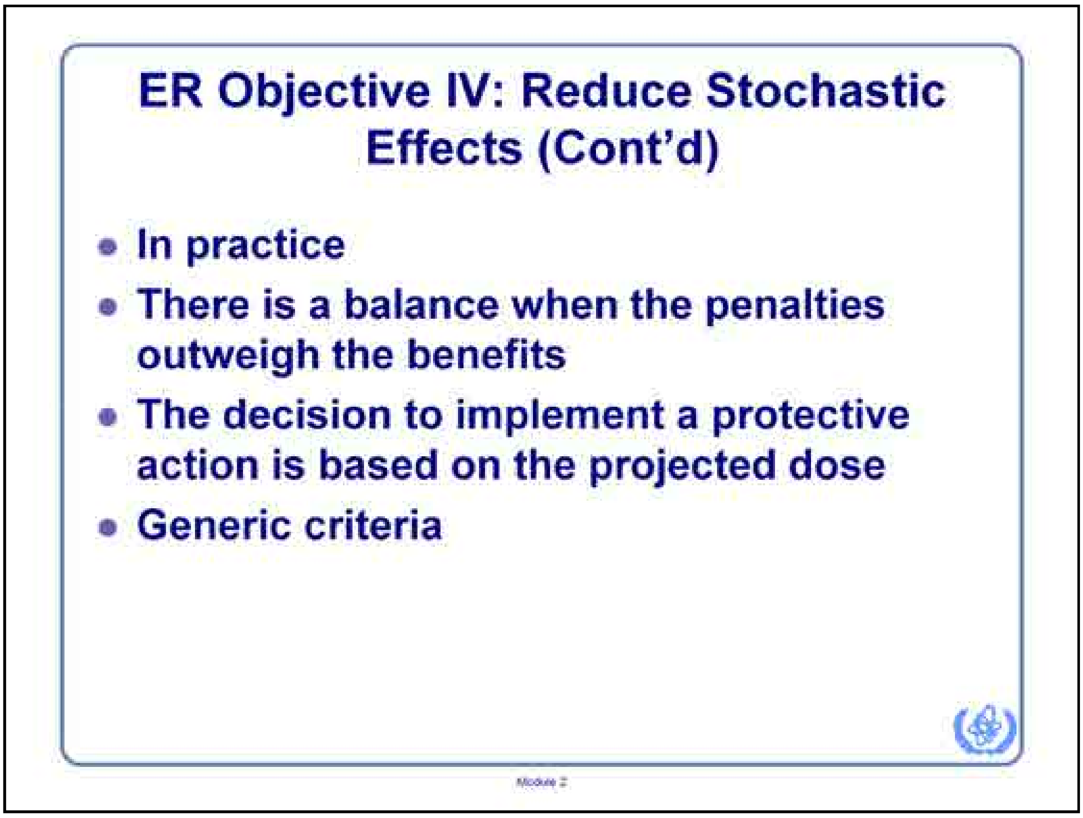


Lecture notes:

Returning to criteria for intervention, another objective of emergency response is to reduce as much as possible the additional radiation-induced stochastic effects (e.g. cancers) in the population.

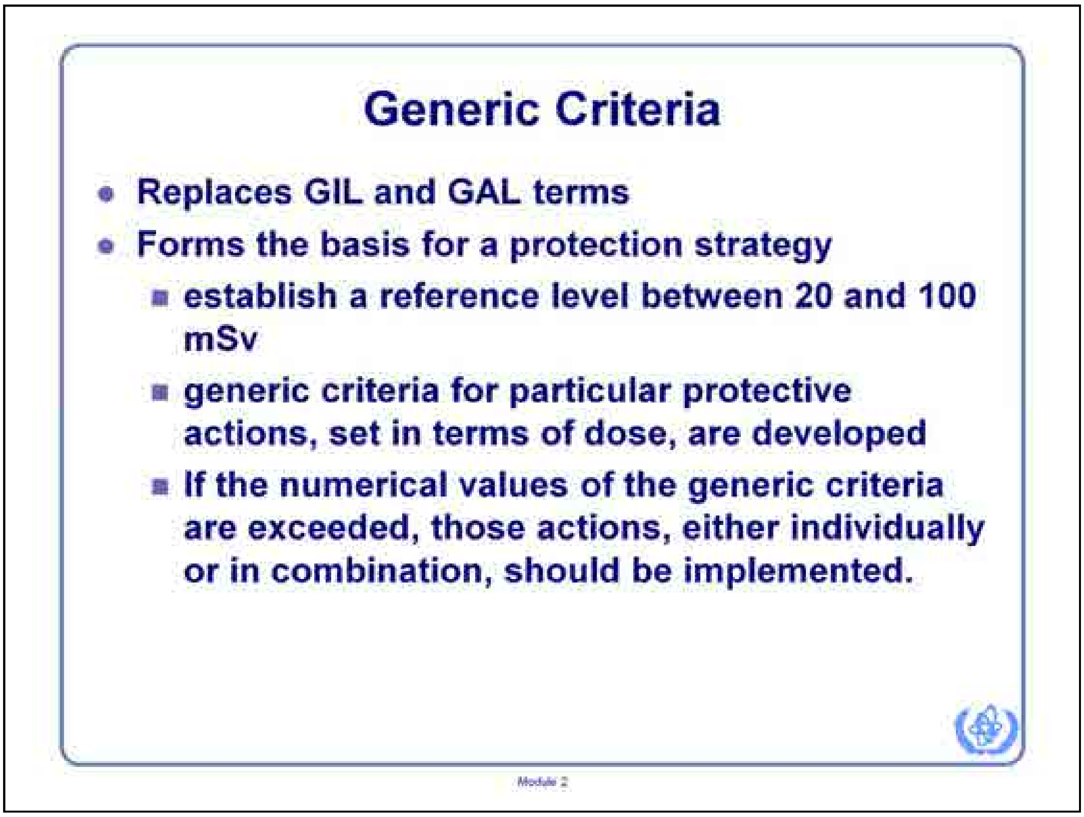
However we should take into account that natural background radiation (from cosmic rays, terrestrial gamma rays, radon etc.) provides on average individual dose of 2.4 mSv per year, and this can range from about 1 to about 10 mSv per year. So on average we each receive about 170 mSv radiation dose from natural background in our lifetimes (assuming 70 years is our life expectancy). So after an accident, we must recognise that it is impossible to reduce the total dose to zero - the accident will increase the lifetime dose and associated risk of cancer.

While intervention, such as food controls, sheltering or evacuation, may have benefits in reducing the dose and therefore in reducing the associated risks, intervention also has penalties. These penalties include the risk of side effects (e.g. reducing the nutrition in the diet if key foods that are already scarce, are banned), increased doses to emergency workers (e.g. to the police in carrying out an evacuation), economic costs and socio-psychological penalties.



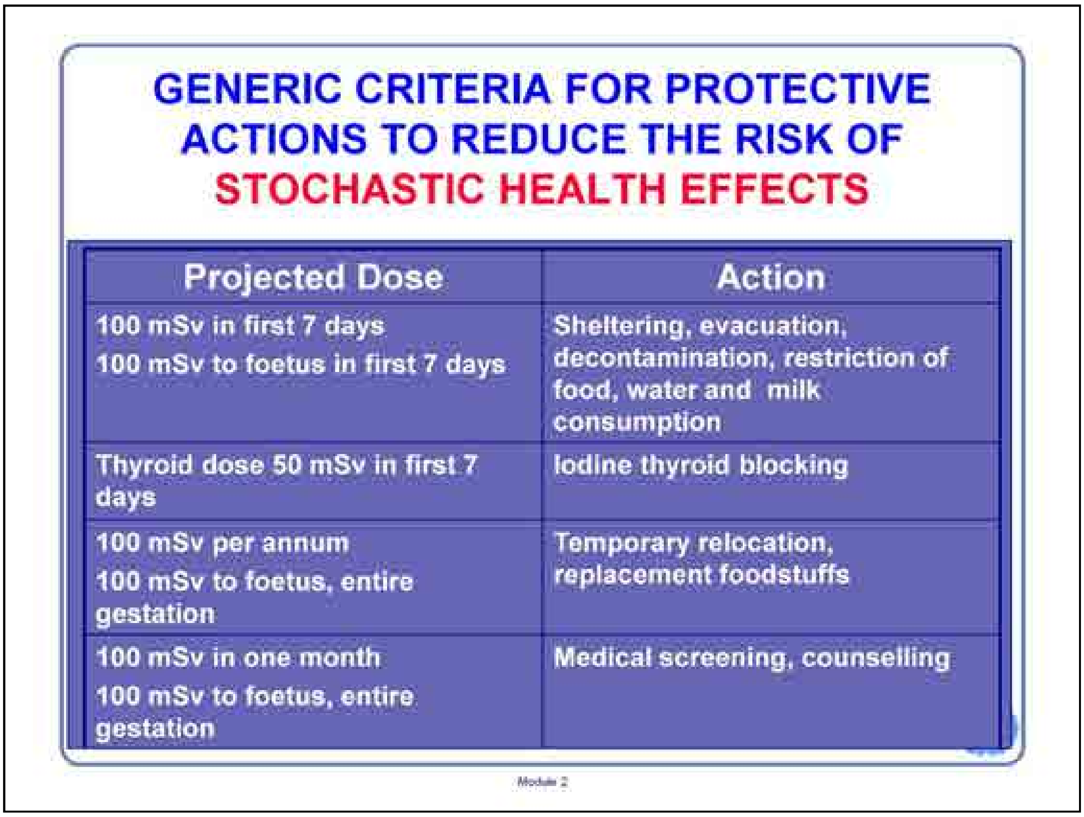
Lecture notes:

So it is clear that for each protective action that might be considered, there is a tradeoff between the penalties of taking the action and the benefits of reducing radiation exposure. For example, the risks associated with evacuation include road accidents that may result in injuries and death, and the cost includes the interruption of economic activities and the emotional troubles associated with having people stay in emergency shelters. The question is, at what level of dose saved will evacuation be worthwhile? - this level is called the *Intervention level.*



GIL was the Generic Intervention Level. GAL was the Generic Action Level. Both terms were used in previous IAEA publications. Besides the names, some other changes will be observed when comparing the earlier publications to GSG-2. The complete term is “Generic criteria for protective actions to reduce the risks of health effects: with the inclusion of “deterministic health effects” or “stochastic health effects” depending on the health effects involved. The replacement meets the need for a common term for the system of values that would be used as the basis for implementation of protective actions and other response actions.

In practice, the intervention levels would be established as a national criteria and the reference level would be chosen as part of the process of establishing these criteria.



GENERIC CRITERIA FOR PROTECTIVE ACTIONS TO REDUCE THE RISK OF STOCHASTIC HEALTH EFFECTS

Projected Dose	Action
100 mSv in first 7 days 100 mSv to foetus in first 7 days	Sheltering, evacuation, decontamination, restriction of food, water and milk consumption
Thyroid dose 50 mSv in first 7 days	Iodine thyroid blocking
100 mSv per annum 100 mSv to foetus, entire gestation	Temporary relocation, replacement foodstuffs
100 mSv in one month 100 mSv to foetus, entire gestation	Medical screening, counselling

Module 2

Lecture notes:

Based on a generic optimization analysis, experts who developed GSG-2 proposed generic criteria that have been adopted by the "International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources". You should notice the new guidance does not contain upper and lower limits like those in the ICRP publications. This is in part a result of the Chernobyl experience where the exact interpretation of these upper and lower limits by different organizations led to delays in the implementation of the protective action, and to mistrust among the affected populations. These drawbacks with the two-tier approach - led to the adoption of a set of generic criteria for each protective action in the Basic Safety Standards.

Emergency protective actions include:

- urgent protective actions, which must be taken within hours of an accident to be effective. These include: evacuation, intake of stable iodine tablets and sheltering; and
- longer-term protective actions, which may need to be adopted in a matter of days following an accident. These include: analysis and control of foodstuff, relocation and resettlement.

The criteria are expressed in terms of the projected dose for each action, except for foodstuffs where they are expressed in terms of the activity concentration of key radionuclides in the foodstuff.

The criteria also introduce reference levels. The values on this slide are based on a reference level of 100 mSv. ICRP 109 proposed reference levels of 20-100 mSv effective dose (annual or acute). The reference level represents the level of residual dose or risk above which it is generally judged to be inappropriate to plan to allow exposures to occur.

Lecture notes:

Now, we will look at what this means in practice.

Experience has shown that projecting dose during an emergency is difficult and usually leads to confusion and decision-making delays.

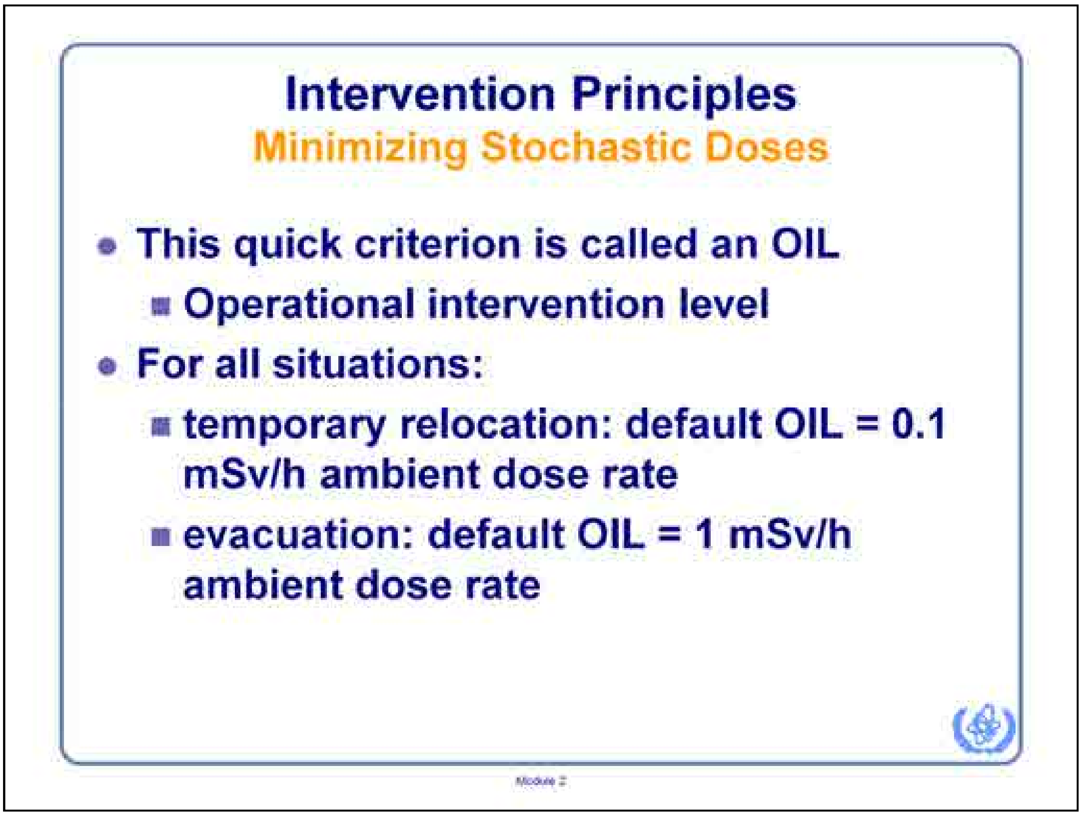
Why is that often the case?

Expect responses such as poorly known source term, time to run computer calculations, changing or uncertain weather conditions, results may not reflect reality, leads to debates over how certain are the results – meanwhile, the exposure is imminent or in progress.

Lecture notes:

The same is true for non-automatic urgent protective actions. During an emergency, there is no time to carry out a careful assessment of projected and avertable doses. A simple criterion is needed.

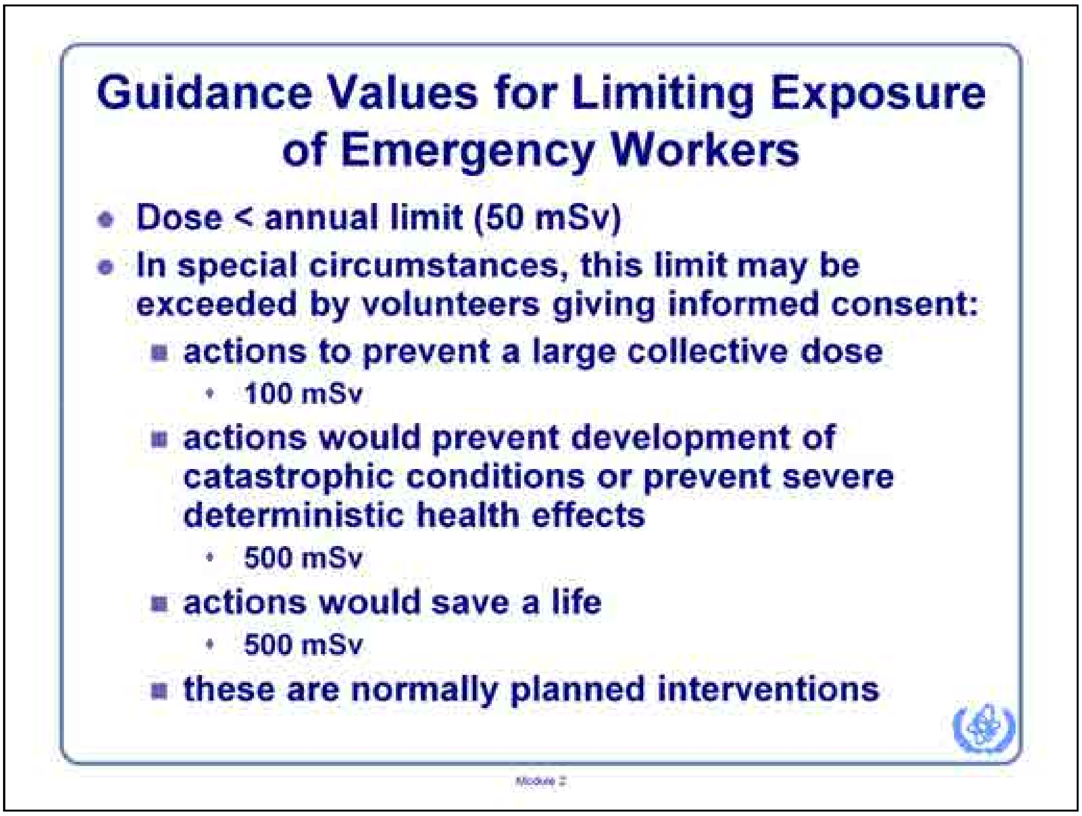
It turns out that the ambient dose rate measurements are somewhat related to the source term. Therefore, it is possible to calculated levels of instrument readings that would correspond to a dose equal to a GIL for the exposition considered.



Lecture notes:

This criterion is called an OIL. Default OIL values are given in GSG-2. These values may need to be revised during an emergency to reflect the exact mix of radioisotopes and better calculate the potential effective dose rate.

The default OILs will be discussed in more detail later.

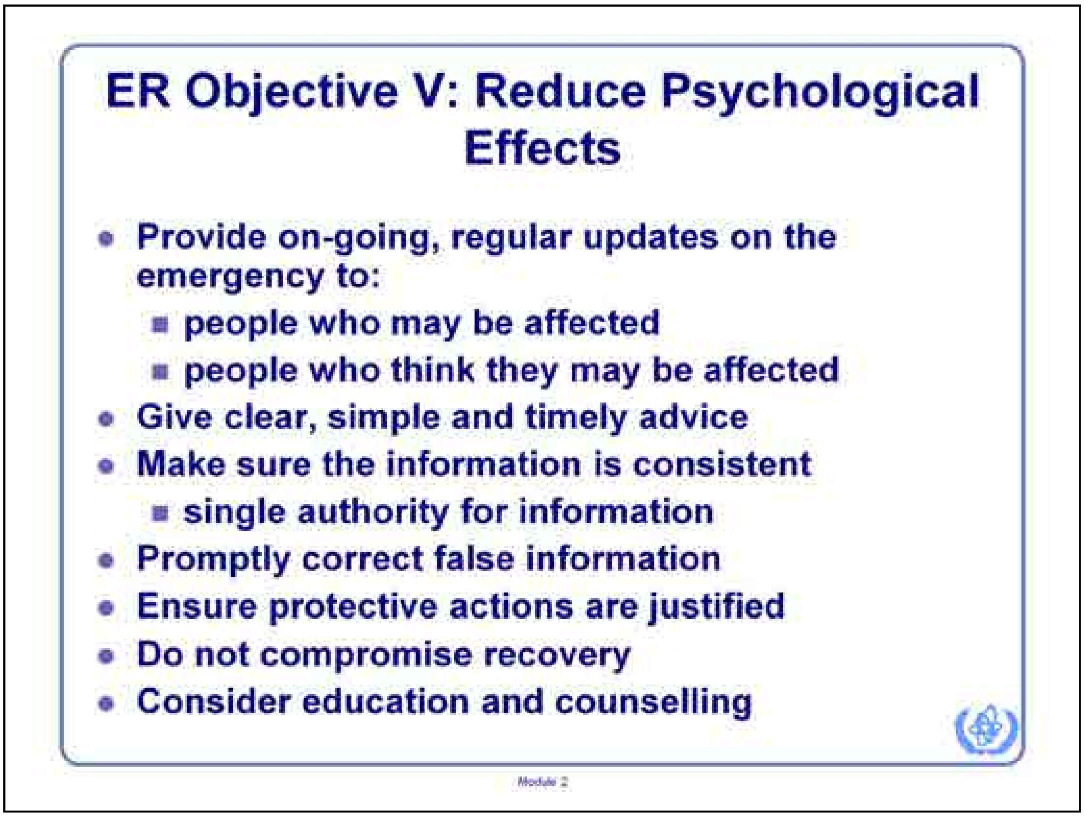


Lecture notes:

The maximum annual dose is 50 mSv and efforts should be made to keep Emergency Worker doses below that value. In some emergency situations that may not be possible and guidance values for limiting exposure in three specific circumstances are recommended. Note that the Emergency Workers not only are fully informed of the risks, voluntarily accept the intervention, but should be trained as thoroughly as possible for the tasks they are expected to perform during the intervention.

Since these are normally planned interventions, how would you plan an intervention when the dose rate values for the area being entered are not well known?

Expected response should include use of intervention time limits, turnback values, and dependable communication to the emergency worker.



Lecture notes:

Psychological factors, while often difficult to measure, can also affect the implementation of protective measures. The compliance with imposed food restrictions was alarmingly low in some areas directly affected by Chernobyl. This was in part because of a lack of information early in the event and conflicting information later. The severity of these psychological effects will depend, in part, on whether people have confidence that the authorities are competent and trustworthy, and have taken prompt and effective action to control radiation doses. In those areas near the plant, information on accidents and protective actions should be provided to the public as part of a routine education programme. At the time of an accident, be honest and provide clear, simple advice based on internationally endorsed guidance to the public. Efforts should be made to provide consistent advice and assessment to the public and media (press), and to correct false information. This is best accomplished by having one source of official information within the country and coordinating protective actions with nearby countries in advance. This may increase the public confidence and compliance with recommended actions. Every effort should be made to maintain public trust.

In truth, this is very difficult to do. Little will be known about the accident at the scene, let alone at some central information centre. Information, once supplied, may turn out to be incorrect. As the accident progresses, new information will contradict the old information, giving the appearance of not being honest.

Psychological health effects will always accompany a radiological accident whether or not it has resulted in persons receiving significant radiation exposure. Some protective actions taken during Chernobyl to reduce the radiological health risks, such as relocation and resettlement, did more harm than good because of the resulting psychological health effects brought on by stress and anxiety. Psychological health effects must be considered when determining protective actions. To minimize the potential for longer-term stress in affected population groups, it is essential to resist pressure to introduce protective measures for political reasons that are well below those justified on radiological grounds.

Lecture notes:

The last objective is to protect the environment and property. This is not very well-defined because environmental damage itself is not well-defined. Nevertheless the concept includes such actions as controlling access to evacuated areas for securing property and taking steps to limit the spread of contamination by humans or naturally by transport through the air, ground or water courses.

Lecture notes:

Additionally, establish controls on the agricultural production system and on the water supplies and controls on forestry use, fisheries and on the natural environment (such as hunting and fishing restrictions, as well as restrictions on activities such as mushroom and berry picking).

Lecture notes:

Controls may also be needed on the movement of traffic and goods from ‘contaminated’ areas to non-contaminated areas and to other countries.

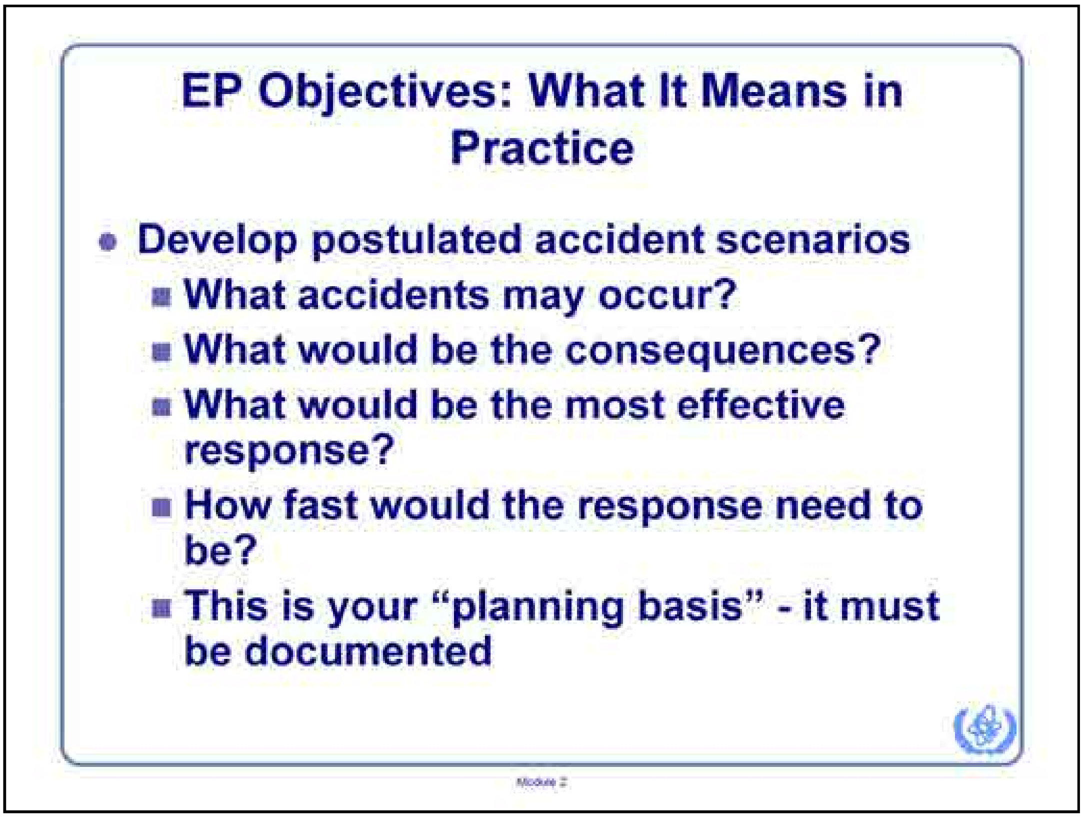
There will be a need to manage waste arising from the emergency controls invoked for foodstuffs.

One principle to apply when managing the protection of the environment is **NOT** to take actions that will compromise long term recovery.

ER Objective VI: Prepare for Resumption of Normal Activity

- Plan ahead
  - Before the emergency
    - levels of “safe” and “normal” in radiation protection terms
  - During the emergency
    - Keep recovery in sight, define when the emergency phase has ended
  - After the emergency
    - Apply criteria developed before the emergency

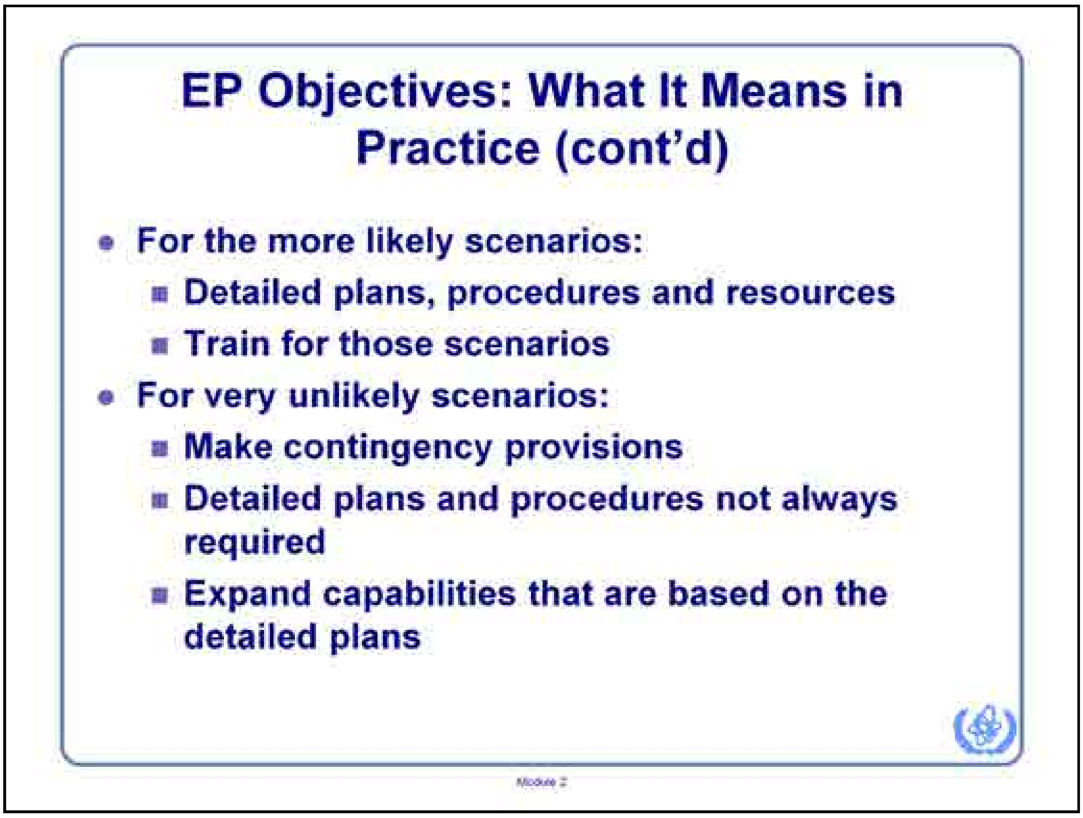
Module 2



Lecture notes:

What does this mean in practice? It is usually very difficult to justify at which point planning is considered sufficient. The next four slides propose some guidance in this respect. There are also several dissertations that discuss the merit of planning in terms of risk reduction. This module will not address those more in-depth discussions.

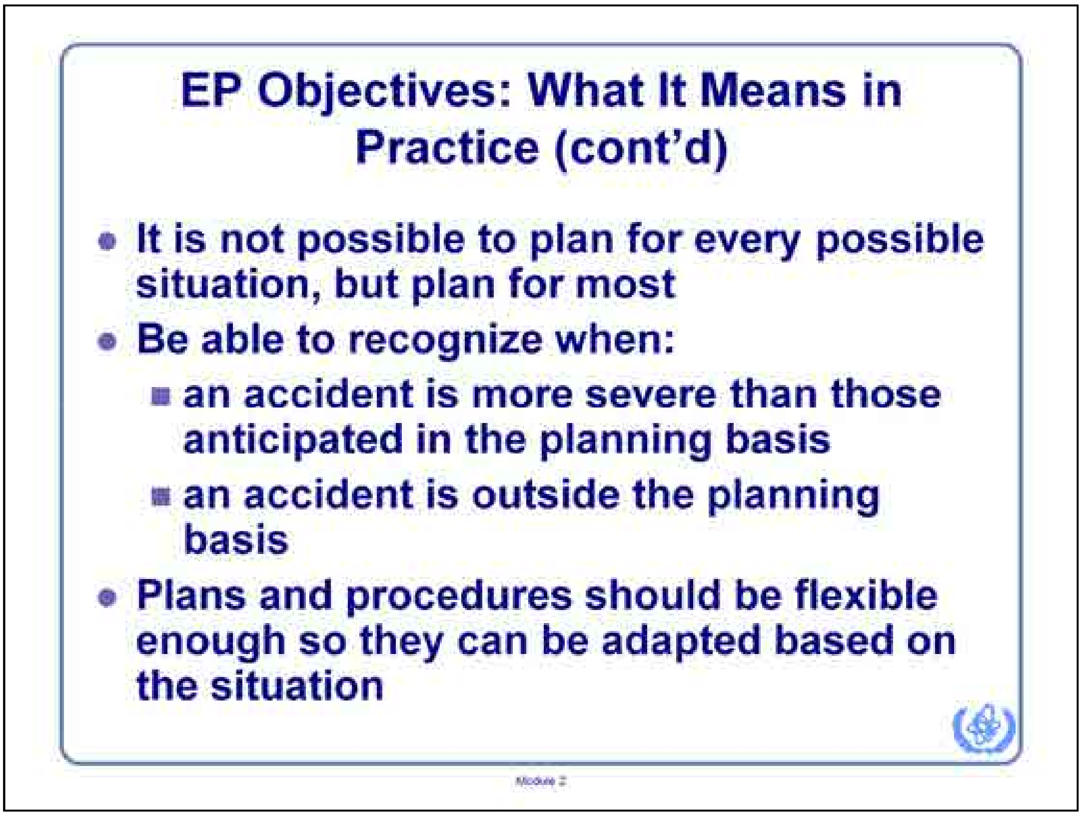
First, to plan, one needs to have an idea of what one is planning for. This is the planning basis. It describes the kinds of accidents and their consequences for which plans are required. It also describes what the planned response would be intended to achieve. For example, earthquake plans may state that the planning basis is an earthquake level 6 on the Richter scale, and that the main response objective would be to save lives and provide for continuity of essential government services. In this example, saving buildings may not be a prime objective.



Lecture notes:

Planners must also consider which severity of accidents they must plan for. While it is not possible to plan for all possible scenarios, especially the very extreme ones considered by some to be incredible, it is necessary to keep in mind that accidents may end up being more severe than the ones for which plans were developed. Hence, it is important to be able to recognize when an event goes beyond what was planned for, and to be able to adapt the plans in place to deal with the impact of that more severe accident. Plans should address how this can be done with sufficient effectiveness to achieve the main response objectives.

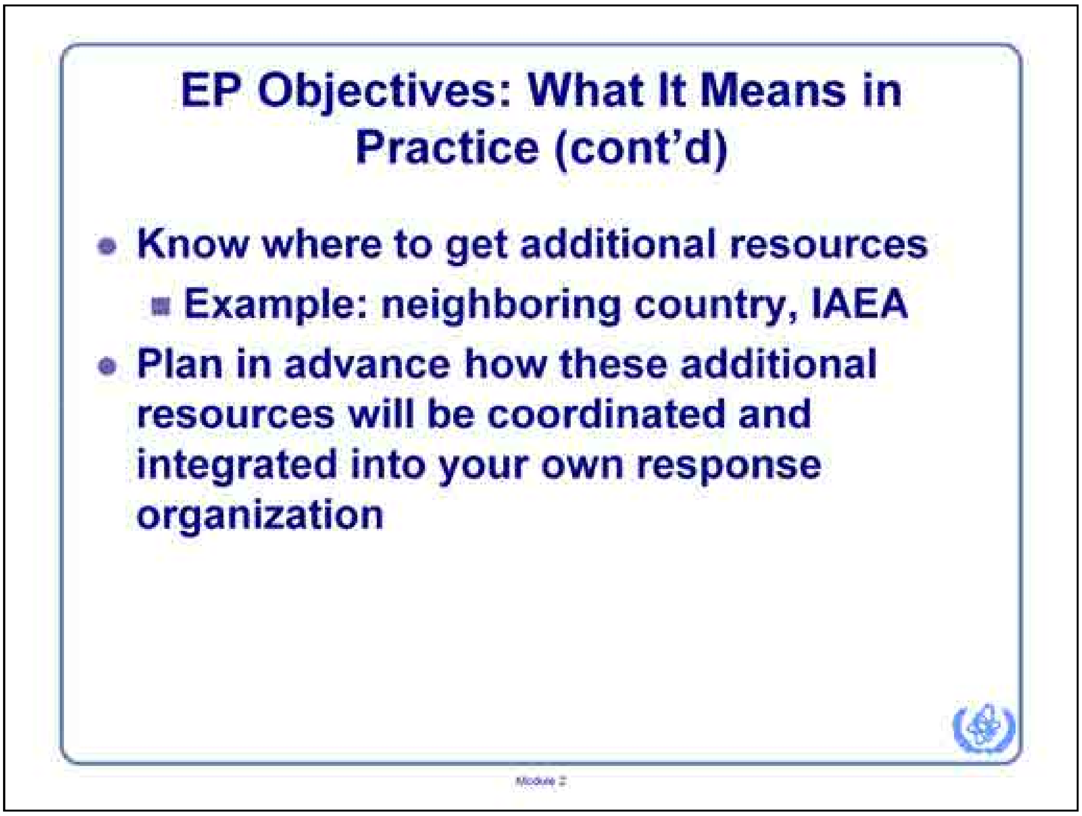
Unlikely scenarios are the judgement of the facility and the local and national authorities, and depend on consequences as well as the potential for the event to occur. Generally, the less likely scenarios have more severe consequences. Often, national regulations determine how much preparation is required depending on event probability.



Lecture notes:

It is nor possible to predict all possible accidents and variations thereof. Therefore, it is important that, when the time comes, emergency responders be able to recognize that they are dealing with a "new" situation. It is also important that they be able to adjust their planned response in a way that respects the intent of the plan and is most effective for the set of circumstances.

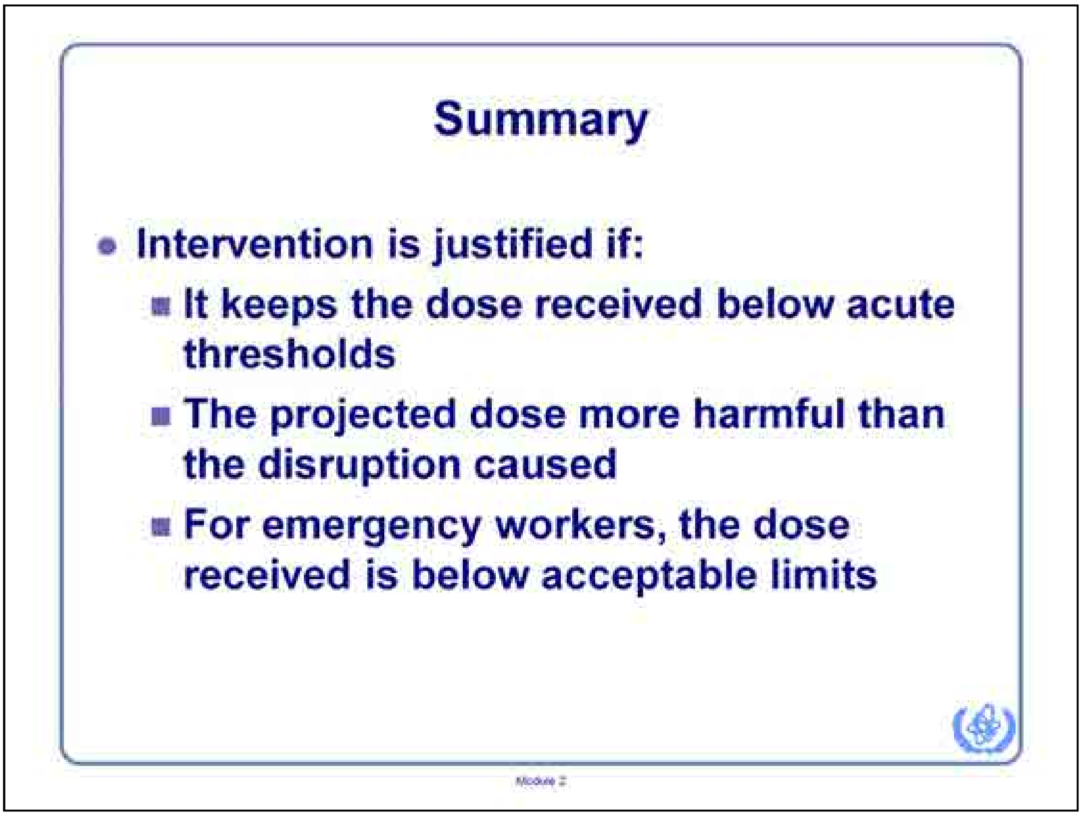
When detailed plans are prepared, consider how these can be adapted for unanticipated events or anticipated events that are more severe than assumed in the planning.



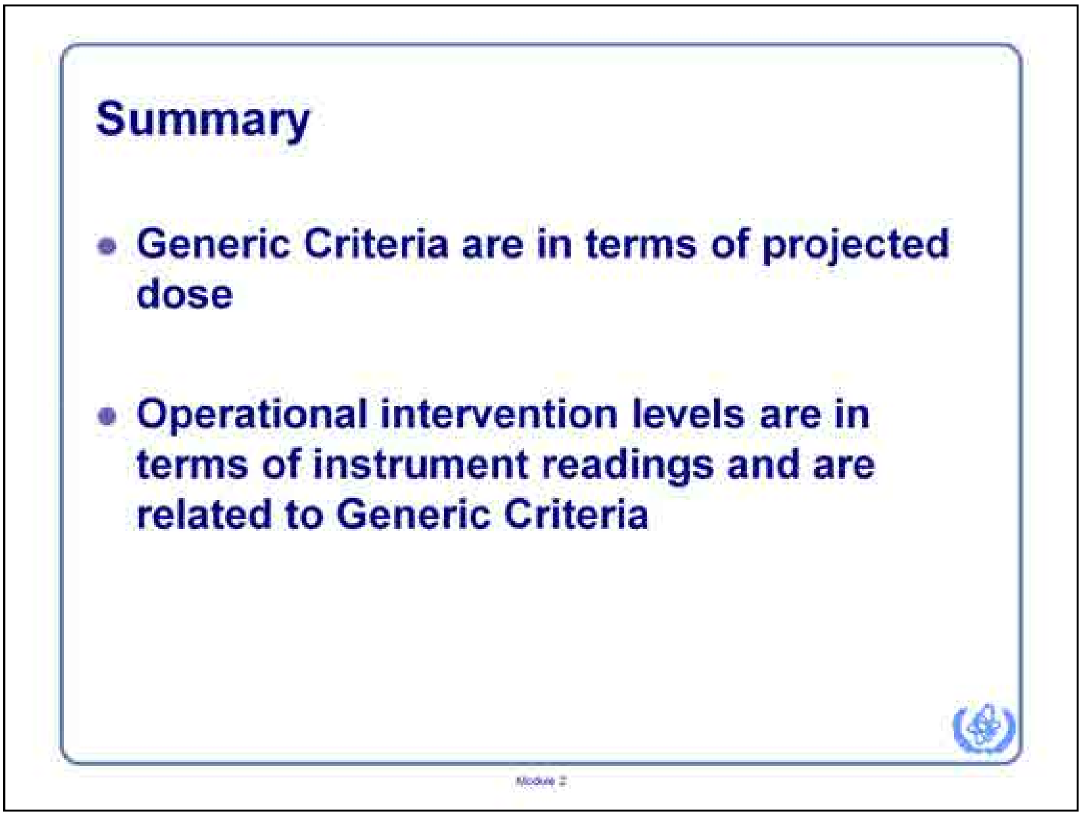
Lecture notes:

Since situations can arise that are beyond the planning basis, there may be a need for additional resources. Plans must make provisions for this in terms of where and how these resources can be obtained and how they can be integrated into the existing response infrastructure.

For example, what resources would be needed if it was necessary to evacuate near the site, and how that could be expanded if the evacuation OIL was being exceeded further from the site than the UPZ established.



Lecture notes:



Lecture notes:

Block 2: Introduction to the Workshop

Module 3: Objectives, Concepts and Basic Principles of Emergency Response – Part 2.

Learning objectives: Upon completion of this module, the participants will:

- list the IAEA threat categories
- list the emergency classes and protective action zones
- be able to describe the basic response strategy: CLAIM
- understand some of the most significant challenges that need to be addressed when planning for research reactor emergencies

Activity: Seminar, questions and discussion

Duration: 1.5 hr

Materials and equipment needed: none

References:

1. INTERNATIONAL ATOMIC ENERGY AGENCY, Arrangements for Preparedness for a Nuclear or Radiological Emergency, Safety Standards Series No. GS-G-2.1, IAEA, Vienna (2007)
2. INTERNATIONAL ATOMIC ENERGY AGENCY, Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency, EPR-METHOD 2003, IAEA, Vienna (2003)
3. INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Reports Series No. 55, Safety Analysis for Research Reactors, IAEA, Vienna (2008)
4. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Response to a Nuclear or Radiological Emergency at Research Reactors, EPR-RESEARCH REACTORS, IAEA, Vienna (2011)

Lecture notes:

In this module, we will focus on emergency planning for research reactors. But first, we will examine the threat categories developed by the IAEA to assist in assessing the risk of a facility and in determining the need for emergency planning. As we will see, research reactor can fit in either of two categories. Depending on which category is most appropriate for a given facility, the needs may be different. So, we will look at the needs in terms of emergency response functions/strategies and in terms of resource requirements. Finally, we will examine some of the more common challenges in emergency planning for research reactors.

Lecture notes:

The degree of planning depends on the level of risk and on the type of potential impacts of accidents associated with the practice being considered. This normally requires a proper risk assessment that takes into account both the probability of accidents and their consequences. This can be difficult for an organization that is at the start of the planning process.

To make this task easier, the IAEA has developed guidance in the form of planning categories. The IAEA EPR-METHOD 2003 proposes five threat categories based on the level and type of risk.

EPR-RESEARCH REACTOR covers the determination of the appropriate emergency class and protective actions for a nuclear or radiological emergency at research reactors. It does not cover nuclear security at research reactors. The term “threat category” is used in this publication as defined in the IAEA Safety Glossary and for the purposes of emergency preparedness and response only; this usage does not imply that any threat, in the sense of an intention and capability to cause harm, has been made in relation to facilities, activities or sources. The threat category is determined by an analysis of potential nuclear and radiological emergencies and the associated radiation hazard that occurs as a consequence of those potential emergencies.

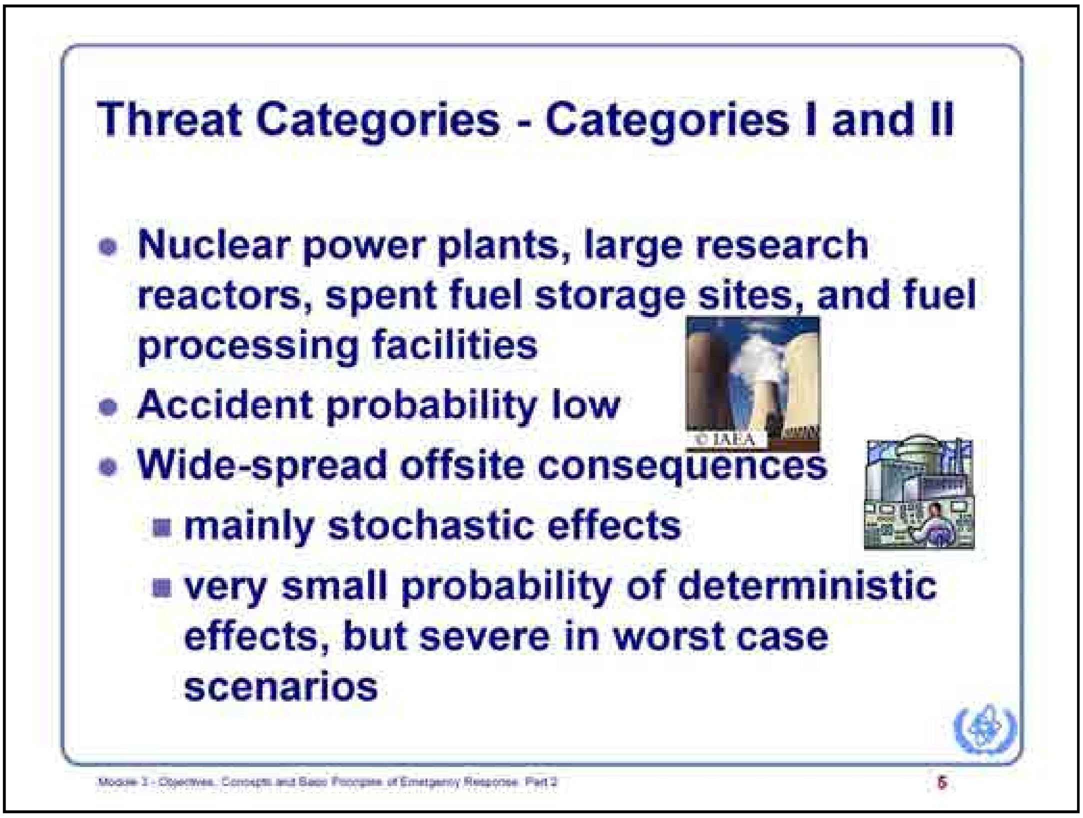
Threat Categories

Threat Category	Radiological Threat
I	Severe deterministic health effects off-site
II	Warranting urgent protective actions off-site, severe deterministic health effects on-site
III	No urgent protective actions off-site are warranted, severe deterministic health effects on-site
IV	Minimum level of threat – all countries
V	Food contamination due to transboundary contamination necessitating food restrictions

Module 3 - Objectives, Concepts and Basic Principles of Emergency Response, Part 2 4

Lecture notes:

Note the large step in affected area that occurs between Categories II and III. This difference adds complexity to the response, both because of the potentially larger affected population, and because of the need to coordinate with off-site authorities.

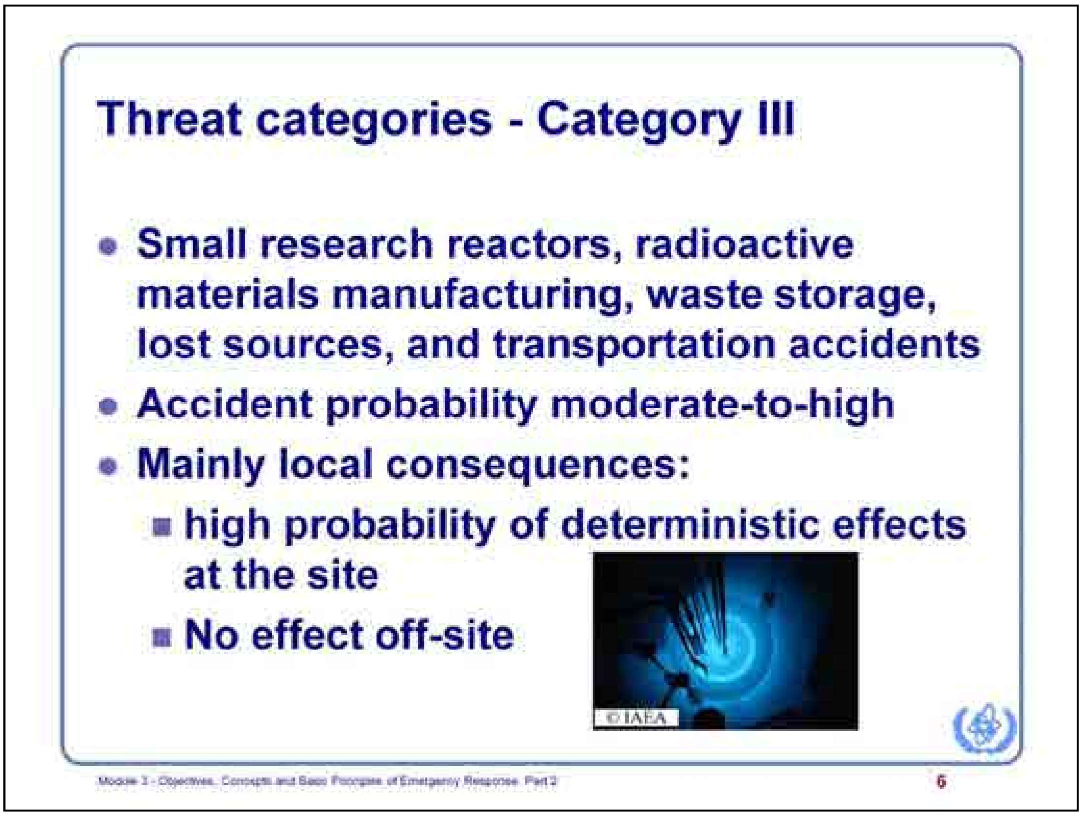


Lecture notes:

Categories I and II deal with the special circumstances that relate to large-scale, fixed nuclear facilities, including large research reactors.. While we will not be addressing plans for nuclear power plants in this workshop, we will address the research reactors that meet criteria to be Category II threats.

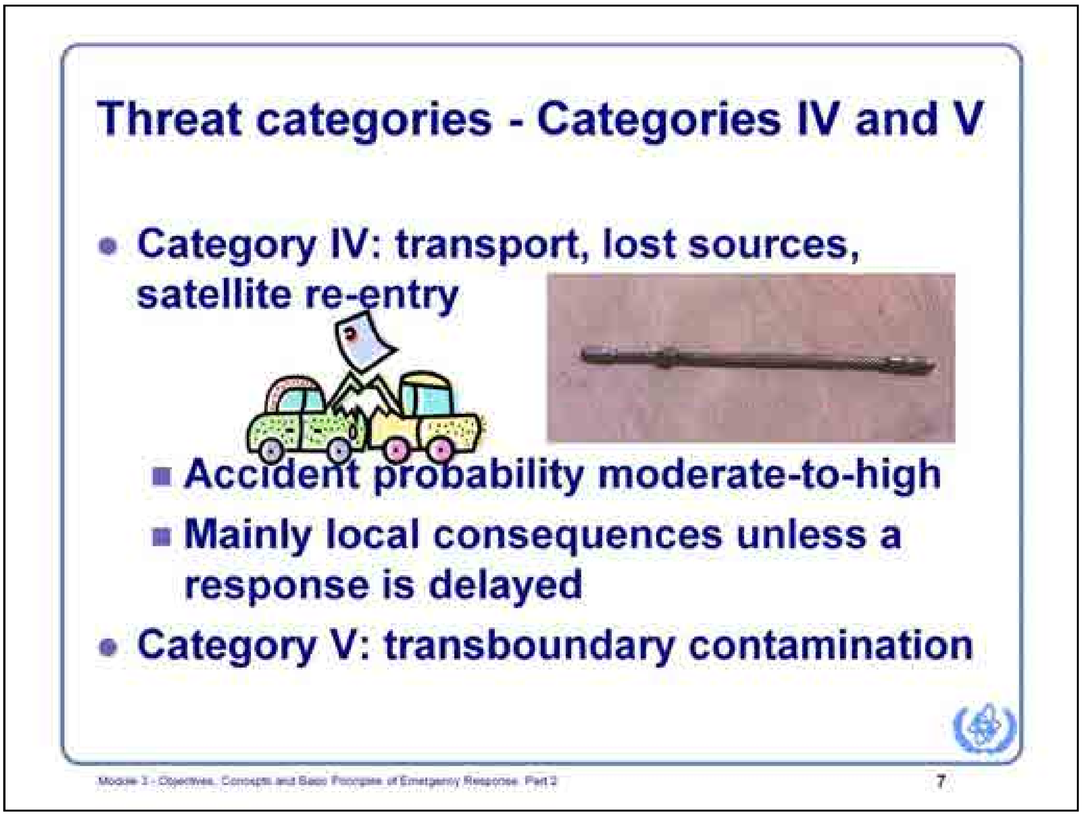
The amount of radiation potentially involved in an accident at a Category I or II facility is great, and the hazard or threat of off-site consequences for people and the environment is high. But due to the technology involved, the likelihood or probability of an accident is very low. In addition, these are “fixed” facilities, that is, the location and its surroundings, as well as the potential threat, is known and easily analyzed, so the level of emergency preparedness and planning can be very detailed.

Comparison between a Category II research reactor and a Category I nuclear power plant is more difficult than just scaling the power levels. Nuclear power plants operate for weeks or months at a time and usually at maximum power. Research reactors do not have the same kind of operating schedule, which results in a different population of fission products.



Lecture notes:

On the other hand, planning categories III, IV & V in EPR-METHOD 2003 describe facilities and situations where the immediate risk or hazard is significantly less, but the probability or likelihood of an accident is greater. Research facilities - even those with small reactors - laboratories, manufacturing facilities using sources for testing and other purposes, radio-pharmaceutical makers and users - including hospitals and other medical facilities- may have serious radioactive sources on hand, but quantities tend to be small. Low-level waste processing and storage facilities may contain large quantities of material, but it is usually separated and packaged in small amounts. Incidents involving lost, stolen or uncontrolled sources are common, but in most cases, the sources are small, sealed, or of such low energy that they pose little danger of serious exposure.



Lecture notes:

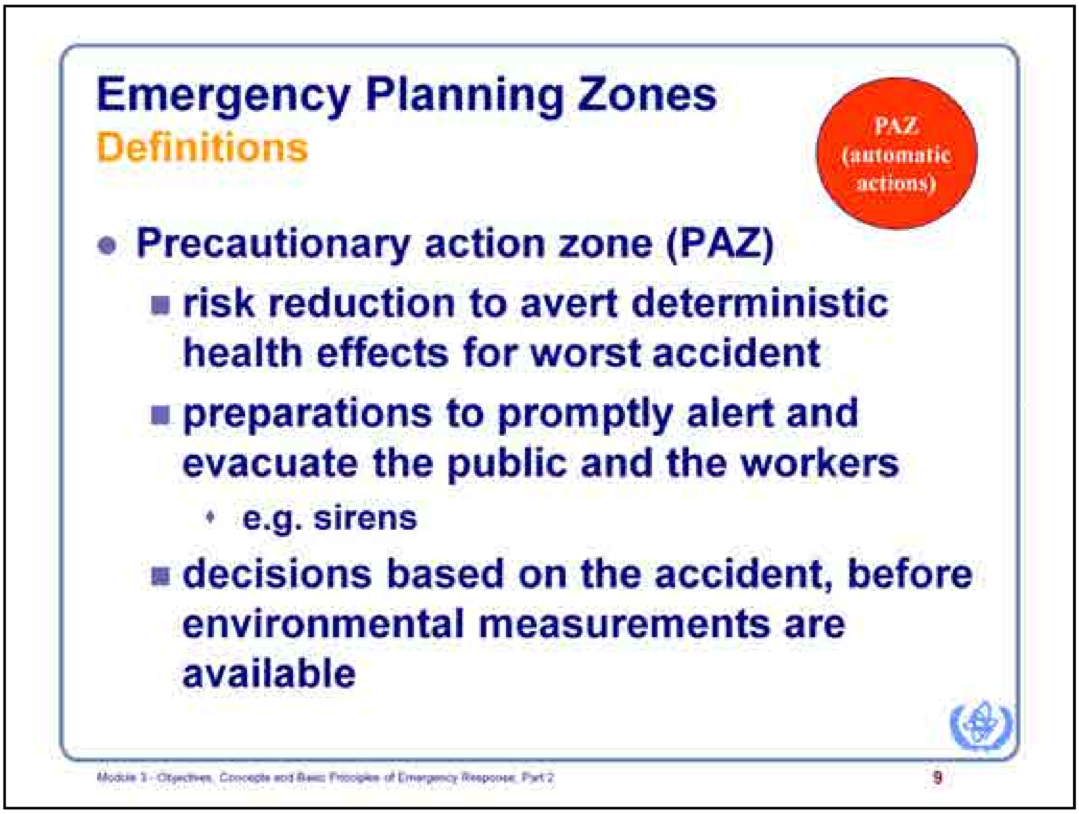
Of growing concern world-wide is the amount of radioactive material in transit. On a daily basis, hundreds of shipments involving many different types of radioactive materials occur in commercial transport. They move in cars, trucks, trains, boats and planes that could become involved in an accident at any time, anywhere. While packaging requirements for these materials are generally very strict, a transportation accident that involves radioactive materials can cause significant anxiety even when there is no immediate threat.

The last category involves trans-boundary incidents. These are accidents that occur in another jurisdiction, but with potentially wide-spread consequences, particularly for the food chain and environment.

Lecture notes:

While the three planning zones previously discussed apply directly to categories I and II practices, they are not so relevant for the other categories.

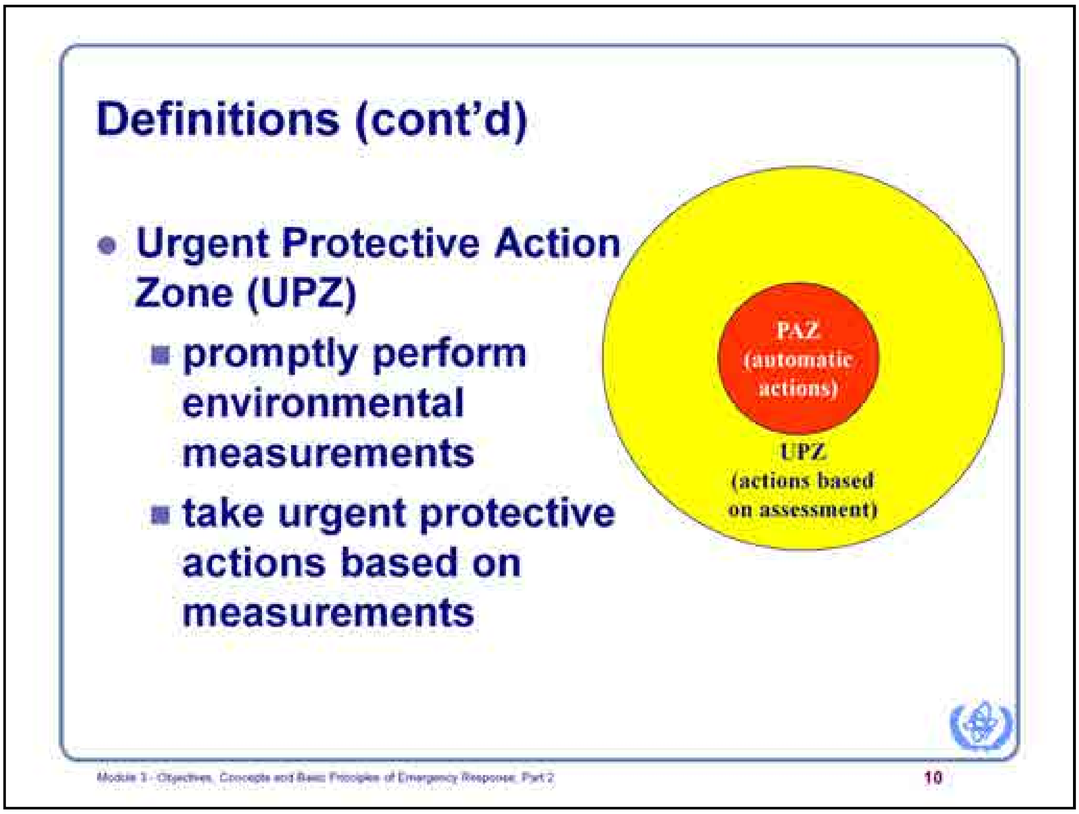
In the case of category III, the only zone where detailed plans are required is the facility itself, or the facility boundary.



Lecture notes:

Precautionary action zone: a zone in which plans should be developed to implement immediate protective actions (substantial sheltering or evacuation) based on the accident classification (general emergency), *before environmental measurements are available*. This is based on the fact that, for the worst case accident, deterministic health effects are possible in this zone unless urgent protective actions are promptly implemented.

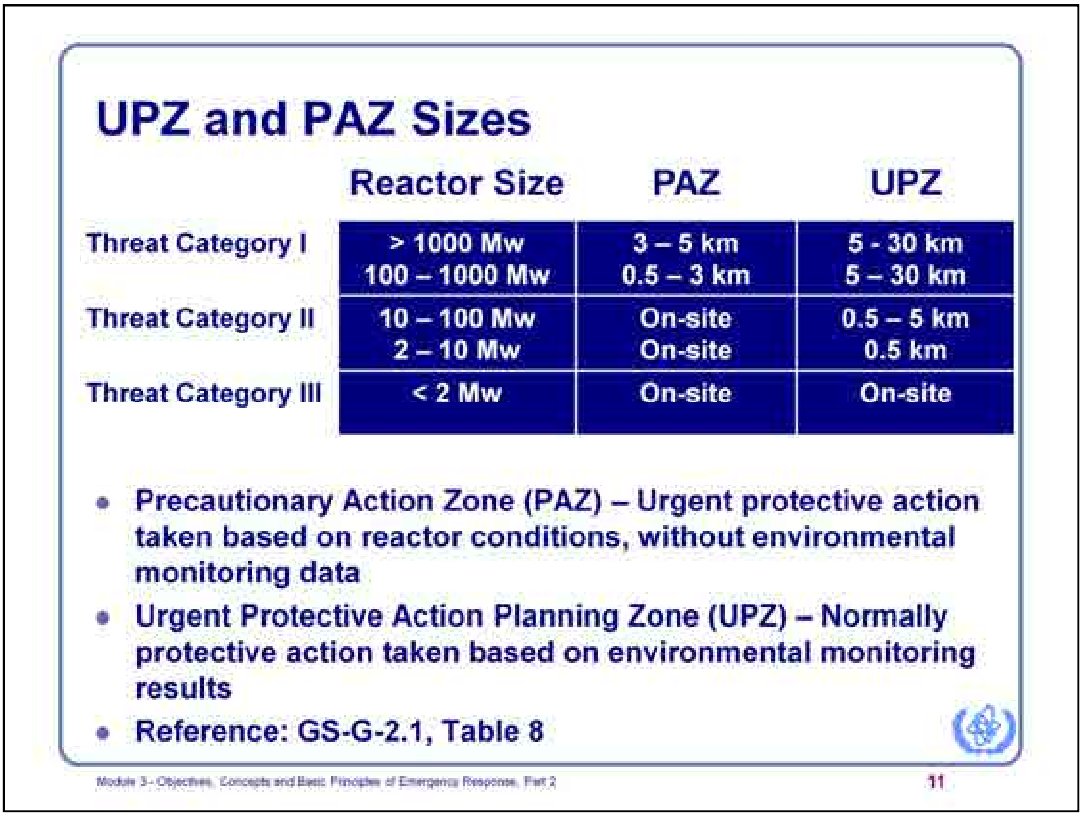
For both Threat Category II and III research reactors, deterministic effects are not expected beyond the site boundary for any emergency at the reactor. Deterministic effects could occur in some emergency events within the site boundary.



Lecture notes:

Urgent protective action planning zone: a zone in which detailed plans should be developed to implement urgent protective actions based on environmental measurements. Within the UPZ, stochastic health effects may occur for some emergency events. Environmental surveys within this zone should be initiated within one hour.

Threat Category III research reactors are not expected to cause stochastic health effects beyond the site boundary.

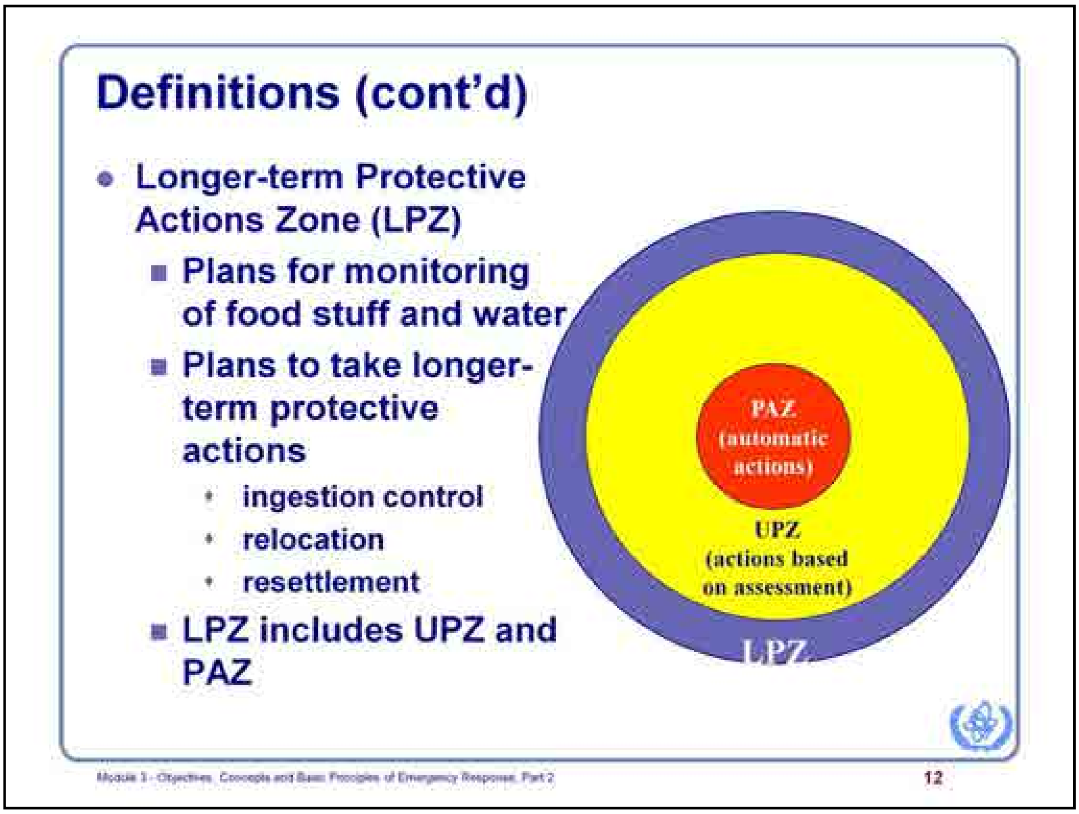


Lecture notes:

These suggested zone sizes are from GS-G-2.1, Table 8, and should be used with caution. Assumptions for release size and local conditions can cause large differences between these results and actual conditions, a factor of two or more is possible. We will spend some time on zone sizes later in this course.

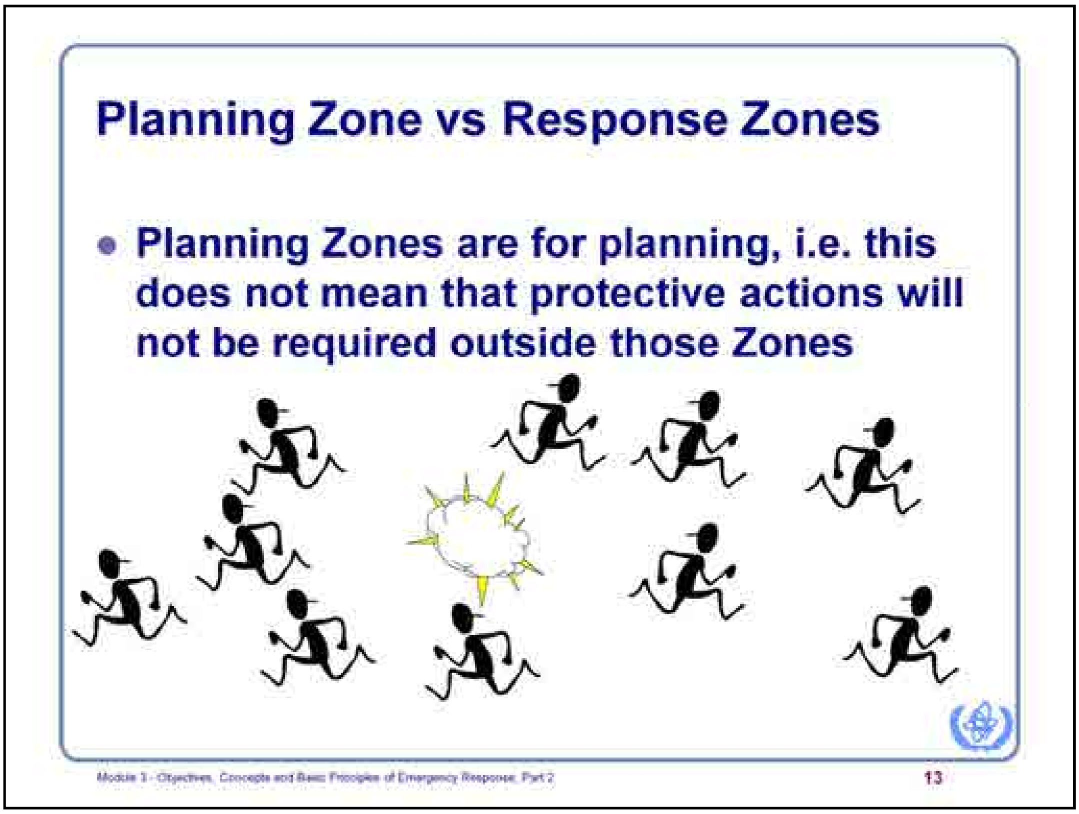
This table emphasizes the difference in the threat categories and establishes a link with emergency class. General emergencies will result in recommending protective action for the entire PAZ even before any measurements have been made. So a prompt response is important, even if future events show it was unnecessary. The same action is proposed in the PAZ for Threat Category II and III reactors, however, in these cases the PAZ is within the site boundary so no members of the off-site population are within the PAZ.

Zone sizes are a preparedness determination. One cannot figure them out during the emergency, they need to be defined in advance, just like the threat analysis needs to be determined in advance.



Lecture notes:

Longer term protective action planning zone: a zone within which detailed plans should be developed to implement food control measures based on environmental measurements.



Lecture notes:

It is important to make a clear distinction between emergency preparedness and emergency response. Emergency preparedness addresses the plans, arrangements and capabilities that we think may be required for responding effectively to an emergency. Emergency response is what we do when an emergency occurs.

Remember that difference. Planning zones are for planning, not for response. With the exception of the precautionary action zone, where response decisions usually affect the entire zone, the fact that a planning zone is only 10 km does not mean that no protective action will ever be taken outside of 10 km. Based on the assessment at the time of the accident, for example environmental readings, there may be a need to act beyond 10 km. On the other hand, there may not be a need to take the action all the way to 10 km. The fact that planning is done within 10 km simply means that the risk inside that 10 km zone is large enough to warrant planning. Also, in general, provided that the plans are effective, they can be extended at the time of an accident to include areas beyond the 10 km zone. This is the concept of contingency planning.

Lecture notes:

In the case of category IV, fixed planning zones cannot be established. However, following, for example, a transport accident involving radioactive sources, there would be a need for a safety perimeter around the accident site. This is equivalent to an emergency planning zone, with the exception that the zone is “mobile”.

Lecture notes:

The question that we would like to address now is: how do those principles and concepts translate into practical needs for the development of an emergency response capability at research reactor facilities? The next section presents a broad overview of these needs. Future workshop modules will discuss some of the requirements in detail.

Research reactors vary in size, type, use, safety and location. It is therefore very difficult to establish a list of practical requirements that fits all research reactor facilities.

EP needs depend primarily on the reactor size (and use) and on the on-site resources available to deal with upset situations. In general, larger facilities will have access to more on-site resources. However, this may not be the case always. Therefore, it is recommended that facility owners perform a risk assessment and a needs analysis as part of the planning process.

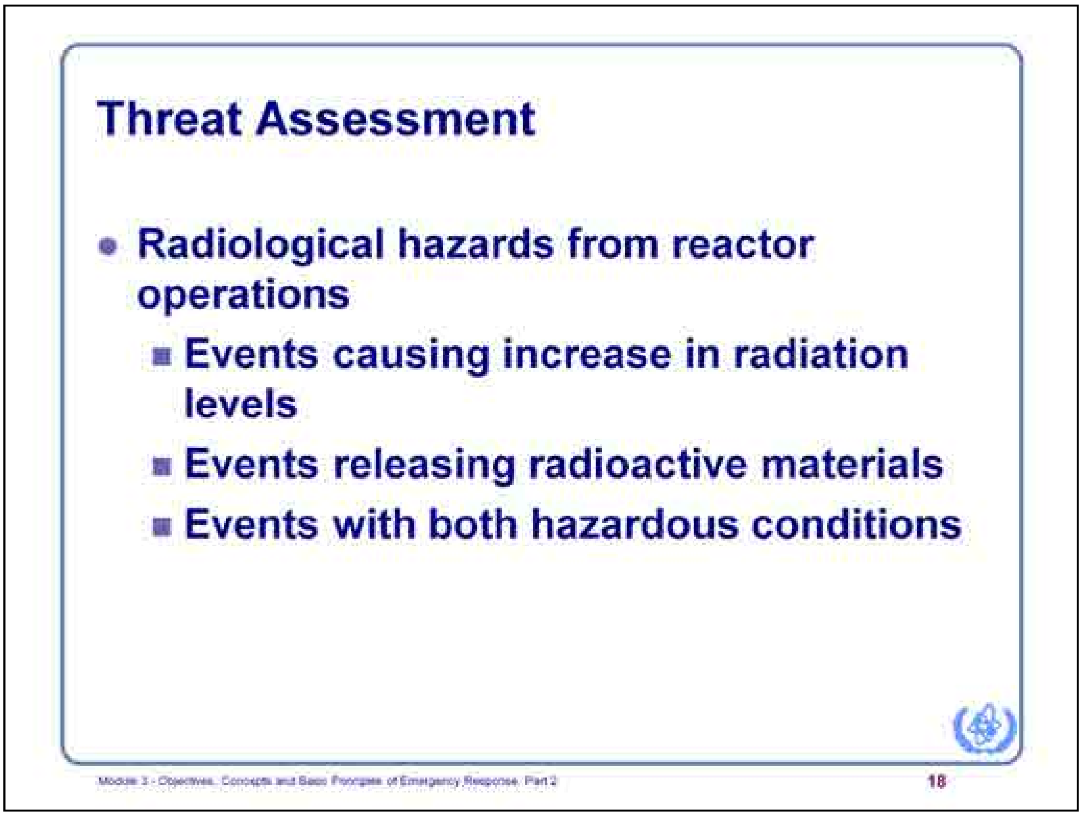
Lecture notes:

The threat/risk assessment should provide an appreciation for the type of hazards that are present, the type of accidents that could occur and the type and severity of the consequences that could result. This can be a simple order-of-magnitude analysis of a more detailed probabilistic safety assessment (or its equivalent). The questions are:

- What are the possible accidents?
- What would be their consequences to individuals, public or environment?
- How can they be prevented or dealt with when they occur?

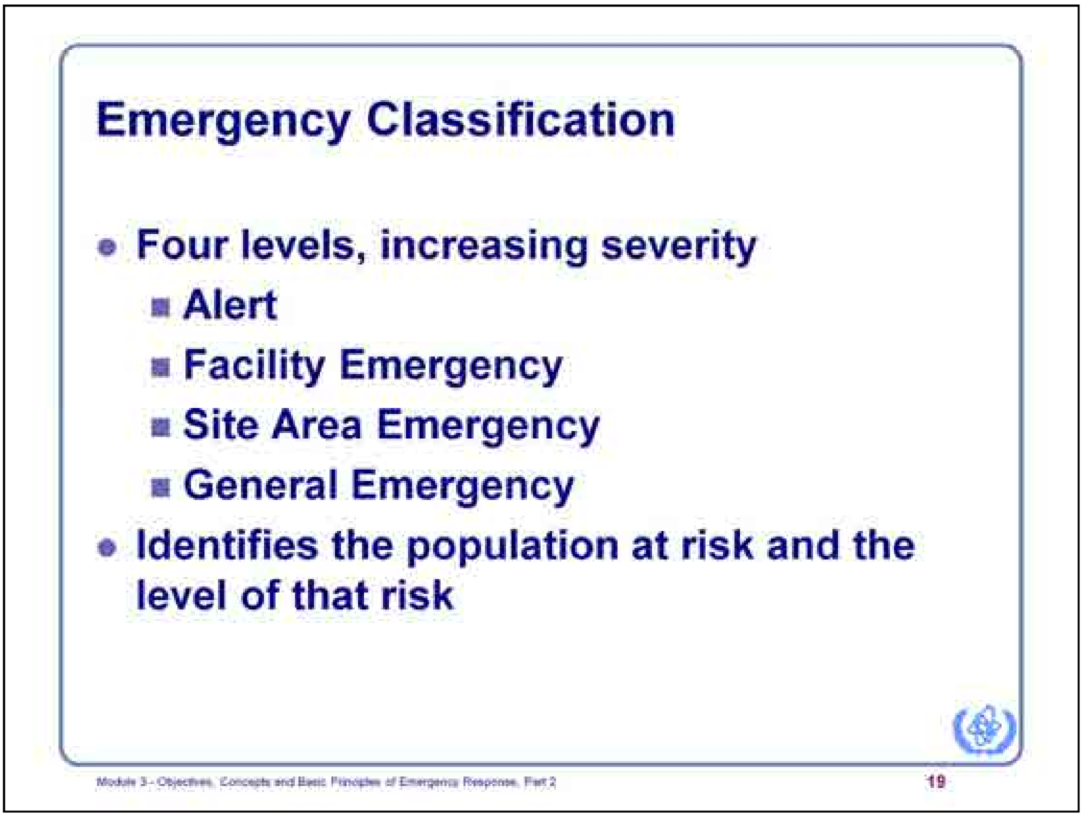
Lecture notes:

Some of the threats that need to be considered are conventional.



Lecture notes:

Some of the threats are radiological. Consequences may be in terms of individuals, facility population, the public or the environment. Usually only releases of radioactive materials creates a threat beyond the site boundary. Either condition can create a threat to the people at the site.



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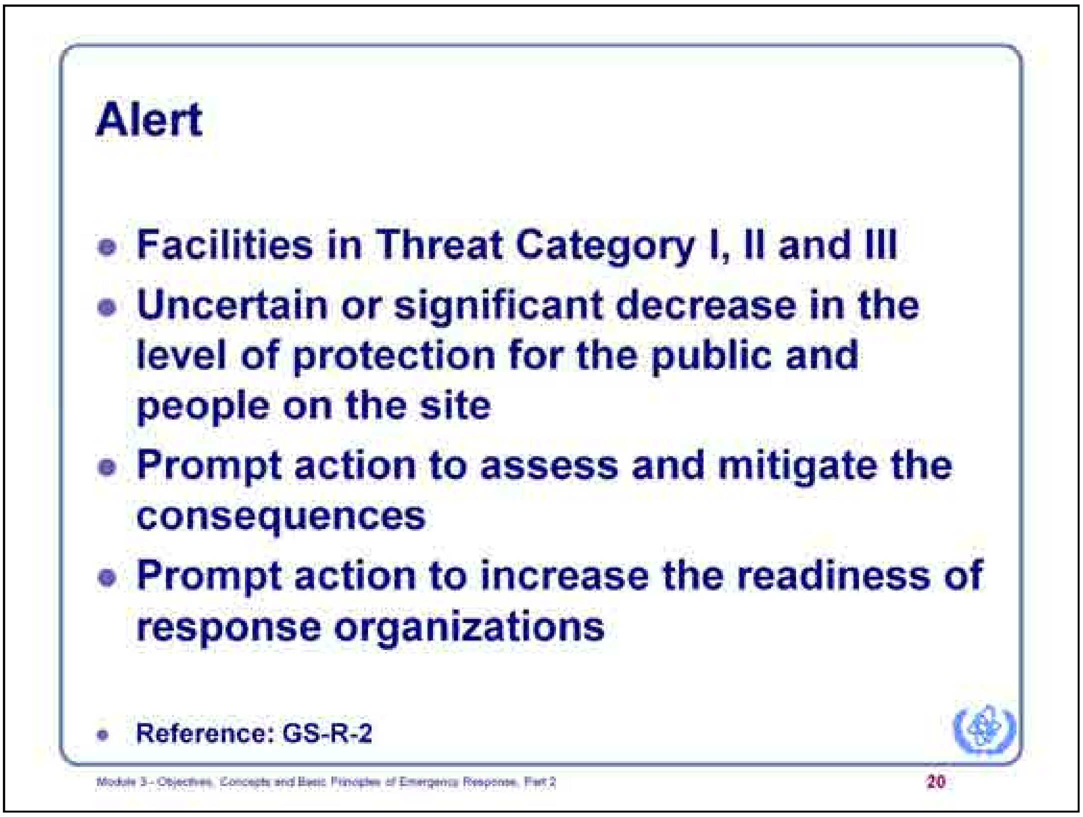
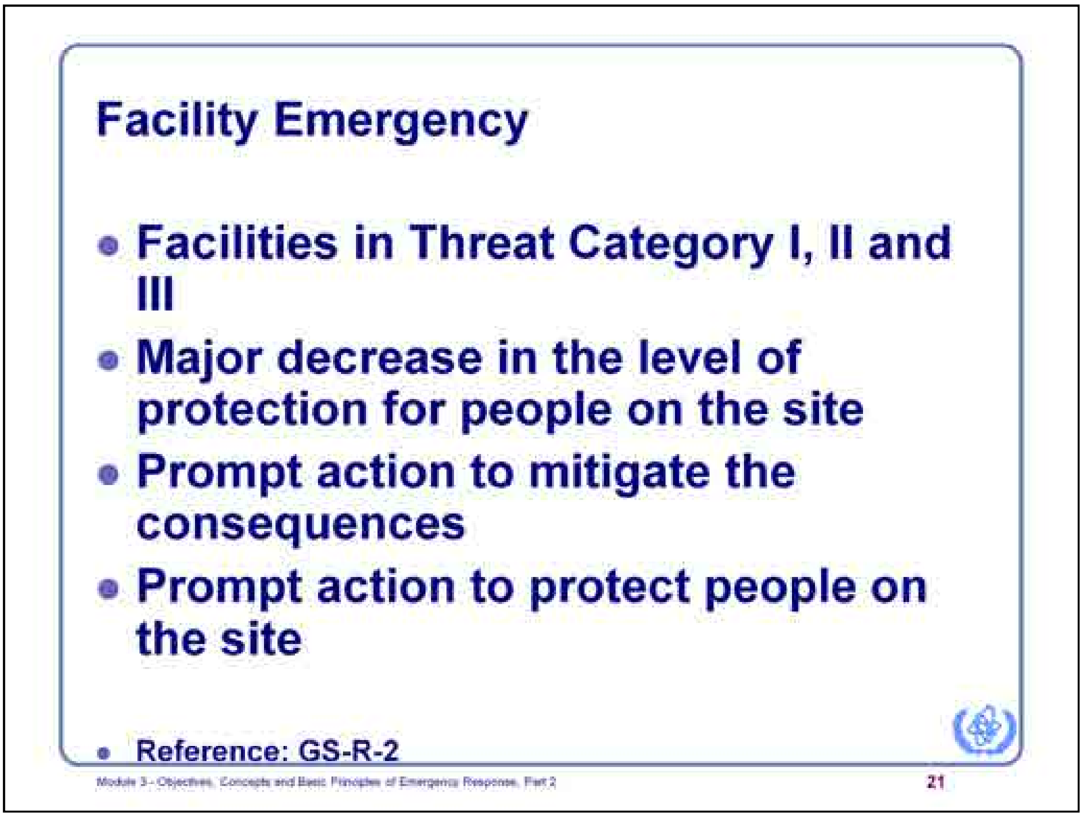


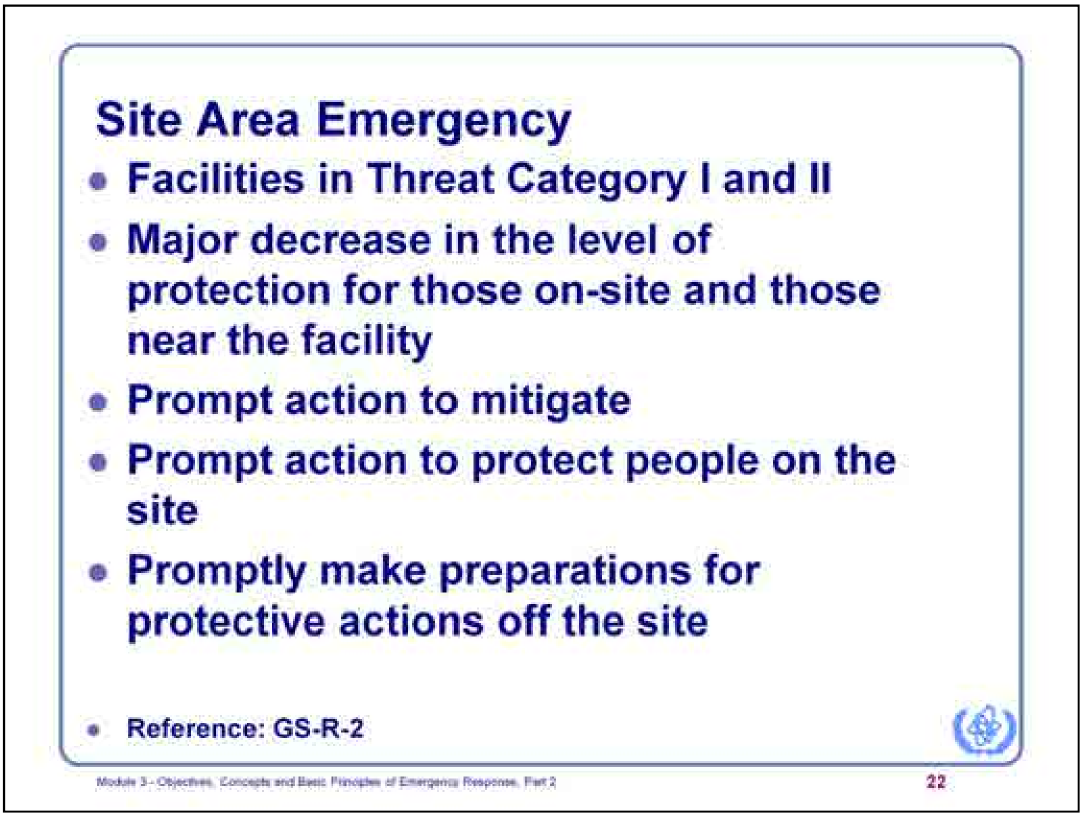
Lecture notes:

This is the lowest level and is often reserved for those situation that do not represent an immediate direct threat, but require the emergency response team to verify that the emergency stays in that way. Most drastic action is considered to be an increase in readiness and closely monitoring to ensure the emergency doe not escalate.



Lecture notes:

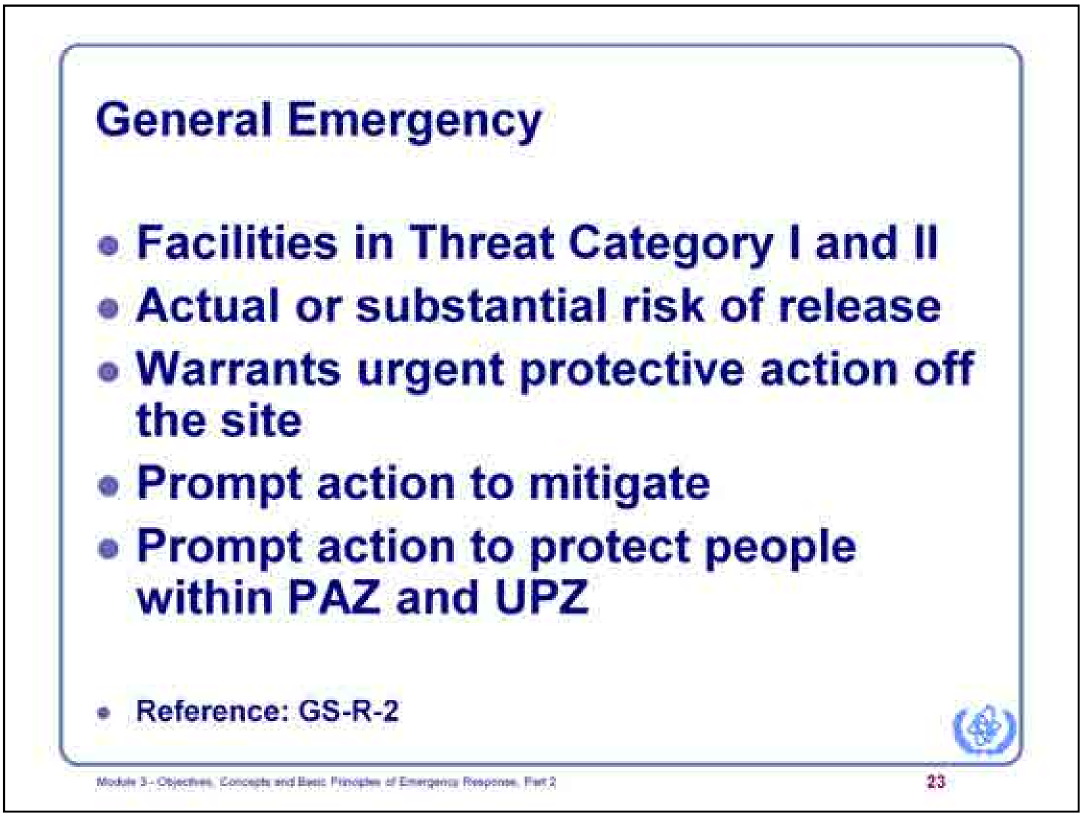
Note that this class is intended for situations where no risk to off-site populations will occur. The on-site population may be at risk, even on sites with more than one facility. For example, a waste handling facility located next to a research reactor may need to be evacuated for certain reactor emergencies. The site authorities have a duty to direct such an action. Contrast that with a Site Area Emergency that threatens individuals beyond the site boundary. The site officials do not have the authority to remove those people to a safer location. That authority resides with the local government.



Lecture notes:

A common description to distinguish Site Area Emergency from General Emergency is that a Site Area Emergency is just one more failure from would cause fission products, or other radioactive material, from being released.

There is frequently confusion between a Site Area Emergency, as established in IAEA Safety Guides, and a commonly used term “Site Emergency” that occurs at sites with multiple nuclear or radiological facilities. In IAEA Safety Guides a Site Area Emergency is appropriate if off-site areas are threatened by the particular emergency. And clearly, off-site areas are beyond the site boundary. A locally defined “Site Emergency”, if only affecting the population within the site boundary, would not qualify as a Site Area Emergency, but would be a Facility Emergency. Note that the work “facility” is very general, does not imply any physical space or constraint, and could be something as small as an experimental facility within the reactor, or the entire reactor itself.



Lecture notes:

The emergency classes used in EPR-RESEARCH REACTOR are described in IAEA Safety Standard GS-R-2.

General Emergency is the class for the most severe risks or consequences of the emergency. This should be reserved for the cases when enough radioactive material has been released or is about to be released that off-site populations will be recommended to take urgent protective action, or when developing conditions make that likely to occur.

For Category II research reactors, even a General Emergency is not likely to require recommended urgent protective action off-site until environmental monitoring confirms the need. The smaller fission product inventory when compared to a Threat Category I reactor reduces the threat of deterministic health effects beyond the site boundary.

Lecture notes:

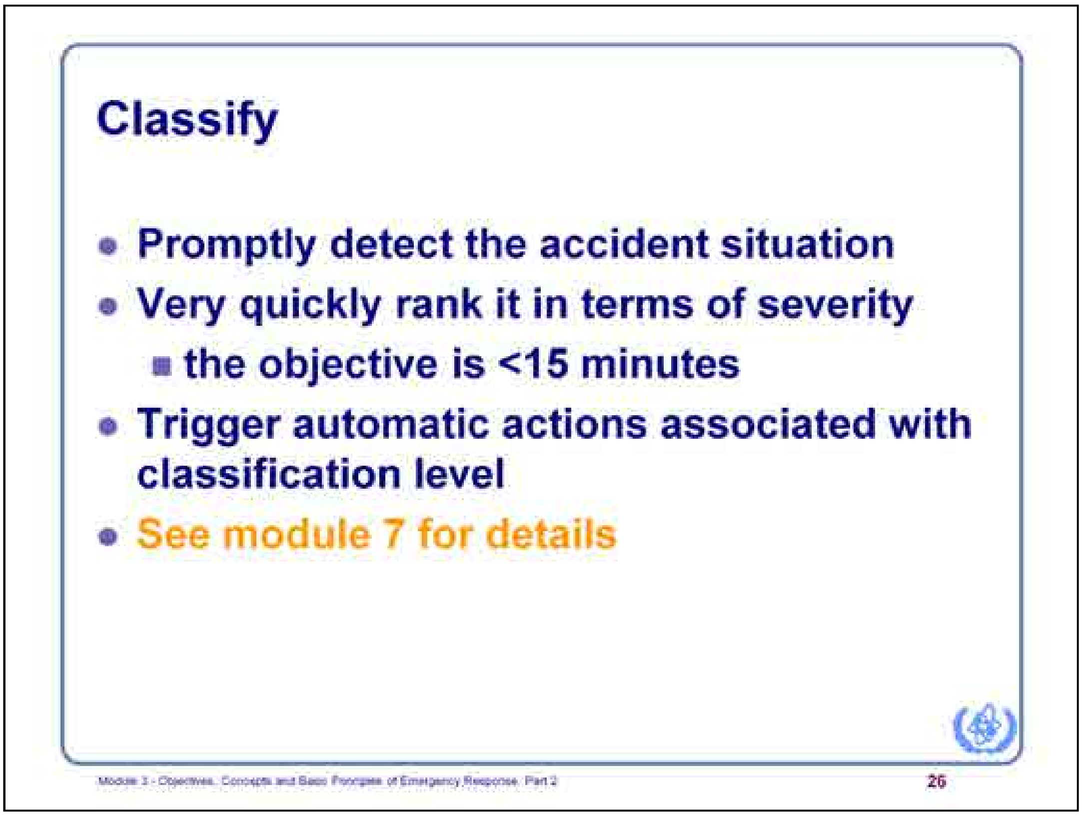
Once the threat has been assessed, it is necessary to determine what is needed to deal with accidents. EPR-METHOD 2003 provides guidance on infrastructure and functional requirements an is the basis for the following discussion.

Needs will be discussed in terms of response strategy and resources.

Lecture notes:

Remember ***CLAIM***.

It stands for classify, life-saving, assess & protect, inform and manage. These basic response functions are defined in the next few slides and described in detail in the rest of the workshop.



Lecture notes:

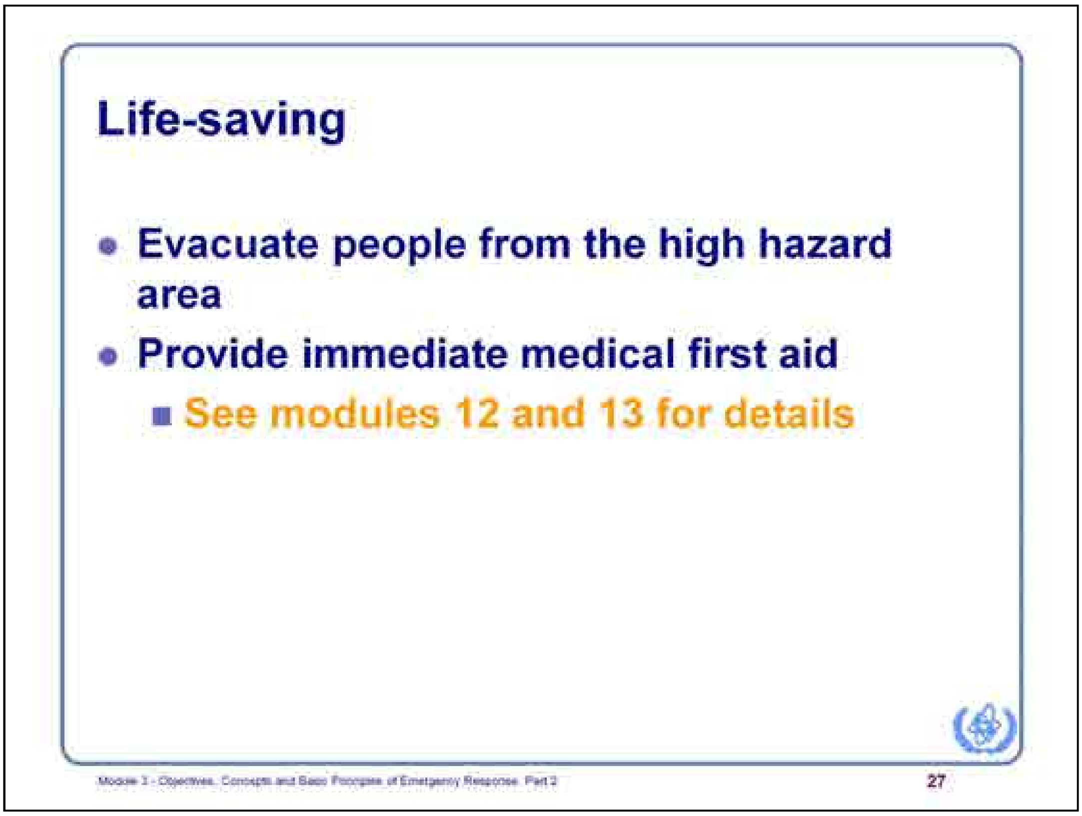
Classifying is a way to quickly categorize the severity of an accident.

When an emergency occurs, the initial information is generally very limited and very confusing. Nevertheless, critical decisions must to be made:

- what immediate actions should the emergency organization take
- what immediate protective measures must be initiated

Failure to make the right decision regarding the protection of on-site personnel and the public may, in some cases, render the measure ineffective.

Classifying the accident is also a very effective way of communicating its severity to other people. If the classification system is well defined and understood by all, it is easier to convey the message with a simple statement about the emergency class than to try to provide a detailed description of the event, which may be confusing at first.



Lecture notes:

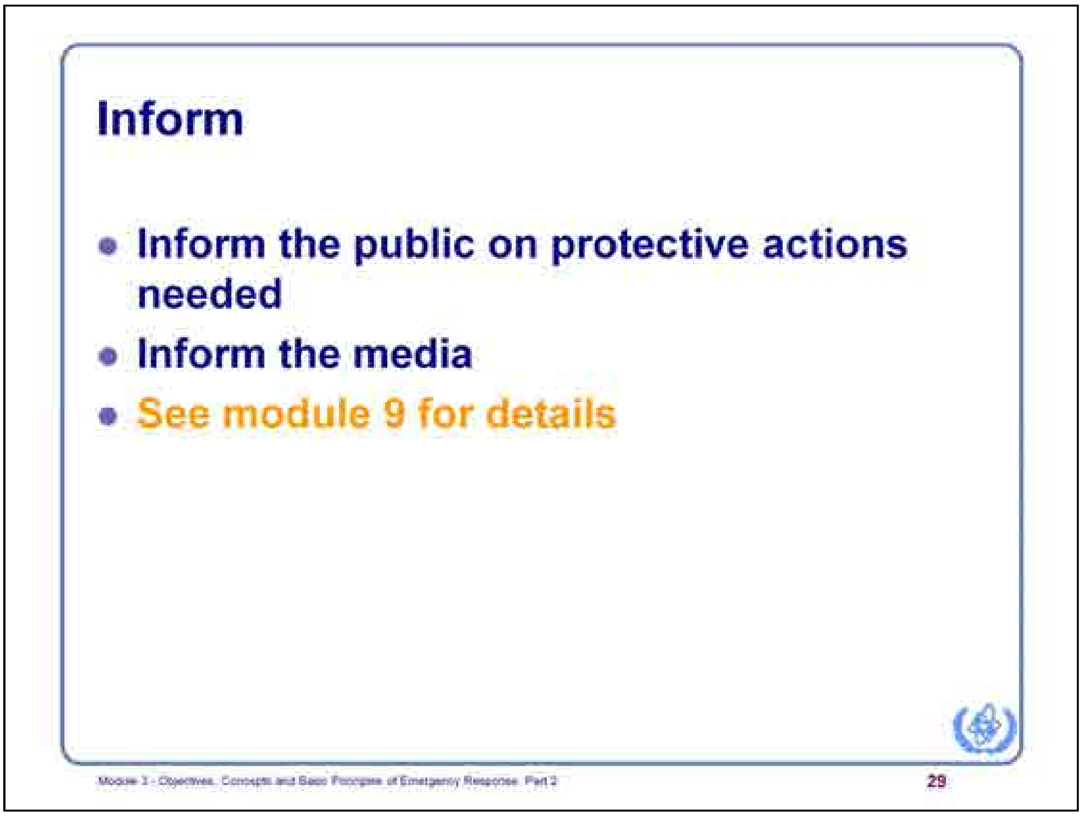
Life-saving can be preventative or responsive.

Preventative means that an evacuation of the areas where the risk of injuries is greatest should be done as soon as the risk is present. This can be likened to the concept of precautionary action zone discussed in part 1.

Responsible measures are those aimed at providing conventional medical first aid to casualties. Although this refers to conventional first aid, the fact that the patient may be contaminated or may have been overexposed, and the fact that a radiological hazard may still be present where the victim is found complicates the response significantly.

Lecture notes:

Assess and protect refers to the need to avert levels of exposure that are not life-threatening but may lead to a stochastic risk increase. This requires a careful evaluation of the conditions ate the time of the accidents. Normally, these measures are not automatic and they are implemented on the basis of ambient radiation readings (shine or airborne concentrations or surface contamination).



Lecture notes:

Informing the public and the media is often left out of plans because 1) the media is often considered an obstacle rather than an ally and 2) it is often felt that if the population is not directly affected, they do not need to know.

Both these statements are wrong!

A proper public information plan can enhance the value of the response by ensuring that instructions (including instructions to do nothing!) are respected, trusted and followed. Furthermore, providing good information to the public and the media may prevent future pressures (public, media and political) that may ultimately detract from the response work required.

Lecture notes:

Of course, none of the above will be very effective unless it is coordinated by an emergency manager.

Lecture notes:

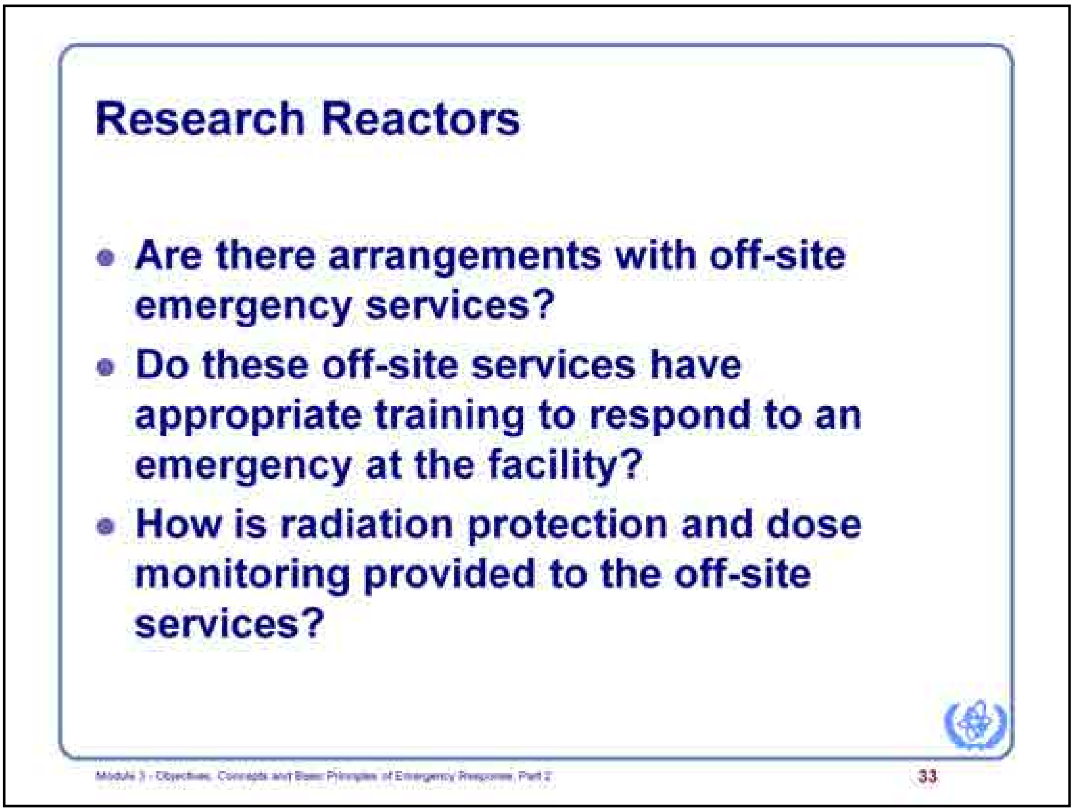
In this last portion, we look at some of the key planning issues that need to be addressed when developing plans for such emergencies. The discussion is in the form of questions. They do not cover all aspects of the planning process. A complete discussion is contained in TECDOC 953. But the questions look at some of the most important practical challenges based on past experience.

Lecture notes:

Category III facilities are often small, with a small staff and few resources. Although procedures usually exist, they do not often include classification considerations. This means that the response can be slowed down by the assessment process in the initial stages of the emergency.

If there is a classification system, it is often understood by only a few people.

Some of these facilities do not operate 24 hours a day. In this case, there needs to be a way to contact a responsible person/radiation protection officer outside working hours, for example if there is a fire and the fire fighters need to enter areas where sources are stored.



Lecture notes:

Many smaller facilities rely on outside emergency services in case of accidents. If that is the case, these arrangements must be well-defined and documented. In some cases, off-site emergency services have been known to refuse to provide assistance to facilities if they suspect that radiation may be present. This suggests the need for training and frequent exercises. Furthermore, there has to be arrangements to protect such off-site workers who may enter high dose rate or contaminated areas. That is usually provided by the facility.

Lecture notes:

Many smaller facilities rely on outside emergency services in case of accidents. If that is the case, these arrangements must be well-defined and documented. In some cases, off-site emergency services have been known to refuse to provide assistance to facilities if they suspect that radiation may be present. This suggests the need for training and frequent exercises. Furthermore, there has to be arrangements to protect such off-site workers who may enter high dose rate or contaminated areas. That is usually provided by the facility.

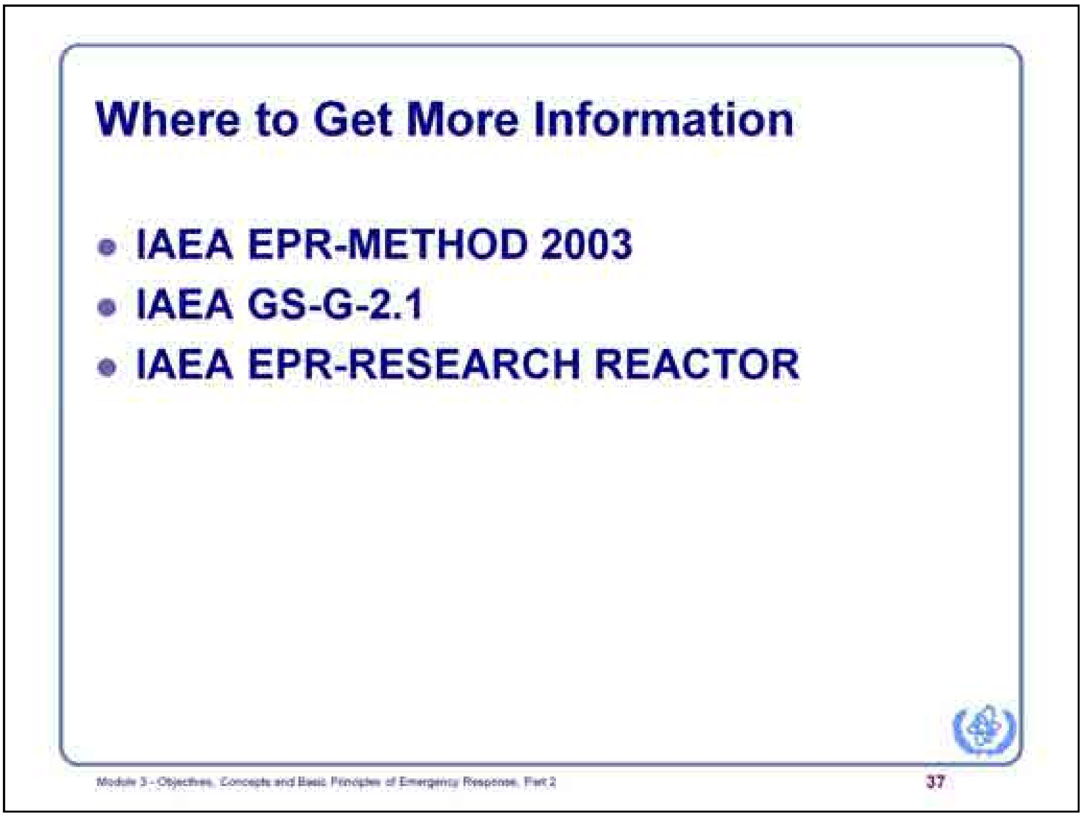
Summary

- There are five threat categories identified in EPR-METHOD
  - Research reactors are category II or III
- Research reactor planning needs are based on the reactor size and the resource pool available at the site
- Response strategy = CLAIM

Module 3 - Objectives, Concepts and Basic Principles of Emergency Response, Part 2 35

Lecture notes:

Lecture notes:



Questions:

1. What are the five threat categories defined in TECDOC 953?
2. Name the main components of a generic response organization.
3. Define the basis emergency response strategy.
4. Give two practical challenges for response to research reactor accidents and propose a practical solution for each.

Block 4: Development of a Response Capability

Module 4: Concepts of Operations and Responsibilities

Learning objectives: Upon completion of this module, the participants will:

- Understand the importance of assigning responsibilities
- Be able to use the worksheet provided to identify and resolve gaps and conflicts in responsibility
- Understand the role and importance of the Concept of Operations in coordinating the planning
- Be able to develop a basic Con-ops for events possible at research reactors
- Know how to ensure panning for a research reactors is integrated with national planning

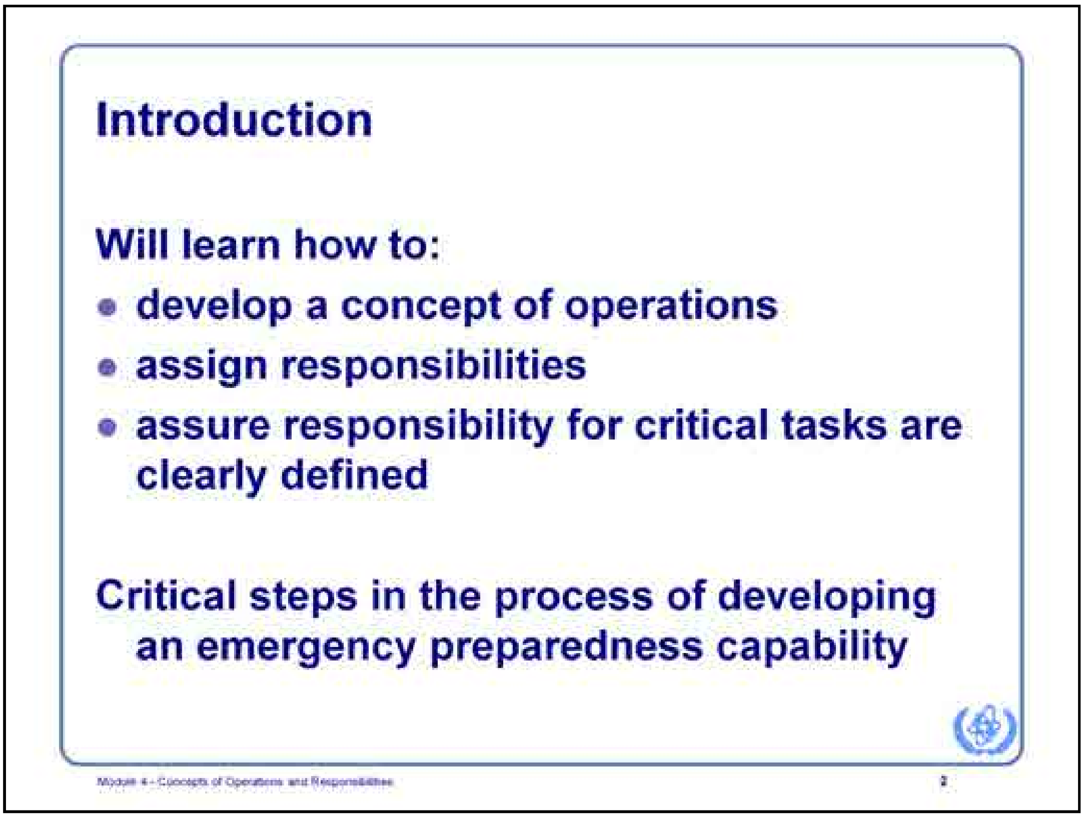
Activity: Seminar, questions and discussion

Duration: 1 hr

Materials and equipment needed: Worksheets for “Identification and Assignment of Critical Tasks”

References:

1. INTERNATIONAL ATOMIC ENERGY AGENCY, Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency, EPR-METHOD, IAEA, Vienna (2003)



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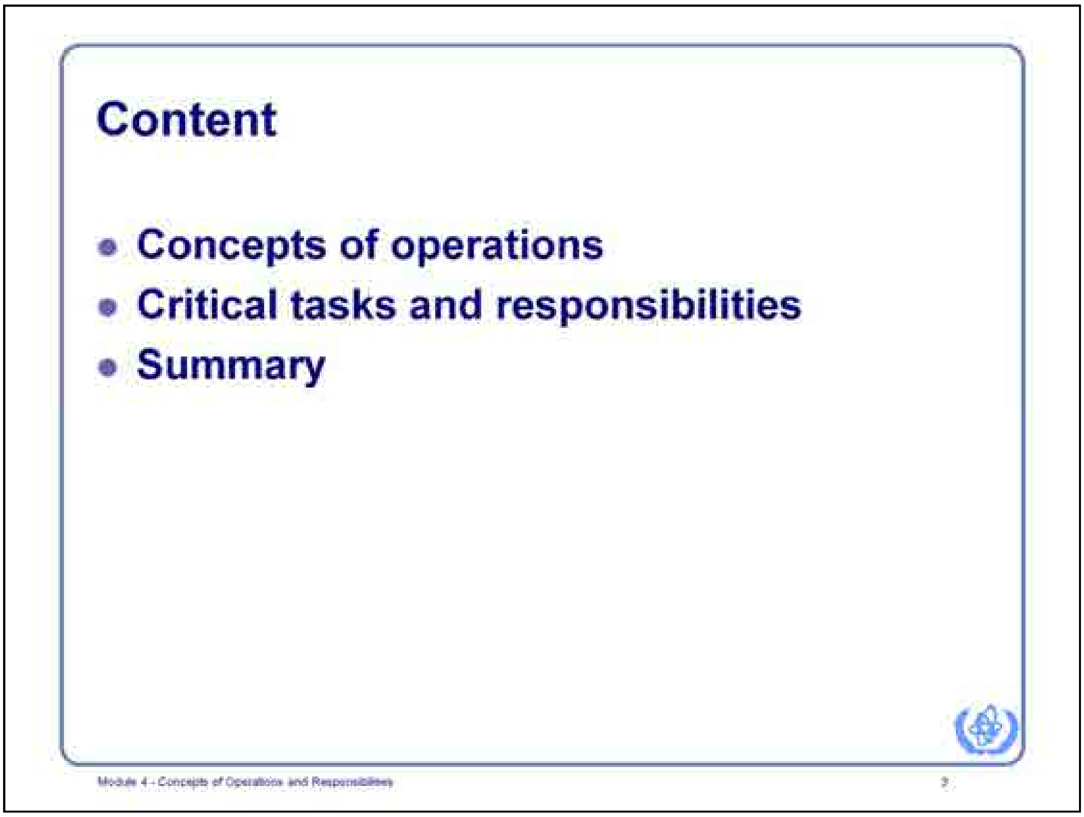


Lecture notes:

Development of Concept of Operations (Con-ops)

- A simple overview of how the ideal response will proceed
- Describes the basic responsibilities of the major responders
- Used:
  - To assure all parties understand and agree to roles
  - Basis for development of detailed plans
- Must be completed and agreed to before planning begins

Module 4 - Concepts of Operations and Responsibilities 4

Lecture notes:

A Concept of Operations (Con-ops) is both part of the emergency plan and is also part of the planning process. The Con-ops:

- Is a simple overview of how the ideal response will proceed
- Describes the basic responsibilities of the major responders
- Used:
  - To assure all parities understand and agree to roles
  - Basis for development of detailed plans
- Must be completed and agreed to before planning begins.

Lecture notes:

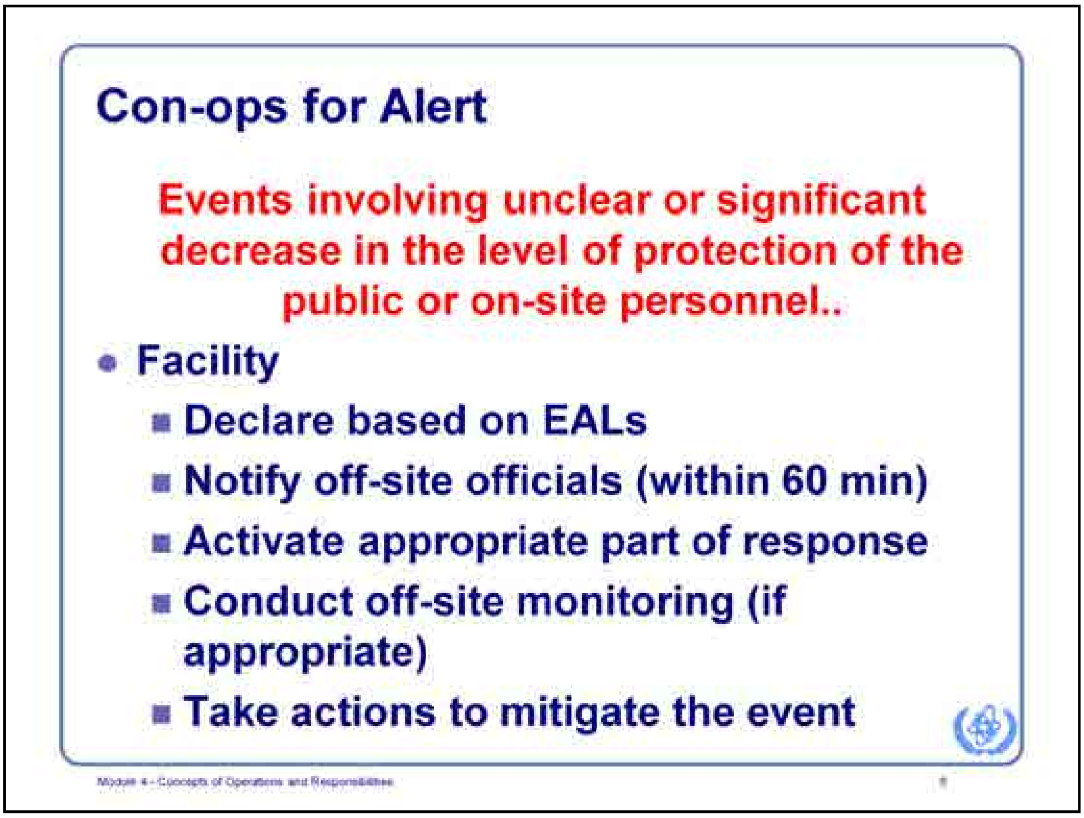
The major parties in a response (responders) are:

The operating Organization can be the staff at the facility or the personnel using or transporting the material at the time of the emergency. They are responsible for:(1) the immediate actions to mitigate the emergency;(2) protecting people on-site; (3) notifying off-site officials and providing them with recommendations on protective actions and technical assistance, and providing initial radiological monitoring.

Emergency services: The local off-site response organizations that provide emergency services and which can typically respond anywhere. These include police, fire and rescue brigades, ambulance services, and possibly hazardous materials control teams.

Local officials: the government and support agencies responsible for providing immediate support to the operator and prompt protection of the public in the vicinity.

National and regional (province or State) officials: the governmental agencies responsible for planning and response on the national (or regional and State) level. These agencies are typically responsible for tasks that do not need to be implemented urgently to be effective. This includes:(1) longer-term protective actions, and (2) support of local officials in the event their capabilities are exceeded.



Lecture notes:

Alert

Events involving unclear or significant decrease in the level of protection of the public or on-site personnel..

Facility:

- Declare based on EALs
- Notify off-site officials (within 60 min).
- Activate appropriate part of response.
- Conduct off-site monitoring (if appropriate).
- Take actions to mitigate the event

Time is based on IAEA GS-G-2

Lecture notes:

Off-site:

- Increase readiness (needs guidance from operating organization)
- Assure all governmental agencies are informed.
- Provide fire, police or medical support if requested.
- Initiate joint media briefings if media or public attention

Lecture notes:

Facility Emergency

Event resulting in a major decrease in the level of protection for the on-site personnel but no off-site risk.

Facility:

- Declares the emergency based on EALs
- Take life saving actions on-site.
- Account for all personnel, including visitors
- Request off-site assistance
- Notify off-site officials within 60 minutes
- Activate part of response needed
- Evacuate or provide substantial shelter for non-essential personnel and visitors on-site and account for all persons on the site.
- Monitor on-site personnel for contamination.
- Provide first aid, decontaminate, estimate exposure and transport injured and exposed individual for treatment.
- Conduct off-site monitoring near facility to confirm that off-site protective actions are not needed.
- Provide protection from hazardous conditions for on-site and off-site emergency response personnel.
- Take actions to mitigate the emergency, provide technical assistance to control room or operating staff.
- Establish continuous communication with off-site officials.
- Take action to ensure contaminated people or items do not leave the site undetected
- Initiate, with off-site officials, joint media briefings.

Lecture notes:

Off-site:

- Activate part of response coordinated under a single director near the scene.
- Assure all governmental agencies are informed.
- Provide fire, police or medical support if requested.
- Provide initial treatment for injured, contaminated individuals and consult with experts to determine treatment strategy for overexposures.
- Initiate, with on-site officials, joint media briefings

Lecture notes:

Site Area Emergency

Events resulting in a major decrease in the level of protection for the public off-site and on-site personnel

Facility:

- Declares an emergency based on EALs
- Take life saving actions on-site.
- Request off-site support (medical, fire, security)
- Activate full response
- Notify off-site officials with in 15 minutes.
- Establish continuous communication with off-site officials
- Take actions to mitigate the emergency, provide technical assistance to control room
- Evacuate or provide substantial shelter for non-essential personnel and visitors on-site and account for all persons on the site.
- Conduct off-site monitoring near facility. provide data to off-site
- Provide protection from hazardous conditions for on-site and off-site emergency response personnel
- Initiate, with off-site officials, joint media briefings.

Lecture notes:

Off-site:

- Prepare to implement urgent protective actions in the PAZ off-site and take measures to protect food supply.
- Activate the full response coordinated under a single emergency manager near the scene using the incident command system (ICS).
- Alert the population and advise them to remain attentive for further instructions.
- Conduct monitoring for determining need for additional off-site protective actions -- incorporating on site data
- Provide fire fighting, police or medical support if requested.
- Provide initial treatment for injured and consult with experts to determine treatment strategy for overexposures.
- Assure all governmental agencies are informed.
- Initiate, with on-site officials, joint media briefings.

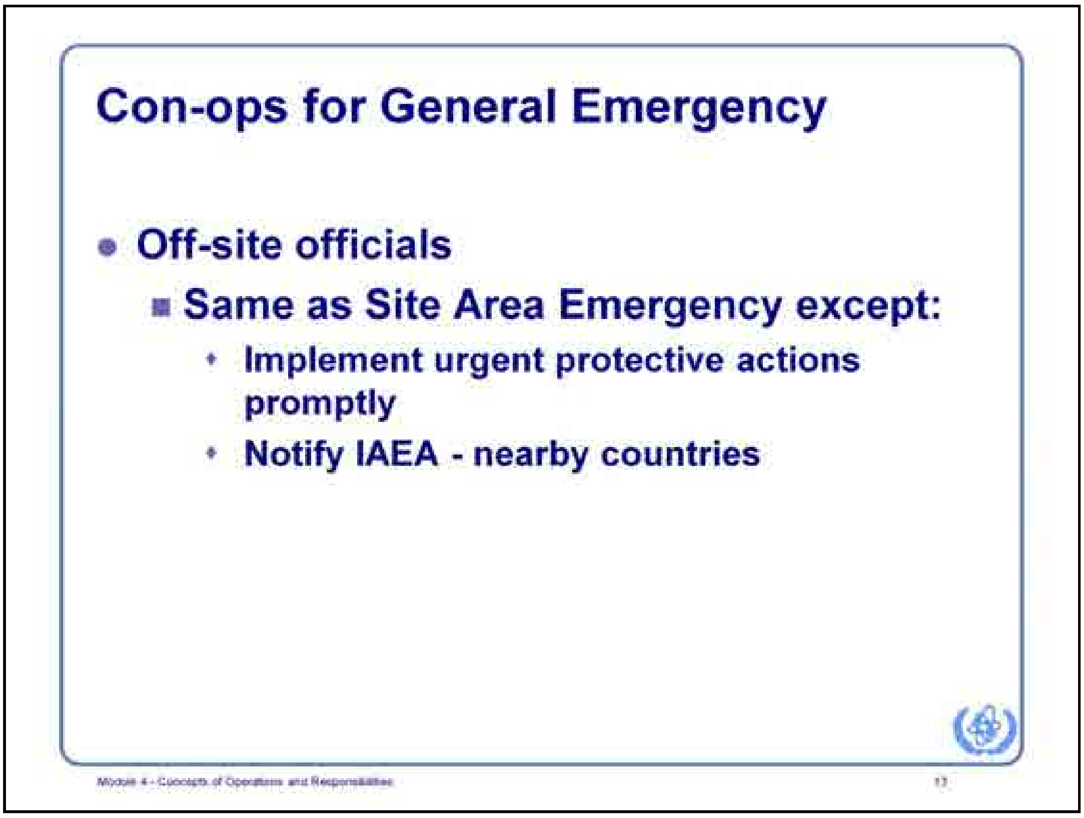
Lecture notes:

General Emergency

Events resulting in an actual or substantial risk of an atmospheric release or shine dose from criticality or loss of shielding requiring implementation of urgent protective actions off-site.

Facility:

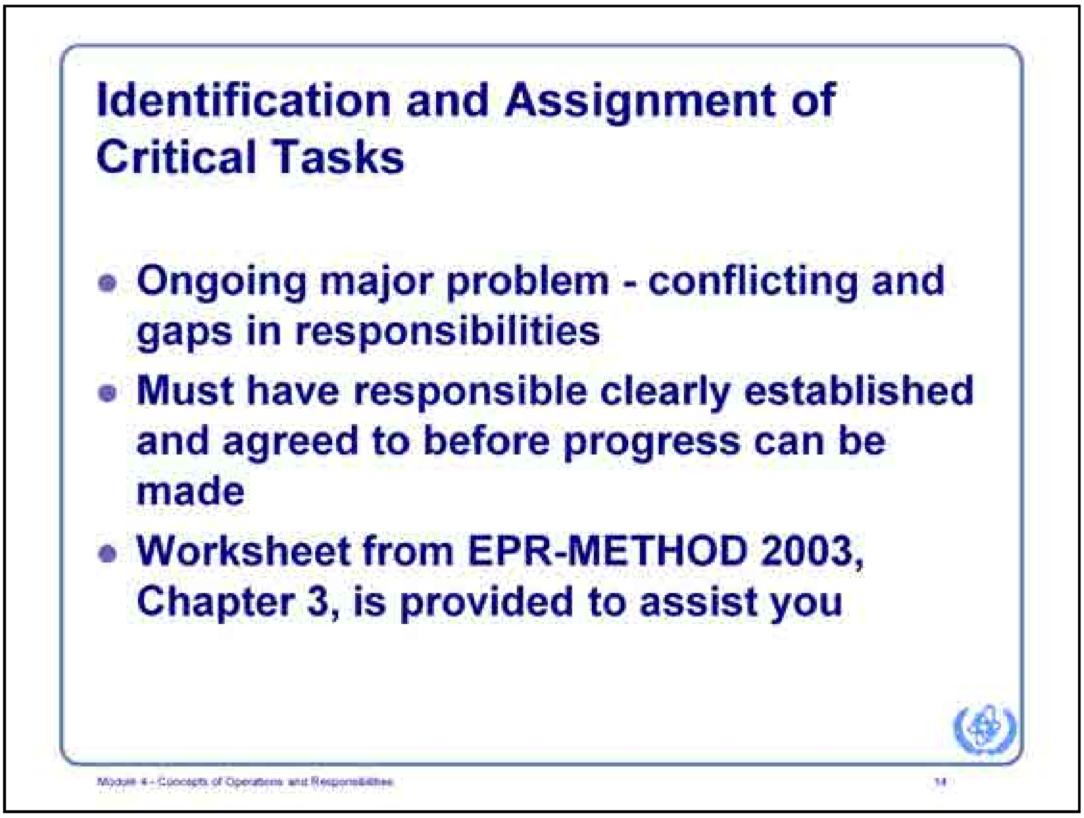
- Same as Site Area Emergency except:
- Participates in the incident command system - command group with off-site officials.



Lecture notes:

Off-site:

- Same as Site Area Emergency except:
- Implement immediate protective actions in the PAZ immediately - start within 30 minutes of notification by plant
- Implement appropriate protective actions in the UPZ based on environmental monitoring results
- Implement actions to protect the food supply (e.g., place animals on stored feed).
- If major release - recommend people do not eat potentially contaminated food within the distance 10 times the UPZ size.
- Conduct monitoring in and around the UPZ and revise protective actions accordingly.



Lecture notes:
Assure that the responsibility for performance of critical; task is clearly assigned is an ongoing problem. In many case different organizations are performing tasks (e.g., monitoring) and not in a coordinated way. In some cases several organizations all believe they are responsible for the same tasks. In other cases no one will take responsible for a task believing that it is someone else's responsibility. It will be very difficult for planning to proceed until the responsibilities for performance of critical response tasks is carefully established and agreed by all response organizations.

This worksheet is a list of tasks that are critical to a successful response.

Instructions for instructor
Show and discuss worksheet.

Lecture notes:

One copy of this worksheet should be distributed to all organizations which may have a role in off-site emergency response, including:

- national ministries and agencies;
- regional ministries and agencies;
- governments within the UPZ (for fixed facilities);
- the operator;
- support organizations (medical, police, fire fighting services) including private -companies (if applicable); and
- others, as required (e.g., non-governmental organizations that provide support).

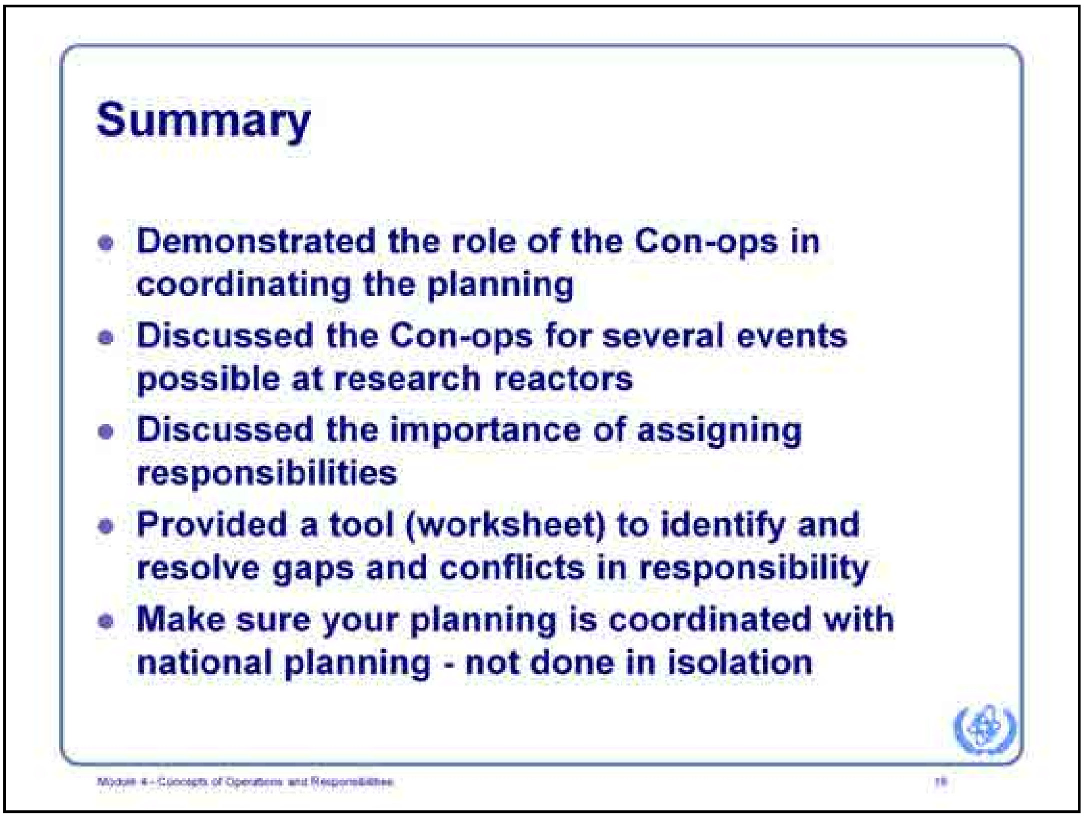
Lecture notes:
Each organization should be asked to complete the portions of the worksheet, which they believe apply to them. In some cases, organizations may recognize their role while admitting also their lack of resources and capabilities; in such cases, the role should be recorded on the worksheet, and a comment regarding resources and capabilities should be added.

Organizations should indicate if they are think they are responsible for the task. All completed worksheets should then be assessed at the national and local levels to identify gaps, overlaps and conflicts. Discussions should then be held between all coordinators responsible for emergency response to resolve these issues.

Once all responsibilities are agreed to, get all the parties to sign an agreement specifying the responsibilities. This could be accomplished by having all parties agree to the emergency plan (if it spells out the responsibilities).

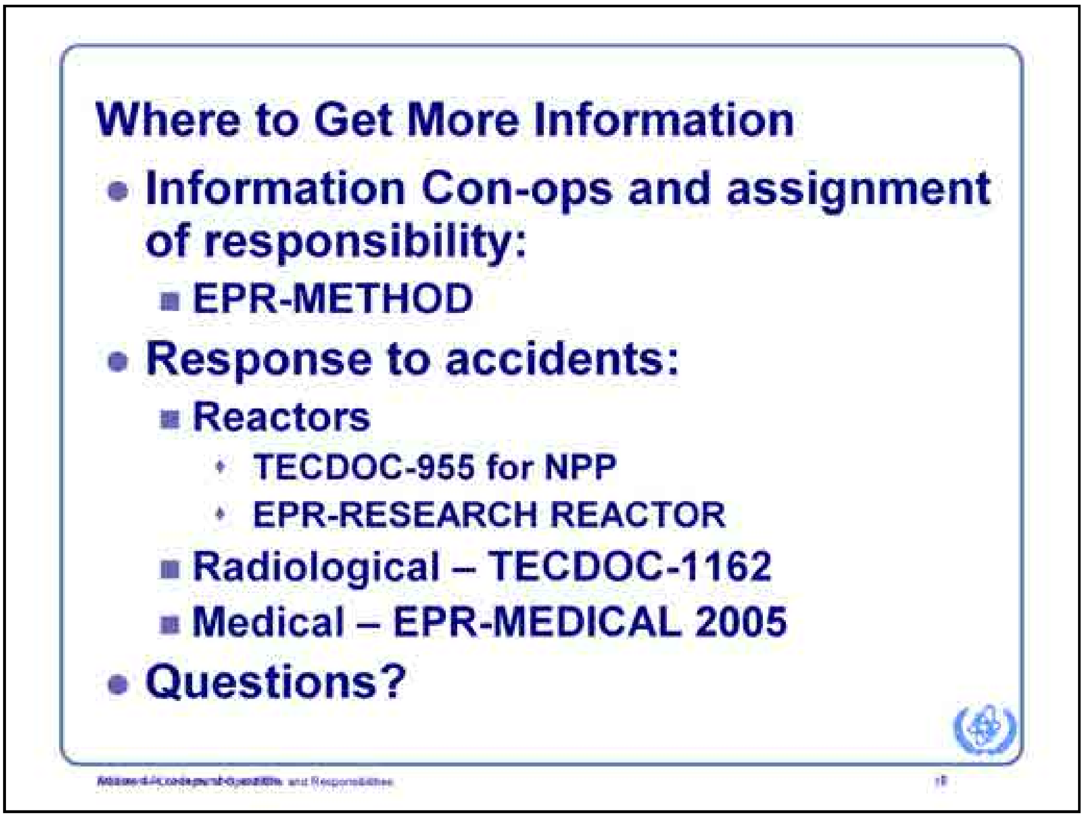
Lecture notes:

Exercises are the key. If the coordinated plans don’t work in a controlled and less stressful exercise, they will not have a chance in a real emergency!



Lecture notes:

Let’s summarize the main subjects we did cover in this session.



IAEA, Method for the development of emergency response preparedness for nuclear or radiological accidents, **EPR-METHOD 2003**, IAEA (2003)

IAEA, Generic Procedures for Determining Protective Actions during a Reactor Accident, IAEA-**TECDOC-955**, IAEA, Vienna (1997)

IAEA, Generic Procedures for Response to a Nuclear or Radiological Emergency at Research Reactors, **EPR-RESEARCH REACTOR**, IAEA, Vienna (2011)

IAEA, Generic Procedures for Assessment and Response during a radiological emergency, IAEA-**TECDOC-1162,** IAEA, Vienna (2000)

IAEA, Planning and Preparing for Emergency Response to Transport Accidents Involving Radioactive Material, IAEA Safety Guide No**. TS-G-1.2 (ST-3),** IAEA, Vienna (2002)

IAEA, Radiation Protection and Safety in Industrial Radiography, IAEA **Safety Report Series No 13,** IAEA, Vienna (1999)

IAEA, Generic procedures for medical response during a nuclear or radiological emergency, **EPR-MEDICAL 2005**, Vienna (2005)

Questions:

IAEA Training Course for Research Reactor Emergency Response

Emergency Preparedness and Response

Accident Management vs Emergency Management

Seminar

Block 3: Emergency Preparedness and Response Overview

Module 5: Accident Management vs Emergency Management

Learning objectives: Upon completion of this module, the participants will:

- know basic concept of accident management and why do we need that accident management
- become aware of accident prevention and accident mitigation process
- become aware of accident mitigation measure
- understand the EOP development guides and procedure
- understand how emergency management differs from accident management
- understand the Facility Response Manager responsibilities
- know the phases of emergency management

Activity: Seminar, questions and discussion

Duration: 1 hr

Materials and equipment needed: none

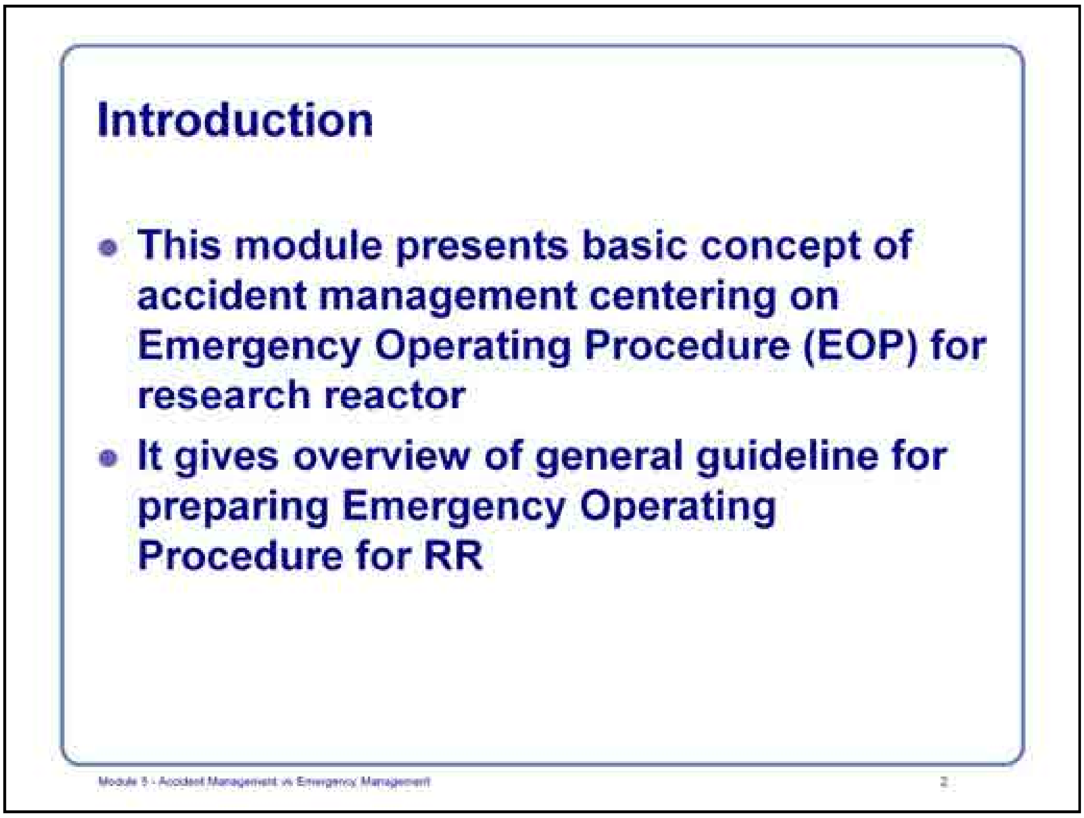
References:

1) INTERNATIONAL ATOMIC ENERGY AGENCY, Safety of Research Reactors, Safety Standards Series No. NS-R-4, IAEA, Vienna (2005)

2) INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct On the Safety of Research Reactors, IAEA, Vienna (2006)

3) INTERNATIONAL ATOMIC ENERGY AGENCY, Operational Limits and Conditions and Operating Procedures for Research Reactors. Safety Standards Series No. NS-G-4.4, IAEA, Vienna (2008)

4) INTERNATIONAL ATOMIC ENERGY AGENCY, EPR-METHOD 2003, Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency, IAEA, Vienna (2003)



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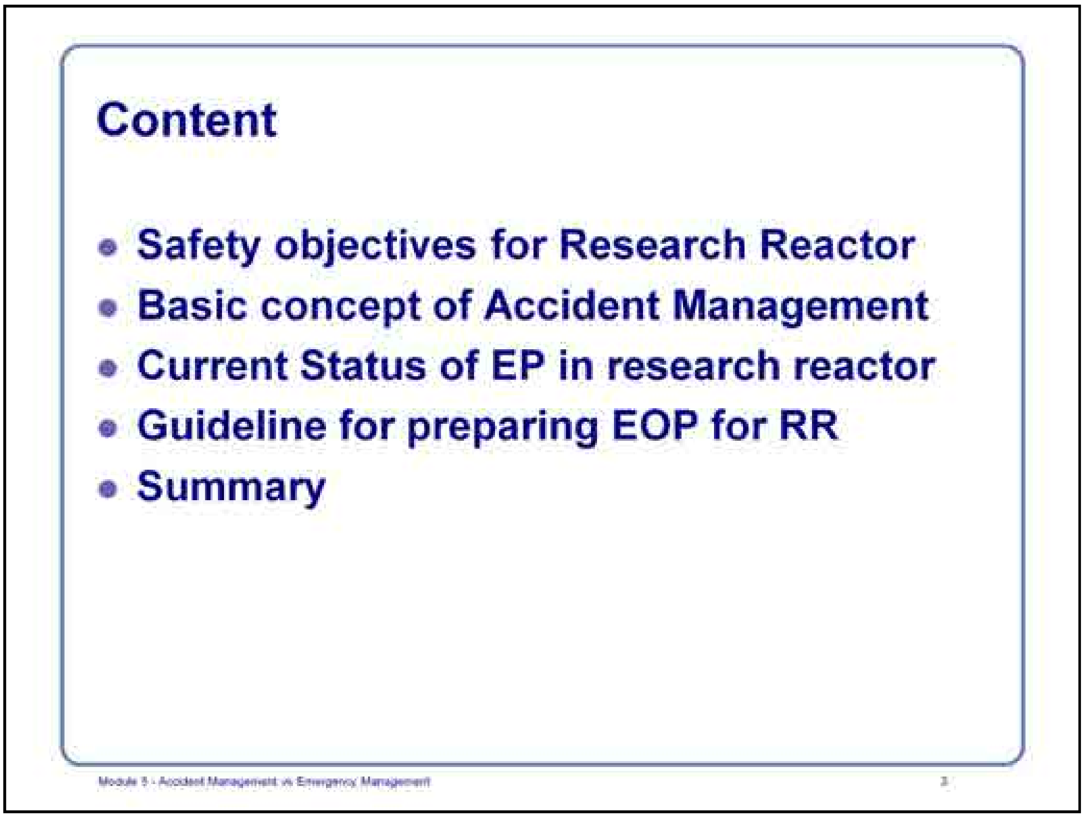


Lecture notes:

In this lecture we will cover safety objectives for research reactor, basic concept of accident management, current status of EP in research reactor and guideline for preparing EOP for RR. We will finish this module with a short summary.

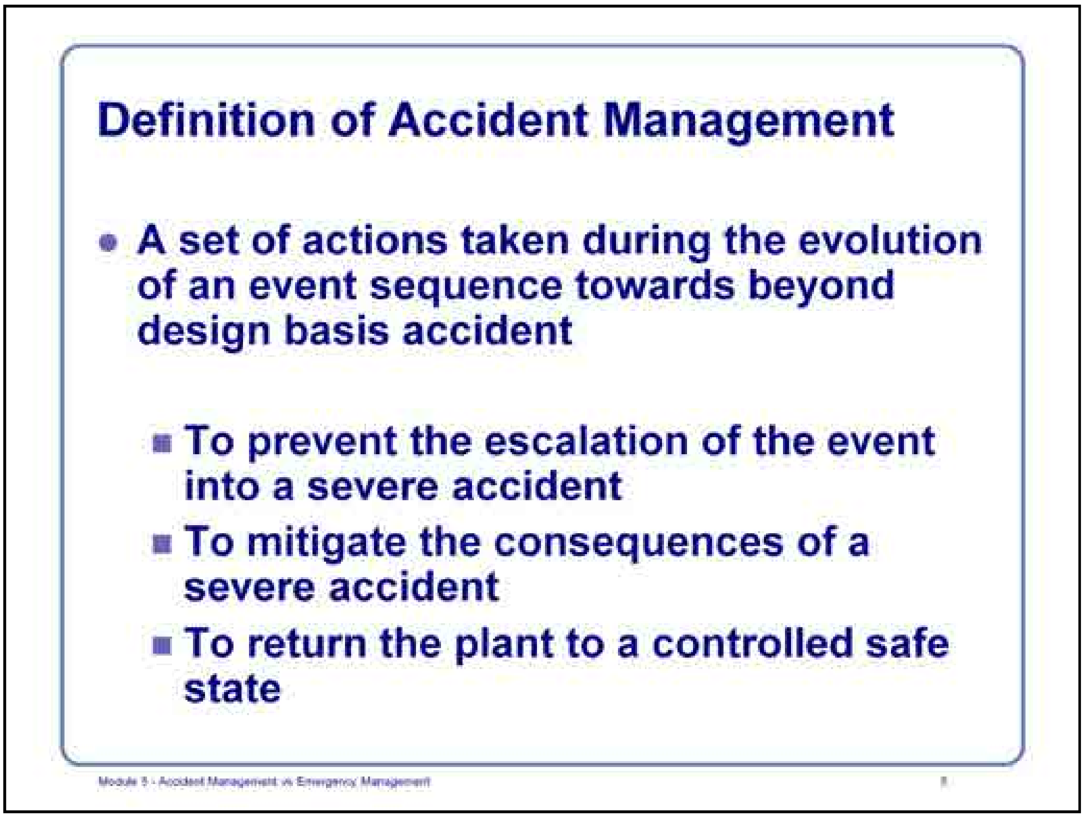
Lecture notes:

There are two corresponding objectives namely, radiation protection objectives and technical safety objectives:

With respect to accident the more detailed objectives are:

Radiation Protection Objective: To ensure that in all operational states radiation exposure within the installation or due to any planned release of radioactive material from the installation is kept below prescribed limits and as low as reasonably achievable, and to ensure mitigation of the radiological consequences of any accidents.

Technical Safety Objective: To take all reasonably practicable measures to prevent accidents in nuclear installations and to mitigate their consequences should they occur; to ensure with a high level of confidence that, for all possible accidents taken into account in the design of the installation, including those of very low probability, any radiological consequences would be minor and below prescribed limits; and to ensure that the likelihood of accidents with serious radiological consequences is extremely low.

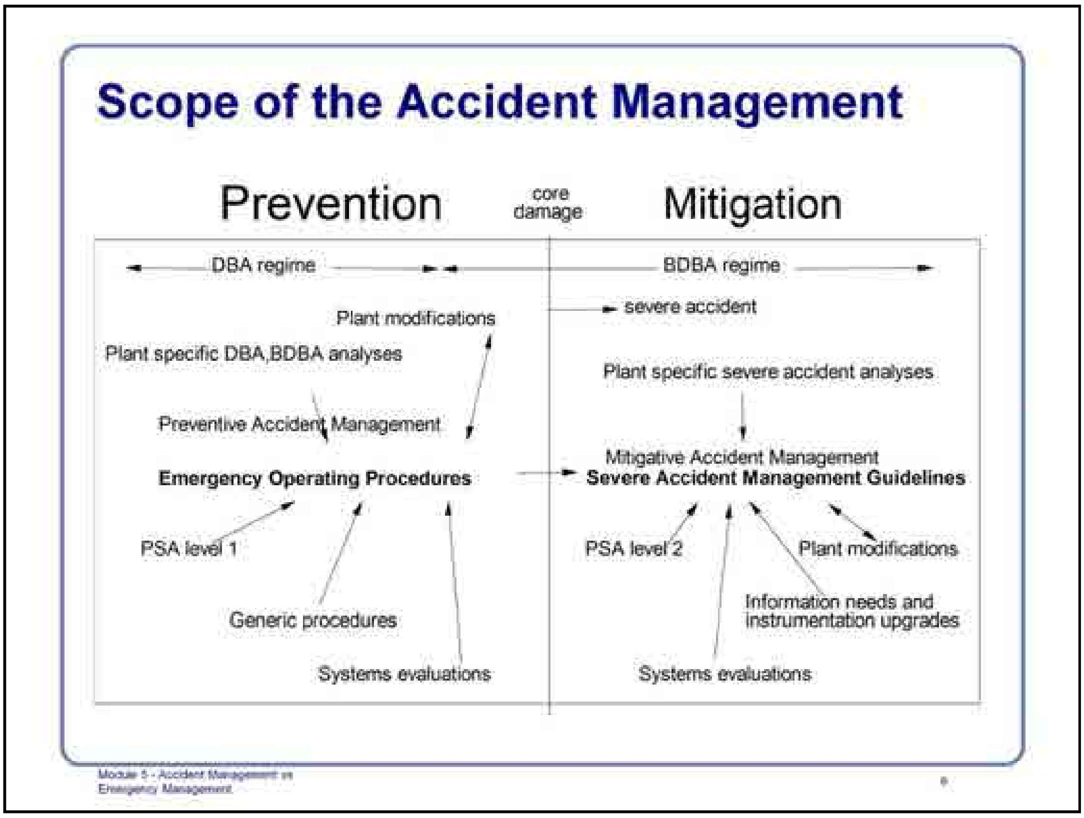


Lecture notes:

The concept of defense-in-depth is an essential element of nuclear safety. One of the levels of the defense-in-depth is that beyond design base accident which can give harm to public, environment and properties should be take into account.

The term of Accident Management (AM)) refers to the overall range of capability of a nuclear facility and its personal both to prevent and mitigate the accident conditions, which could lead to a severe core damage.

The definition of AM as used in IAEA Safety Report states that " Accident management is taking a set of actions during the evolution of a beyond design basis accident



Lecture notes:

The first step of the Accident Management Program development is to decide and document the basic AM strategies to be applied to the specific facility. The selected strategies and their implementation may depend on the basic approach chosen based on the national requirements. In case that plant modifications are involved to enhance the AM Program, the degree of confidence in successful AM actions will be increased.

There are various ways to develop the AM guidance based on the selected strategies. The following possibilities are mentioned:

incorporate preventive strategies into the emergency operating procedures and develop separate guidelines for mitigative strategies;

include all AM guidance (i.e. actions related to beyond design basis events) in separate procedures and/or guidelines;

incorporate AM guidance as an enveloping symptom based or state oriented part of EOP's.

Whatever way is chosen, the following chapters aim at describing the process to develop the procedures and guidelines

Safety Performance

- Safety = Min (S, A, F, E, T, Y)

Where

S: Safety Culture

A: ALARA

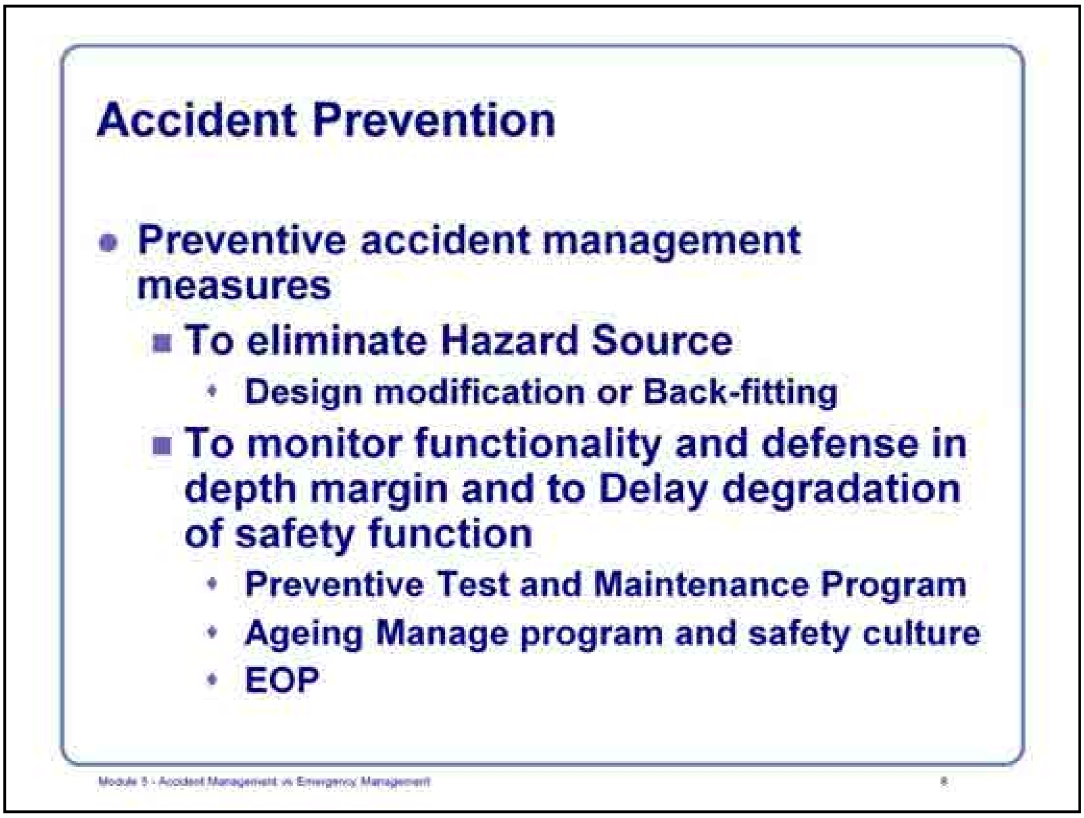
F: Functionality or Reliability

E: Effectiveness

T: Technology

Y: Yield to Principle and Procedure

Lecture notes:



Lecture notes:

The first practical accident management measure is to prevent the accident.

There are two options for preventing accident:

to eliminate hazard source;

to monitor functionality and defense in depth margin and to delay degradation of safety function.

Eliminating hazard source is very difficult depend on initiator. For example, external event such as earthquake, high winds or aircraft crash cannot be managed by human being. Only way of doing is to enhance tolerance with the hazard through design modification or backfitting based on the integrated safety assessment such as PSA.

Safety Requirement No. NS-R-4 gives a good set of criteria for design and operational safety of research reactors in terms of accident prevention.

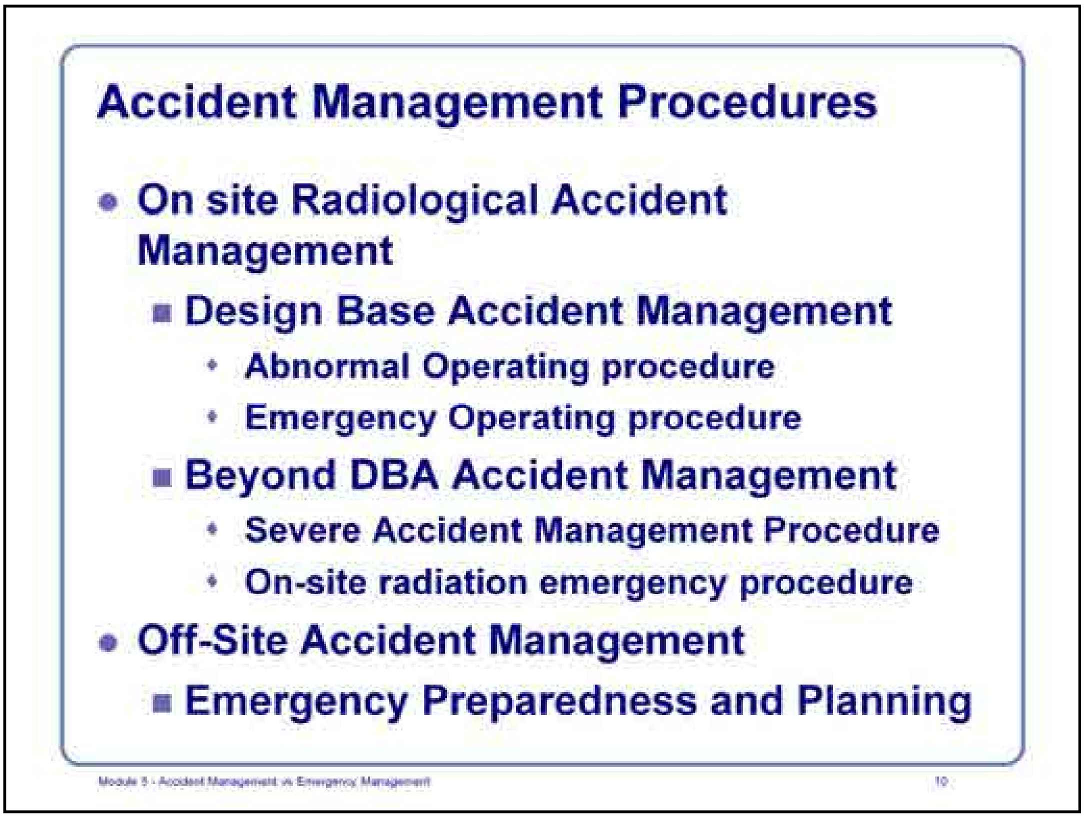
Preventive accident management integrates actions and measure needed to prevent or delay severe fuel damage to the reactor core. Preventive accident management is usually covered by the facility EOP, used by operating group in the control room during an event. These procedures are distinct from the emergency response procedures used to mitigate the consequences to the plant operators and the off-site population.

Lecture notes:

Mitigative accident management refers to those actions or measures which are necessary if the preventive measures fail and severe fuel damage occurs or is likely to occur. This is the reason for emergency response procedures.

A necessary step in accident management planning is to identify the vulnerability to significant radiological release, which are likely to cause challenges to the safety function, and the mechanism by which the barrier to the release of radioactive materials can be challenged. The assessment of vulnerability should be based on an analysis of the facility response to accidents beyond design basis. The assessment should also include all possible facility situations and mode of operation.

On the basis of the vulnerability assessment and understanding of accident behavior, as well as of the facility capability to cope with accidents, the next step is to develop accident management strategies.

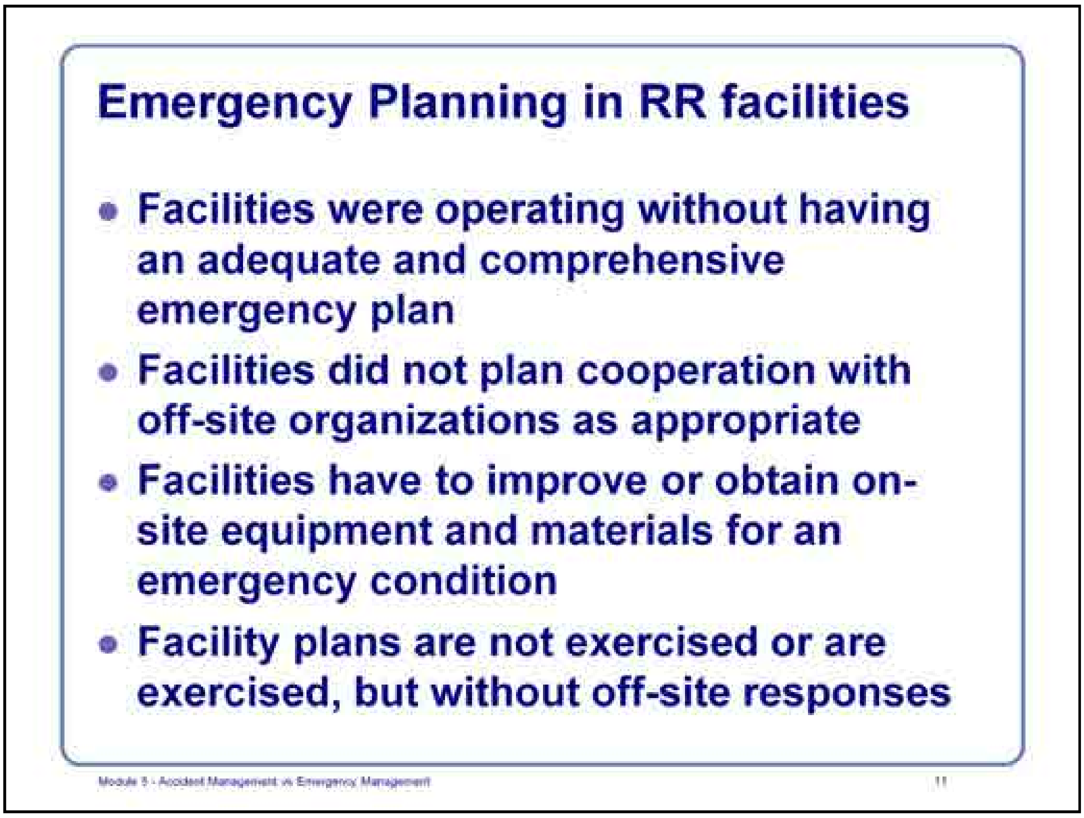


Lecture notes:

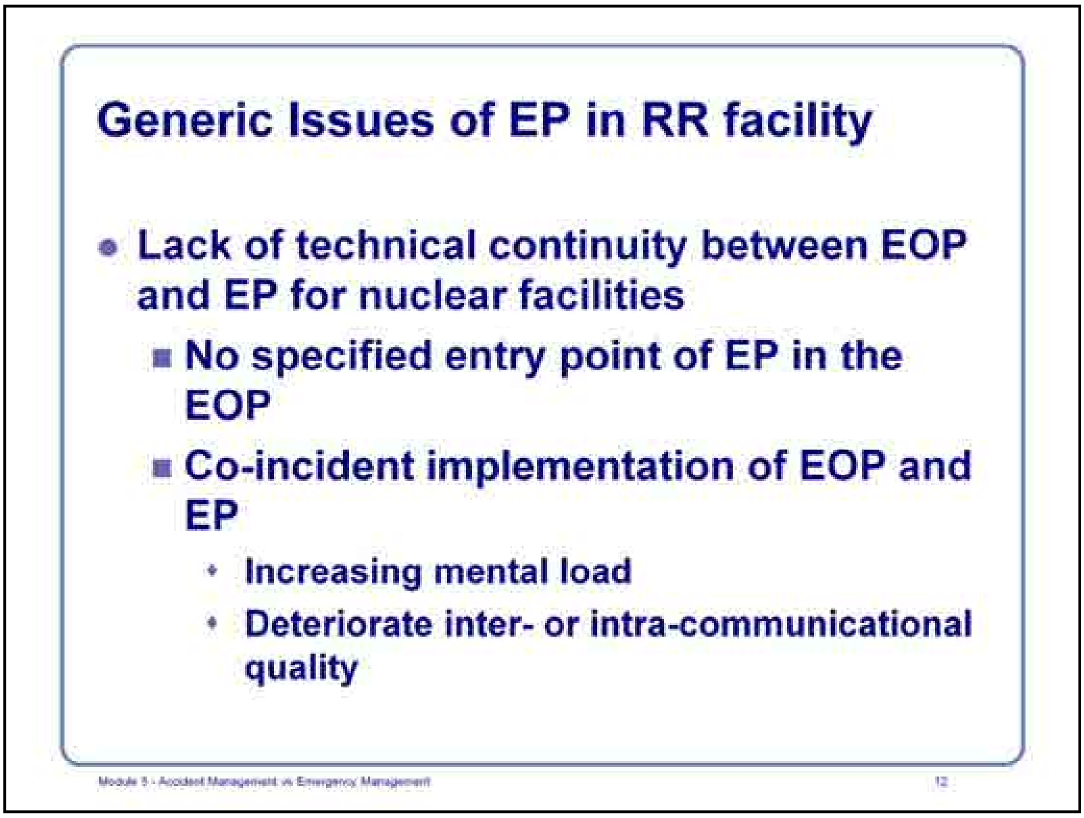
Accident management for research reactor should be differentiated from NPP's due to different mode of operation, radioactive source term inventory and characteristics of accident progression.

AM for research reactor should more focused on the on-site accident management due to that research reactor requires much more human interactions during the operation or experiment than that of NPP.

It is not too much say that the key of completeness of accident management program depends on completeness of the procedure.



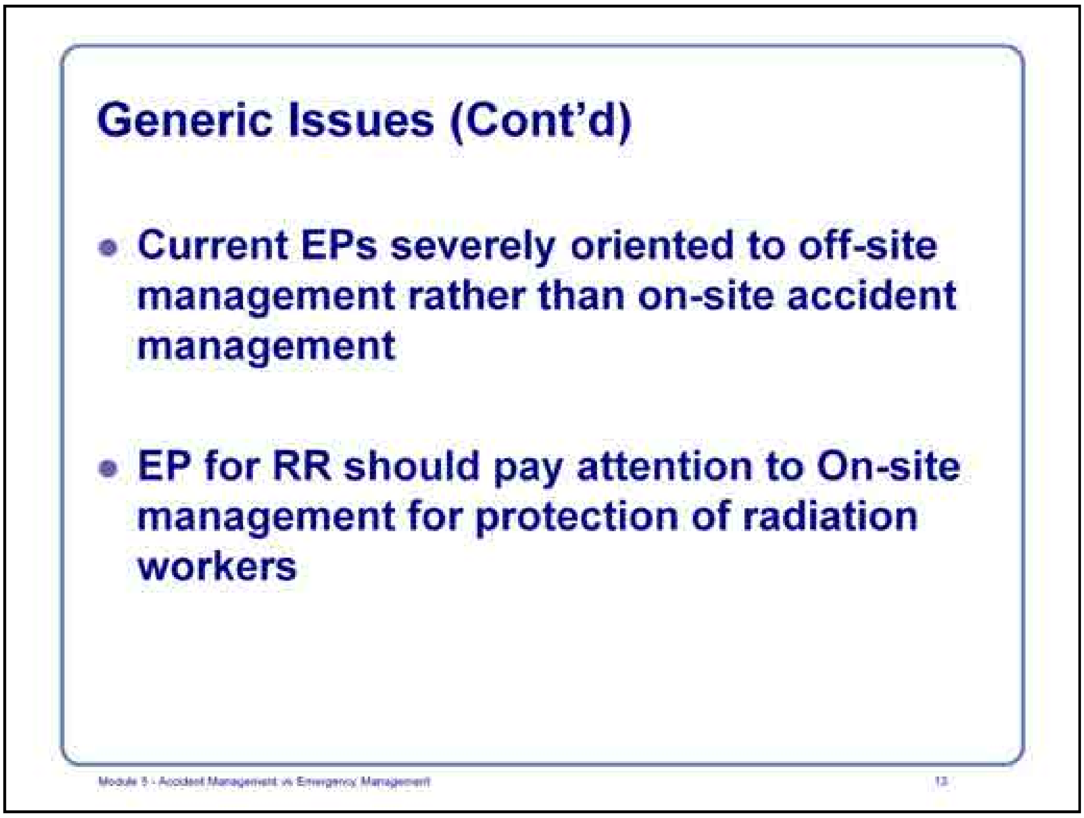
Lecture notes:
Why is this?
It is to expensive, in time or manpower, to make a comprehensive plan.
The facility is so safe that emergencies don't happen
Off-site authorities are uncooperative or have inadequate resources themselves
There are a lot of reasons why this can be difficult, but research reactors need to overcome those difficulties.



Lecture notes:

The EOP does not need a step that says “Implement the EP”. Both should initiate when an emergency occurs.

However, note that plant operator response to an emergency is not to be delayed or disrupted by emergency response procedures. So the message is EOP first, then EP when resources are available. The site needs to provide the manpower resources so both sets of response actions can proceed without interference and in a timely manner.



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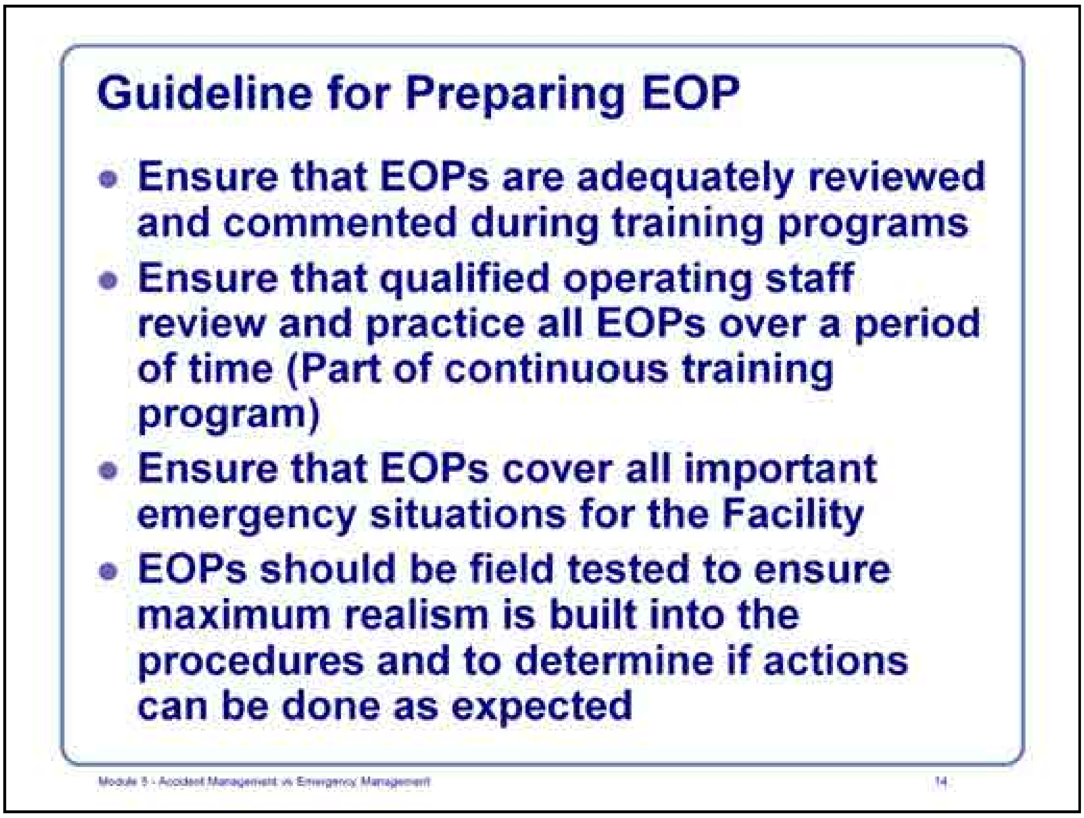
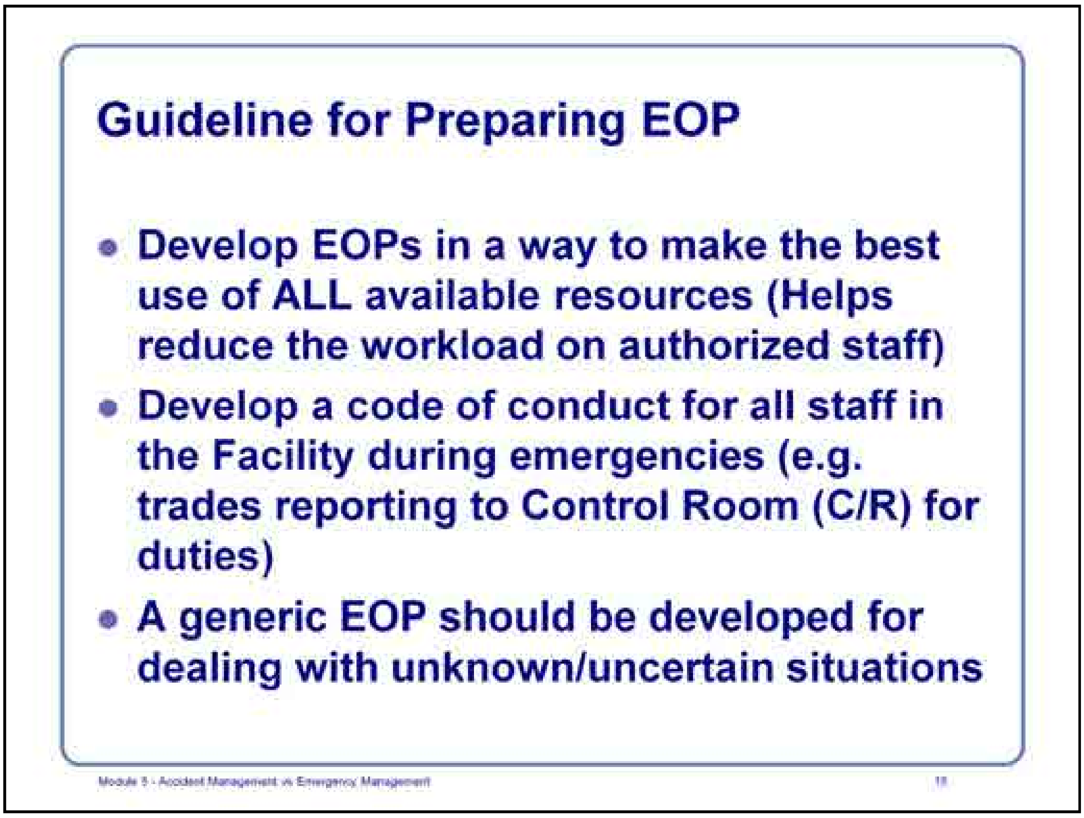


Lecture notes:

Emergency operating procedures are essential for maintaining the fundamental safety function and preventing fuel damage during design basis accident (DBA) and beyond DBAs in nuclear facility.

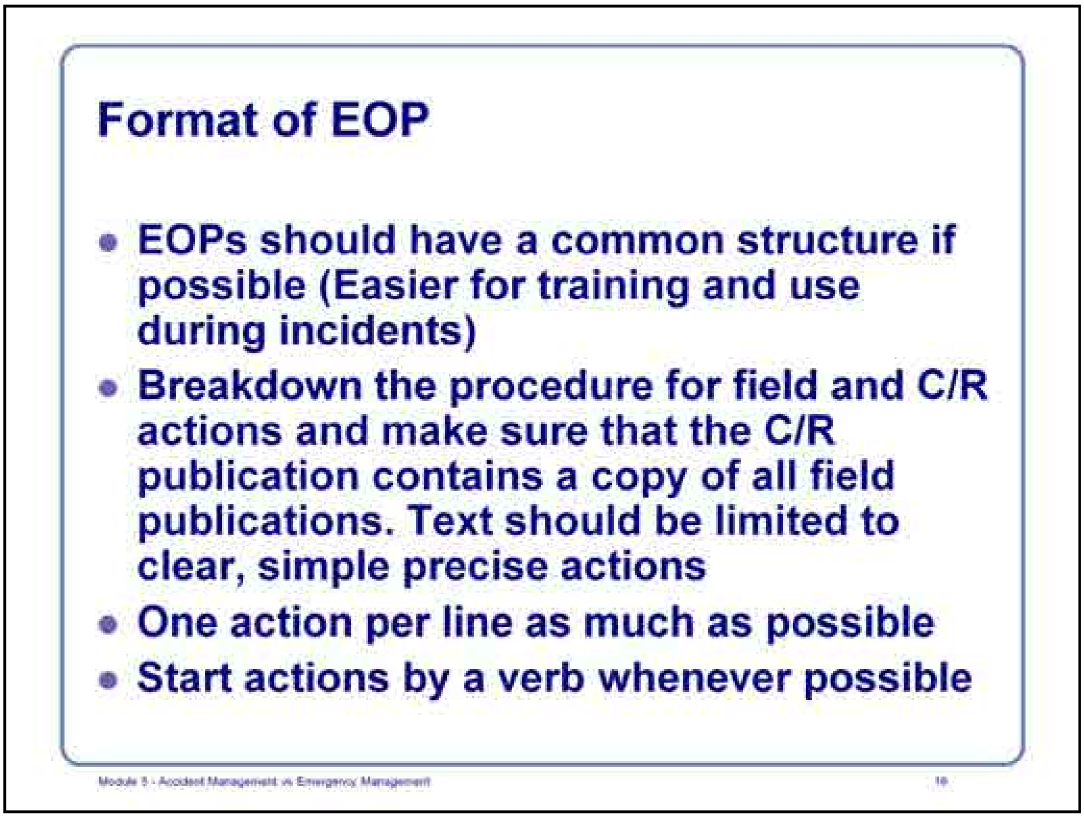
This slide shows general guideline for preparing EOP.

NS-R-4: "Emergency procedures shall be based on the accidents analyzed in the SAR as well as those additionally postulated for the purposes of emergency planning."



Lecture notes:

Code of Conduct: “Establish procedures for responding to anticipated operational occurrences and to accidents.”



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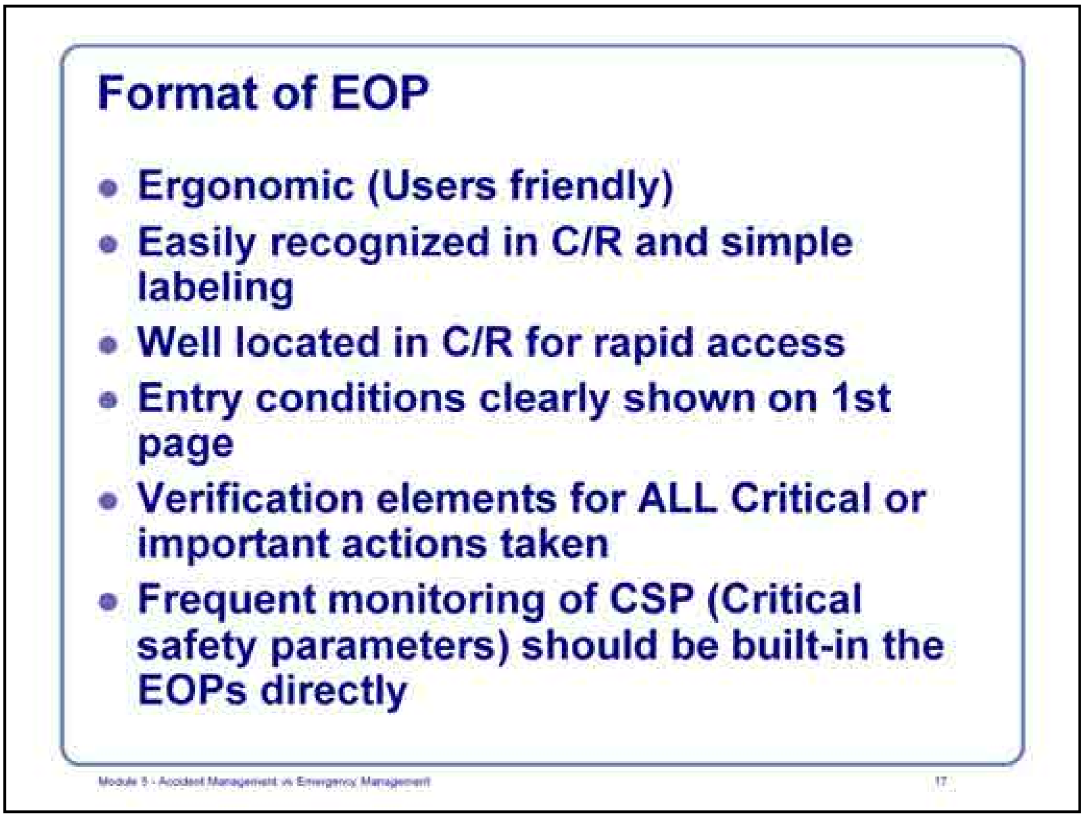
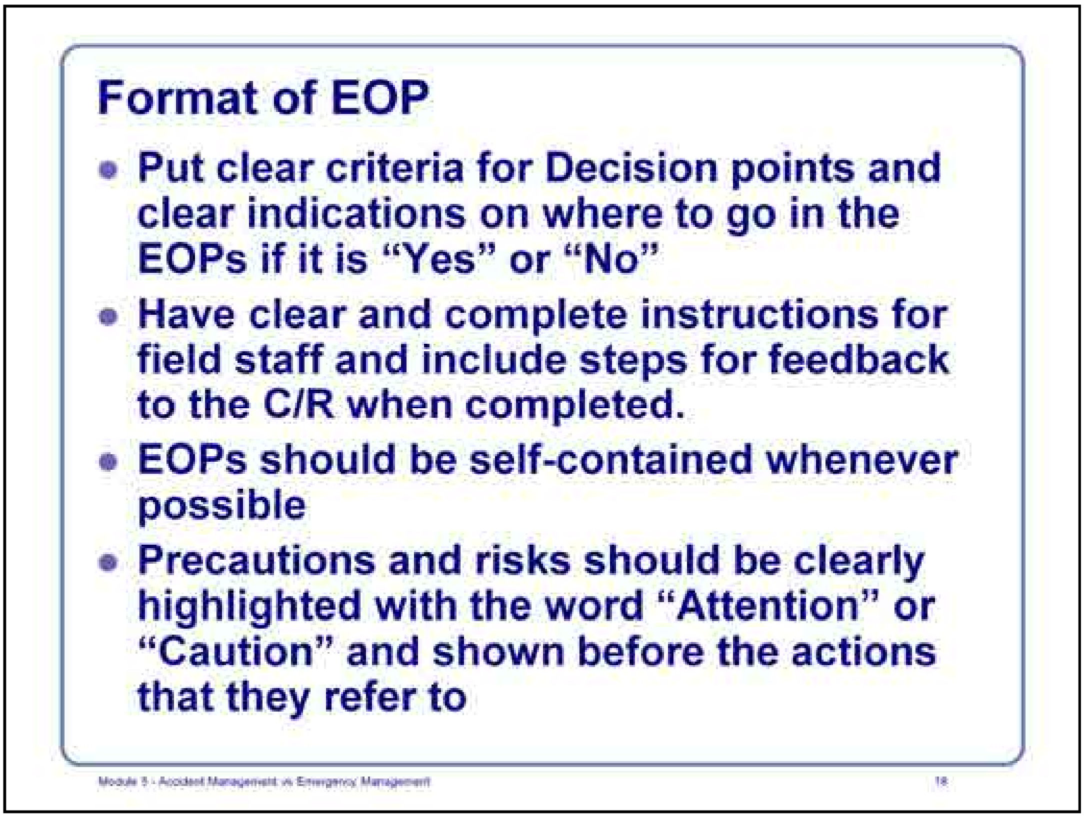


Lecture notes:



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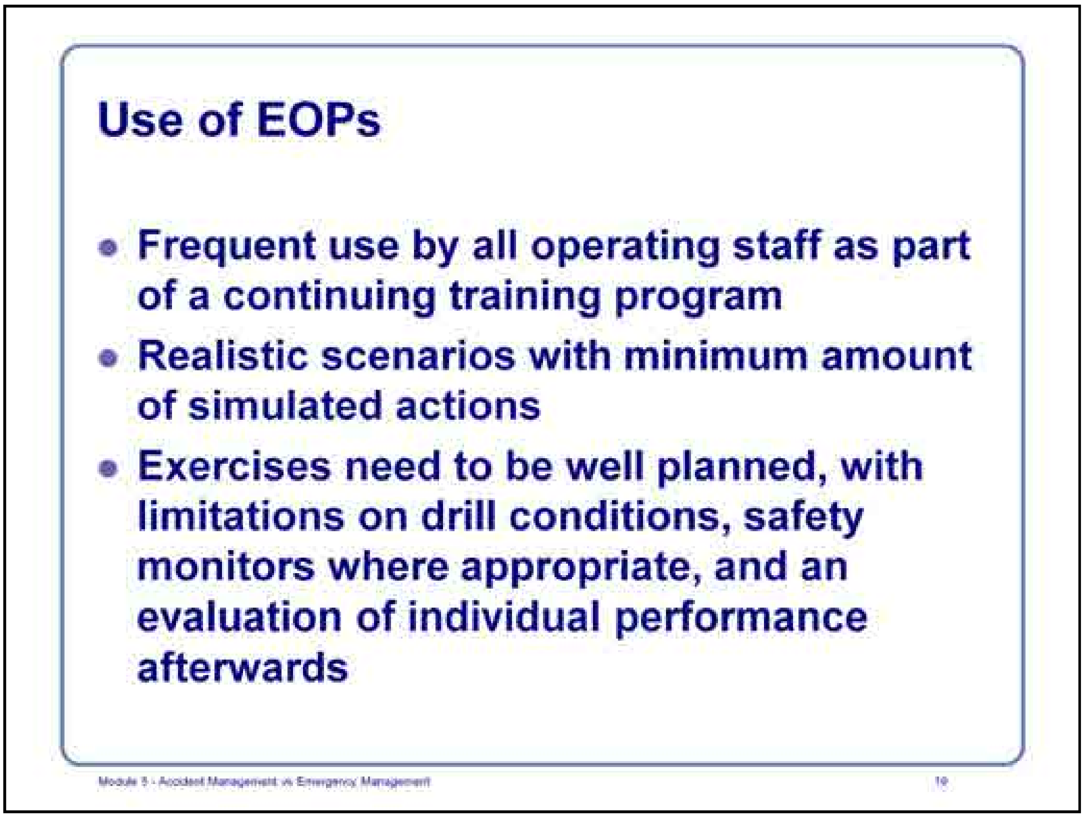
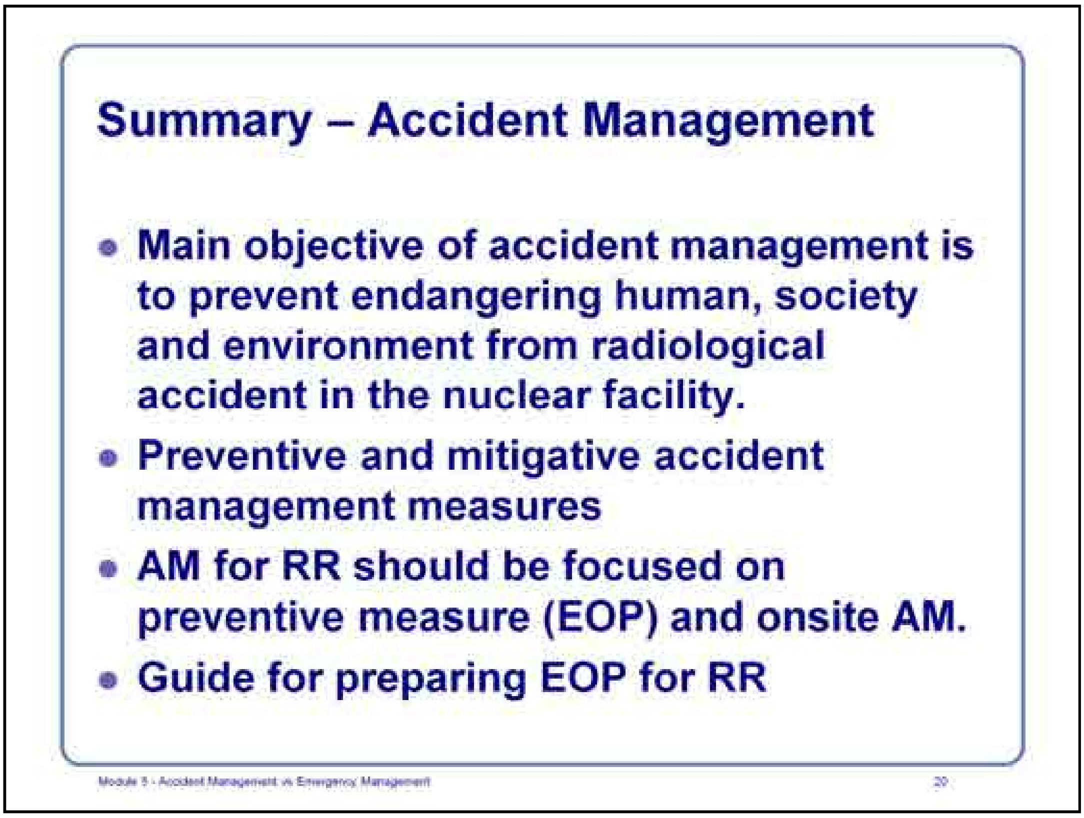


Lecture notes:

Exercising the operators in simulated emergencies is the last stage of developing the procedures. The drills may even show procedure weaknesses that need to be corrected.

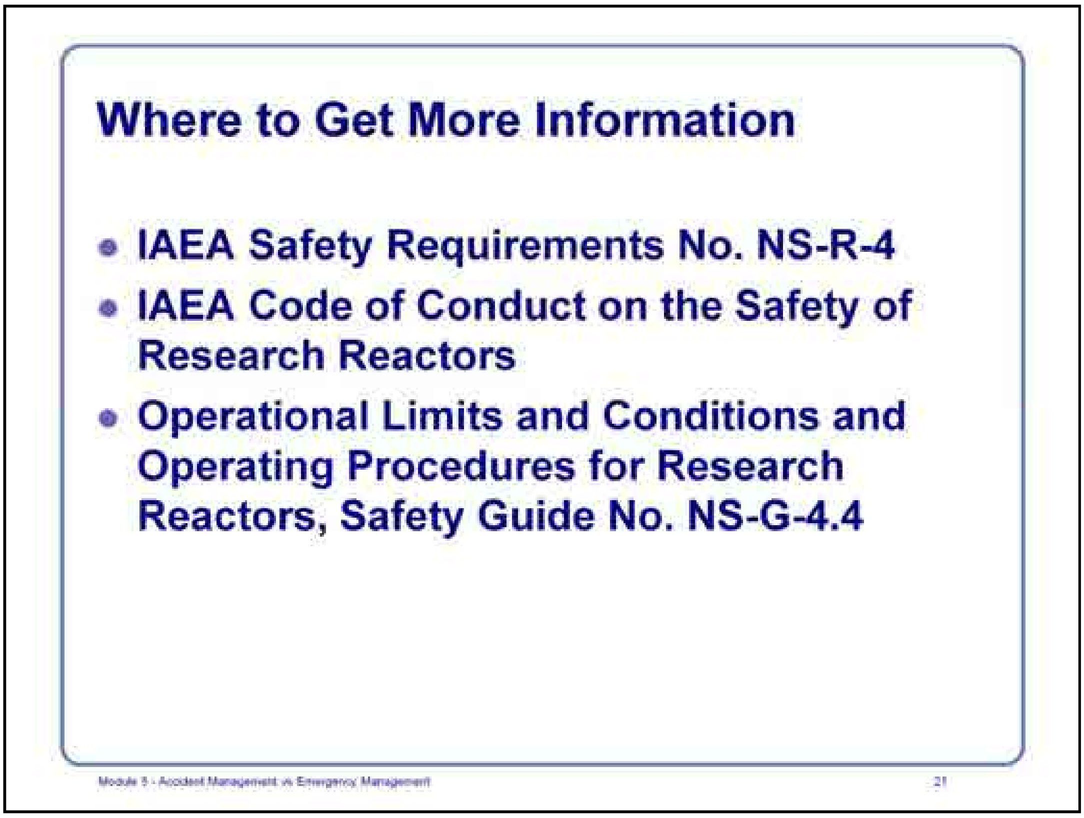
Tabletop or classroom exercises are helpful at the start, but nothing is better than hands on the equipment to determine if the operators are prepared to respond properly to an emergency. Besides. it’s fun!

IAEA NS-G-4.4: “Procedures for guiding the response of the operator to anticipated operational occurrences, design basis accidents and, to the extent feasible, beyond design basis accident conditions should be prepared and should be periodically exercised. To improve their execution, the procedures should be reviewed and modified on the basis of operational experience and the performance of the exercises. “

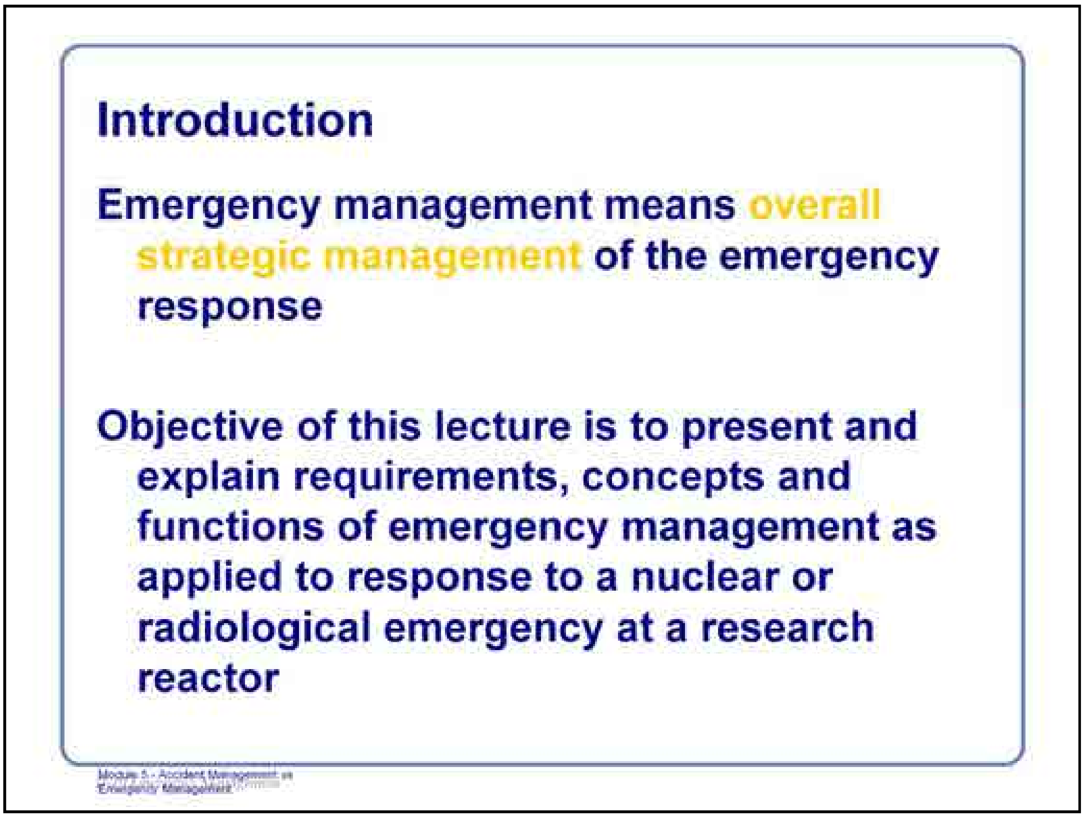


Lecture notes:

Let's summarize the main subjects regarding accident management we did cover so far, then we will discuss emergency management to highlight the different emphasis. One way to think of accident management is that it concentrates on mitigating the consequences by returning the reactor to a stable condition. Before that is achieved, there may be radiological consequences that can affect the off-site population.

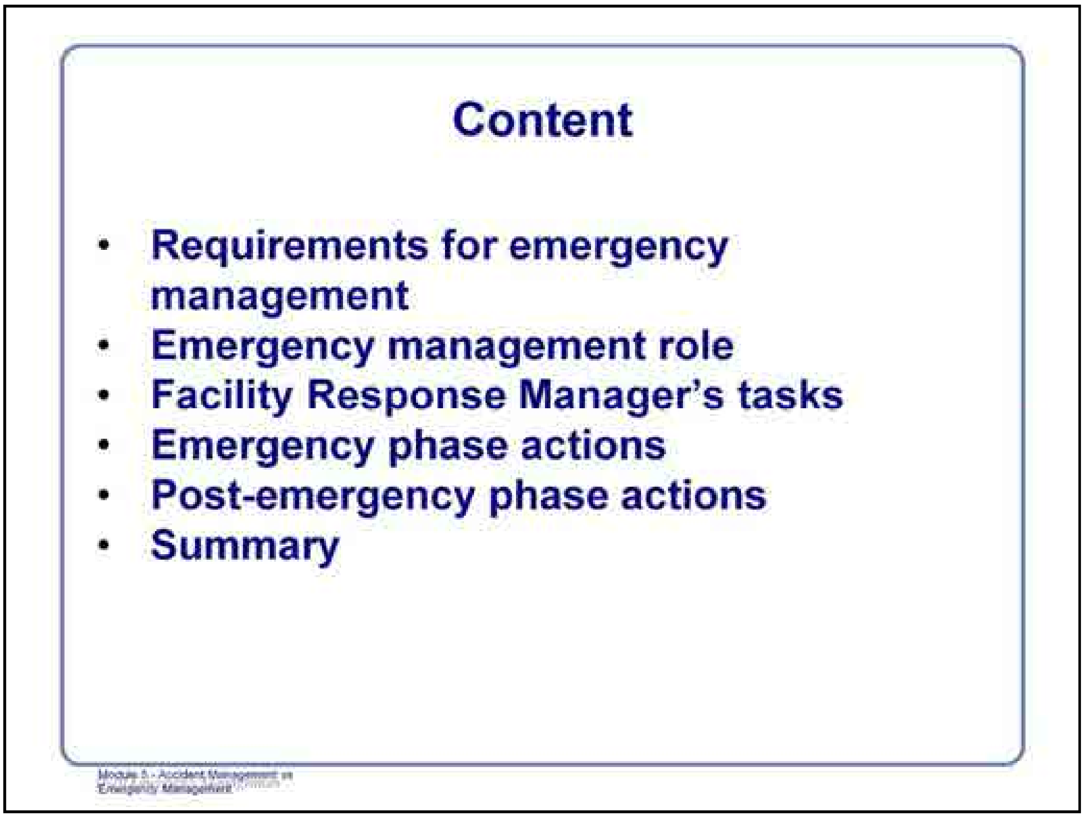

Where to Get More Information
IAEA Safety Requirements No. NS-R-4
IAEA Code of Conduct on the Safety of Research Reactors
Operational Limits and Conditions and Operating Procedures for Research Reactors, Safety Guide No. NS-G-4.4
Module 5 - Accident Management vs Emergency Management
21

Questions:

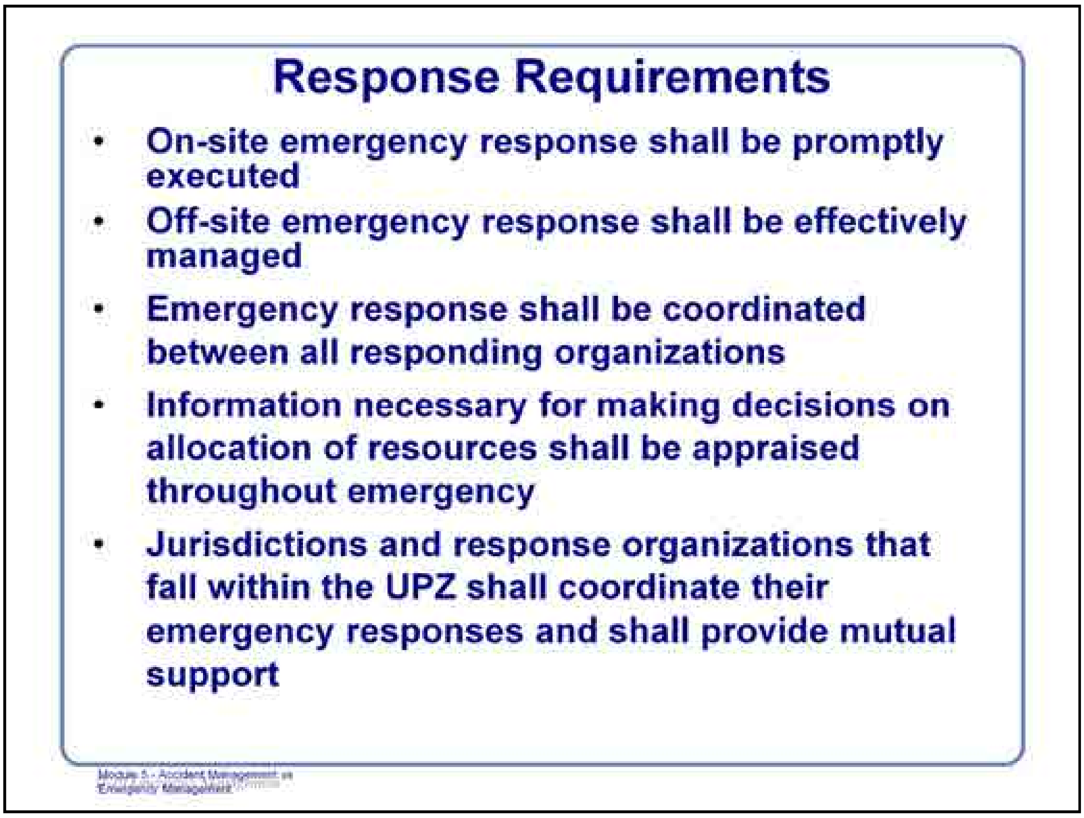


Despite all the precautions that are taken in the design and operation of nuclear facilities and the conduct of nuclear activities, there remains a possibility that a failure (or an intentional act) or an accident may give rise to a nuclear or radiological emergency. In some cases, this may give rise to the release of radioactive materials or exposure within facilities and/or into the public domain, which may necessitate emergency response actions. Overall strategic management of the emergency response – emergency management – constitute an essential part of emergency response.

Objective of this part of the lecture is to present and explain requirements, concepts and functions of emergency management.



We will start the lecture with the requirements for establishing emergency management set out in the IAEA Safety Standards publication *Preparedness and Response for a Nuclear or Radiological Emergency*. We will then continue with emergency management functions and tasks of Facility Response Manager in emergency and post-emergency phase. We will conclude the lecture with a short lecture summary.



A review of the response requirements for establishing emergency management and operations as stated in the Safety Requirements publication:

- The on-site emergency response shall be promptly executed and managed without impairing the performance of the continuing operational safety functions.
- The off-site emergency response shall be effectively managed and coordinated with the on-site response.
- The emergency response shall be coordinated between all responding organizations (to include the response by those response organizations specialized in responding to a nuclear or radiological emergency and those organizations specialized in responding to a conventional emergency).
- Information necessary for making decisions on the allocation of resources shall be appraised throughout the emergency.
- Jurisdictions and response organizations (including other States) that fall within the precautionary action zone for Threat Category II research reactors shall co-ordinate their emergency responses and shall provide mutual support.

Preparedness requirements are presented on the next slide.

Additional GS-R-2 requirements:

- 4.7. For facilities in threat category I, II or III the transition from normal to emergency operations shall be clearly defined and shall be effectively made without jeopardizing safety. The responsibilities of everyone who would be on the site in an emergency shall be designated as part of the transition. It shall be ensured that the transition to the emergency response and the performance of initial response actions do not impair the ability of the operational staff (such as the control room staff) to follow the procedures needed for safe operation and for taking mitigatory actions.
- 4.8. For facilities in threat category I or II arrangements shall be made to coordinate the emergency responses of all the off-site organizations with the on-site response.

Additional GS-R-2 requirements:

- 4.10. Arrangements shall be made for the implementation of a command and control system for the response to a nuclear or radiological emergency. This shall include arrangements for coordinating activities, for developing strategies and for resolving disputes between the response organizations (to include the response by those response organizations specialized in responding to a nuclear or radiological emergency and those organizations specialized in responding to a conventional emergency) concerning functions, responsibilities, authorities, allocation of resources and priorities. In addition, arrangements shall be made for obtaining and assessing the information necessary in order to allocate resources for all response organizations.
- 4.11. For facilities in Threat category I or II, arrangements shall be made for coordinating the response to a nuclear or radiological emergency between response organizations and jurisdictions (including other States) that fall within the precautionary action zone or the urgent protective action planning zone.

Let us now review the practical objectives of emergency response to a radiation emergency. In the context of a nuclear or radiological emergency, the practical goals of emergency response are:

- to take mitigatory action at the scene;
- to prevent the occurrence of deterministic effects in workers and the public;
- to render first aid and to manage the treatment of radiation injuries;
- to reduce, to the extent practicable, the occurrence of stochastic effects in the population;
- to limit, to the extent practicable, the occurrence of psychological effects in individuals and in the population;
- to protect, to the extent practicable, the environment and property; and
- to prepare, to the extent practicable, for the resumption of normal social and economic activity.

One of the most important aspects of managing a nuclear power plant emergency is the ability to promptly and adequately determine and take actions to protect members of the facility, the public and the emergency workers. Radiological emergency assessment must take account of all critical information available at any time and must be an iterative and dynamic process aimed at reviewing the response as more detailed and complete information becomes available.

The Facility Response Manager relies on the Nuclear Condition Analyst for threat assessment (core damage, release to the environment, etc.), and must be critically involved in that assessment by challenging assumptions, not to interfere with the responsibilities of the Nuclear Condition Analyst, but to understand the reasons for the evaluation conclusions and to encourage a questioning attitude.

The Facility Response Manager relies on the Radiological Protection Manager to assess the radiation environment from measurements and promptly exchange needed information with the Protective Action Manager for protective action decisions.

The Facility Response Manager expects the Protective Action Manager to promptly determine appropriate protective actions for on-site personnel and the public, and do so continuously as plant conditions based on assessments by the Nuclear Condition Analyst and environmental monitoring results provided by the Radiological Protection Manager are made available. Implementation for on-site personnel and transmittal to off-site authorities for implementation by the public are reviewed and approved by the FRM.

Let us turn our attention to the overall strategic direction and control of the emergency response.

Facility Response Manager- is in charge of the overall strategic management of the emergency response. This function is concerned with emergency management from a “big” picture perspective – a plant manager or the site manager. This function is concerned about impact on the entire facility, and the local community.

This position manages from a facility wide perspective. This function of Facility Response Manager might be performed by a Shift Supervisor at first, then the Plant Manager or Site Manager as they arrive when the emergency responders are activated.

The emergency management function is one which assembles department leaders to provide decisions and coordinate facility resources in a significant incident. The Emergency Plan for the facility establishes the authority for the position.

The Facility Response Manager ensures all required response personnel are activated, sets priorities, gives direction, documents all actions and decisions, and manages implementation of the facility responses. The Facility Response Manager may act as the primary spokesperson for the facility during the response, however normally a qualified and specially trained spokesperson will interact with the media.

Role and Functions of the Facility Response Manager

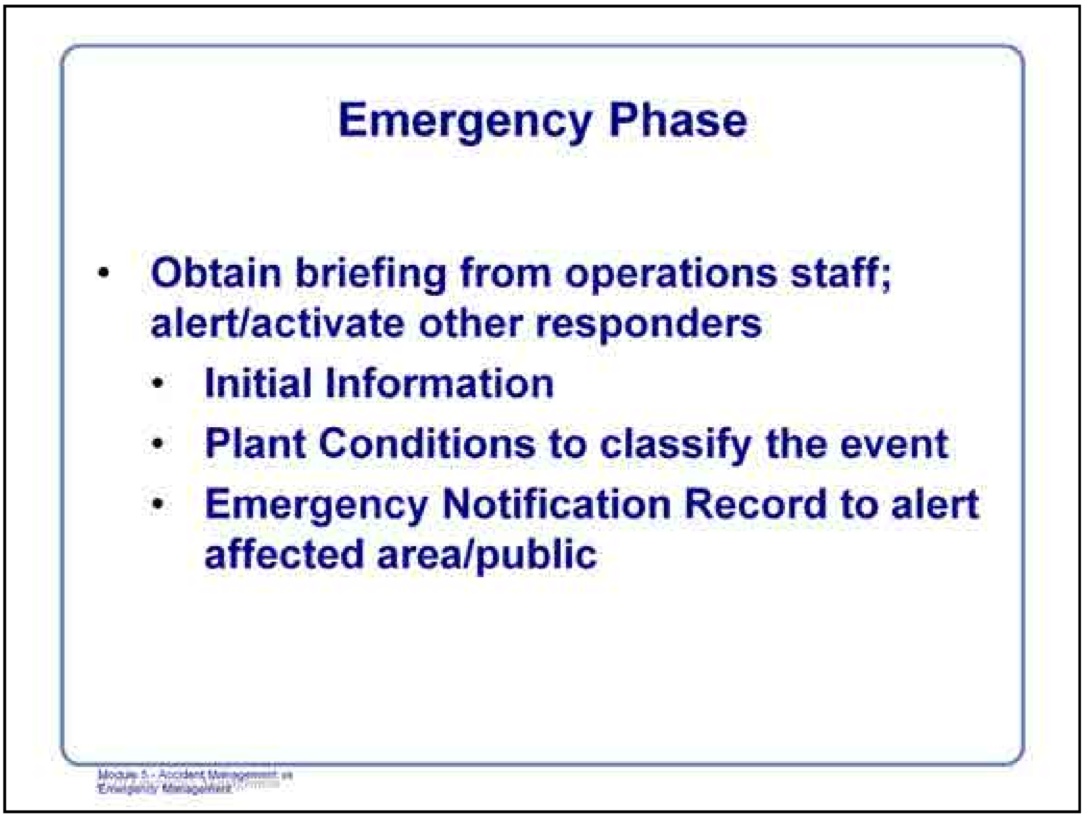
- Who is designated as Facility Response Manager?
  Document in the response plan
- Knowledge/skills required
- Operational location

Who is designated for this role in your jurisdiction or facility now? Since a person at the facility must always be available for this role, it should be clear that the individual filling the role of Facility Response Manager will change during the course of the response. Also possible is the need to keep the response team in place for an extended period of time. That means more than a few people need to have the same competency to act in this role. Facility staff with the required knowledge and management skill need to be trained in this role so the facility emergency plans and procedures, including the planned coordination with off-site authorities, are understood.

A Facility Response Manager must be able to:

- focus on the overall response and see how resource requirements fit with priorities,
- coordinate the team of responders
- implement response plans
- make decisions on protective actions proposed by the Protective Action Manager
- request assistance from local and national authorities when facility resources are inadequate
- brief the media, perhaps

Normally the Facility Response Manager will first operate from the Control Room, then the individual who relieves the Shift Supervisor of that role will shift to an emergency response center at the plant. Depending on the complexity of the emergency, the Facility Response Manager will decide (based on plans) which other responders need to be activated.

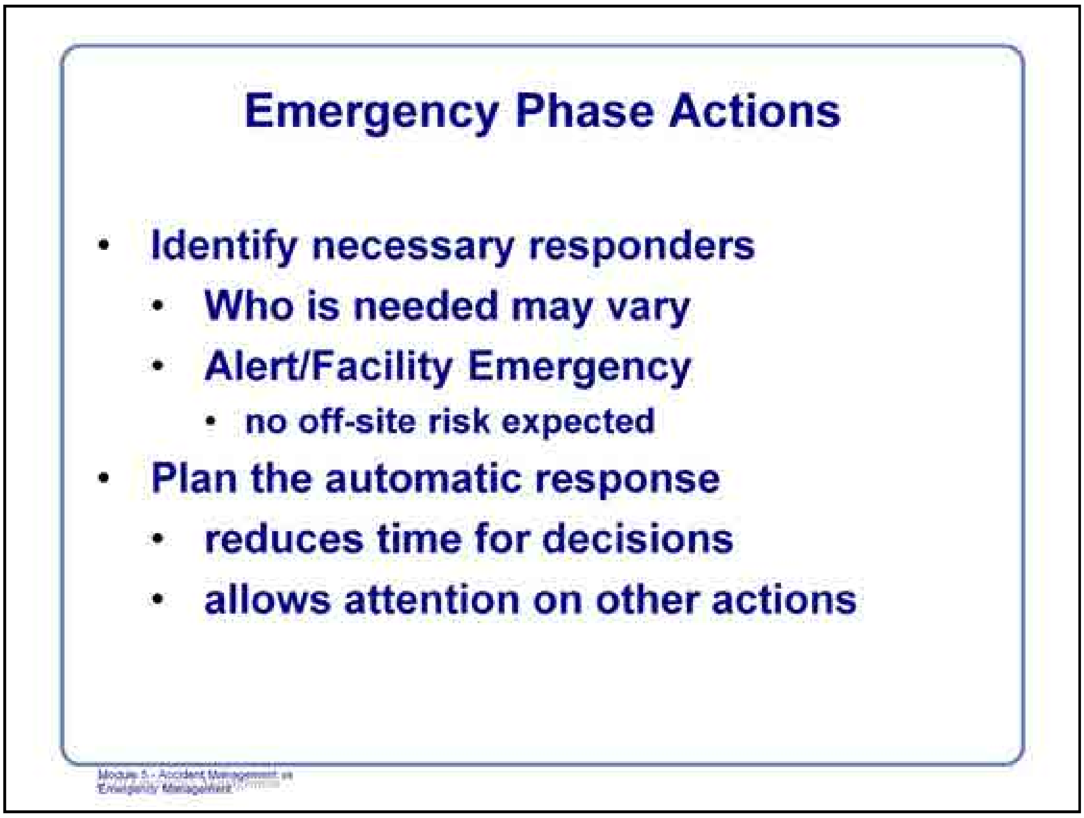


The Facility Response Manager must obtain information of the emergency conditions at once – without delay. This most likely comes from Control Room staff.

The initial information is used by the Nuclear Condition Analyst to classify, and recorded on the appropriate worksheets in EPR-RESEARCH REACTOR. The Shift Supervisor may also be acting in this role at the same time as fulfilling the role of Facility Response Manager.

The worksheets record the type of emergency and the classification. Eventually they will record information on core damage and containment condition.

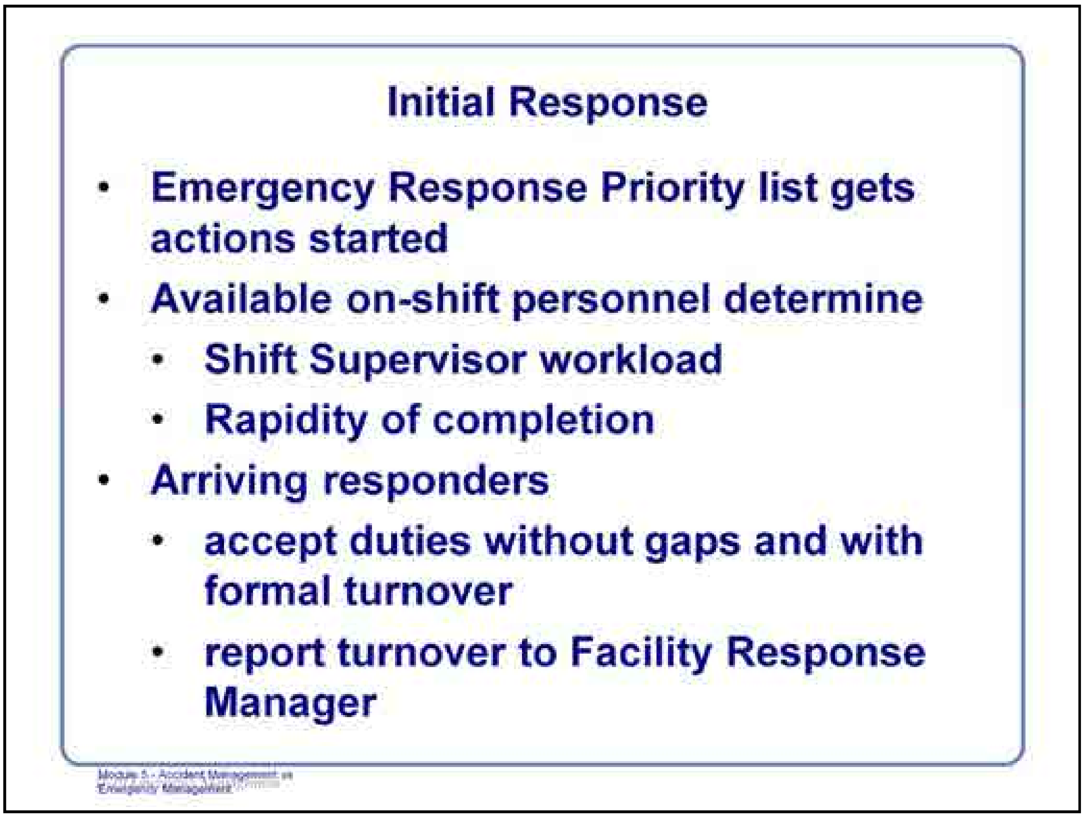
The Emergency Notification Record in EPR-RESEARCH REACTOR is designed to document who was notified at the direction of the Facility Response Manager and when. It is primarily for the purpose of recording that specific notifications went out, so when reviewed by the Facility Response Manager, he can verify all necessary notifications have been made, or could not be made.



The needed responders may not always be the entire response team. There are two competing thoughts on this:

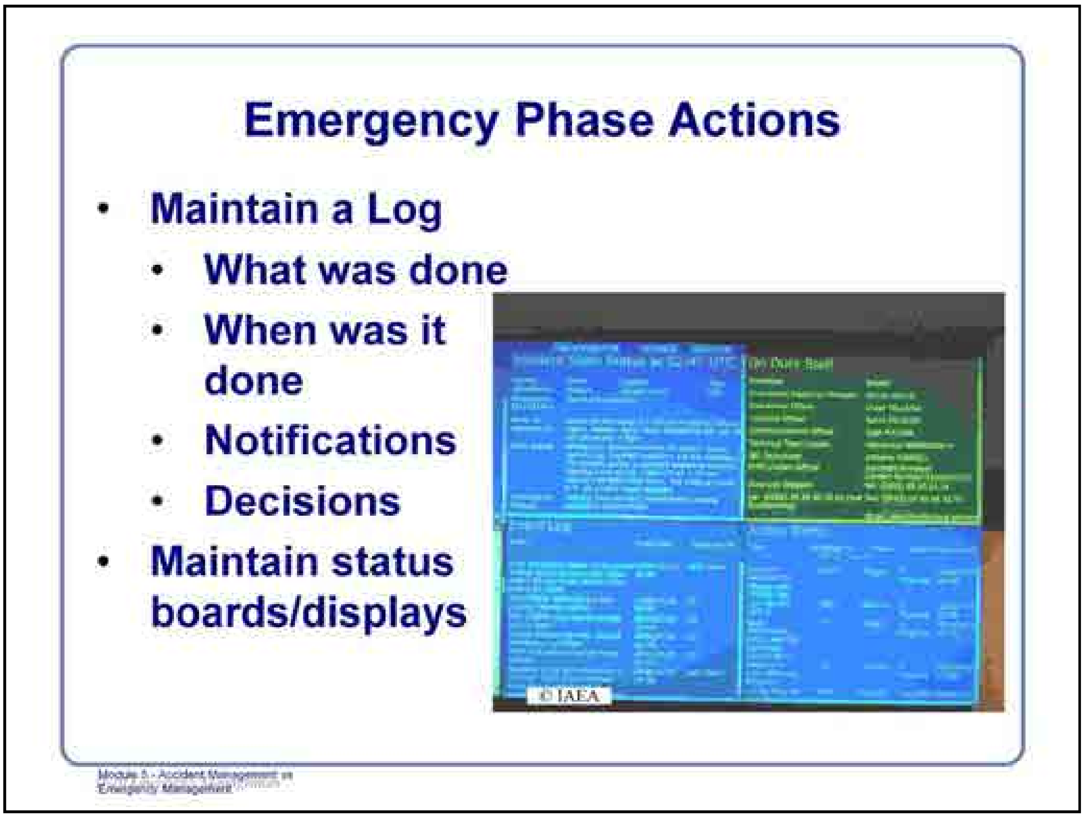
1. The emergency could escalate, and then time getting needed people to the plant has been lost. So it is best to call everyone, every time, then send the unneeded people home when the situation is clearer.
2. Why activate people not needed for the recognized situation? It is wasteful of manpower resources, clutters up the response center with people who have nothing to do, and generally causes ill feelings.

The Emergency Plan needs to address this. It may be as simple as a list of required positions matched against the type of emergency and class. However it is managed, it needs to be part of the plan so everyone involved knows what to do and what to expect.



Once actions are started, it is a matter of following the progress. Is corrective actions by the shift team effective? What are the incoming data showing, confirm or refute initial assessment?

Needless to say, the fewer on-shift people able to divert attention to the emergency response actions, the more urgent it becomes to get more people from off-site. As people arrive to take up the emergency response duties, turnover to them is very important so crucial information is not lost. Turnover needs formality so that there is always someone with the responsibility of the role. The Facility Response Manager needs to know at all times who is in which position, so once a turnover has occurred, the incoming person informs the Facility Response Manager. And a worksheet from EPR-RESEARCH REACTOR showing who is in each position should then be updated.



The Worksheets in EPR-RESEARCH REACTOR are designed to organize specific information and reduce the need for a log. There is also the need for a log that records more general information, even just reminders that have no other place to be recorded. This record keeping may be used later for evaluating the effectiveness of the response actions or for legal arguments.

Status boards need to be kept updated so the information is current. This may require additional people, although computers have made that somewhat simpler.

The Facility Response Manager needs to keep a detailed record of all actions and information received. This documentation may require an assistant if the emergency is sufficiently complex and extends over a long period of time. Also, in an extended response, this information is the necessary report of status, what has been done to date, that is essential for the oncoming replacement for the role of Facility Response Manager.

Research reactor emergencies do not occur frequently as compared to natural disasters and "normal" HAZMAT incidents. For this reason, when there is a research reactor emergency – the public and the media request a great deal of information quickly. If you do not get your story out, the media will get theirs out.

The Facility Response Manager may fill the role of information officer but in any significant emergency, it is best to have a staff member knowledgeable about radiation with the skills required to write press releases and conduct briefings/interviews. It is essential that the local authorities become actively involved in the media contacts and information releases. Locating the information center in an off-site location has two advantages:

•convenient to local authorities, and;

•keeps media out of the way of the facility emergency response team.

Timely and accurate public information is critical- it can eliminate rumours, calm the public, the media might even help by announcing the protective actions for the public to implement.

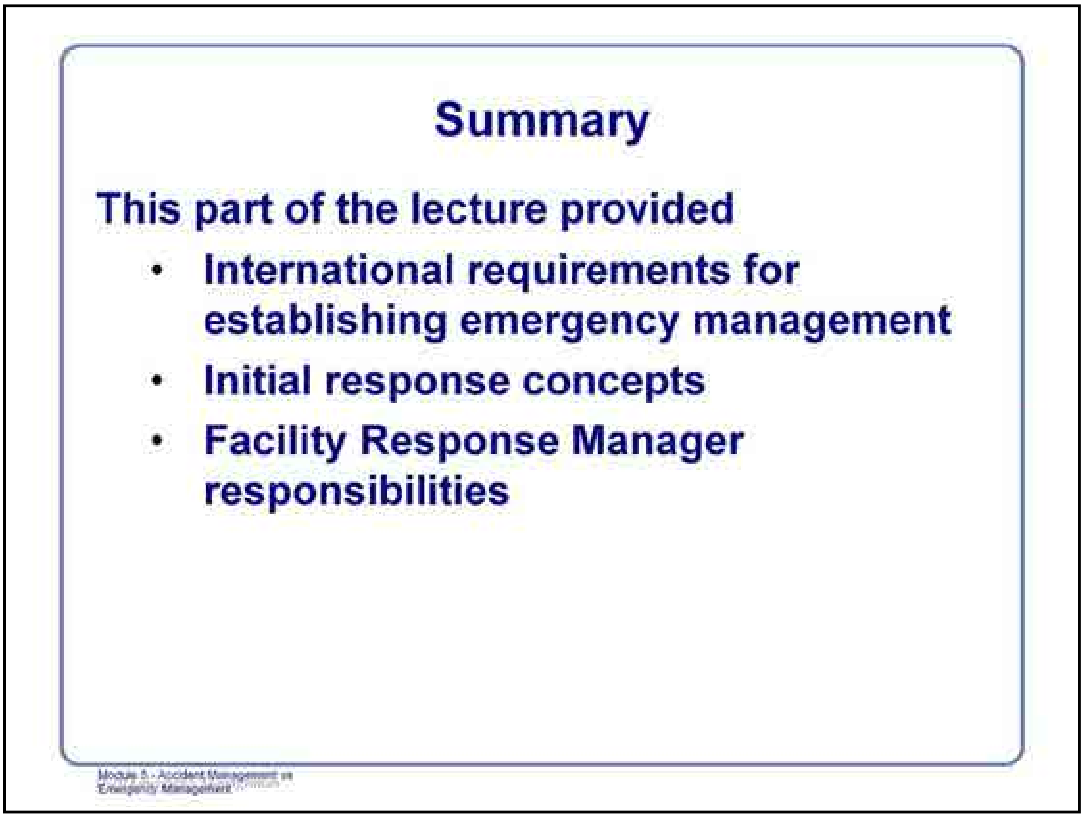
We will discuss further public information and media briefings/interviews in a later lecture (Module 8).

Question

So there's just been an emergency at your research reactor – how do you get the word out to the public and media? Do you currently have plans and procedures in place which answer the question?

The emergency will be terminated when there are no risks of additional releases, the plant is in a stable condition, environmental monitoring has identified all needed urgent protective action areas, and the off-site authorities and facility responders agree the emergency phase has ended. An acceptable recovery organization should also be defined and include all the affected organizations.

In EPR-RESEARCH REACTOR there are no post-emergency actions. Refer to EPR-METHOD.



In this lecture we covered specific information about the role of the Facility Response Manager as the leader of the facility response organization. The initial response includes:

•obtain information from the operations personnel on the shift;

•establish an emergency class, and;

•activate appropriate plant staff and off-site authorities.

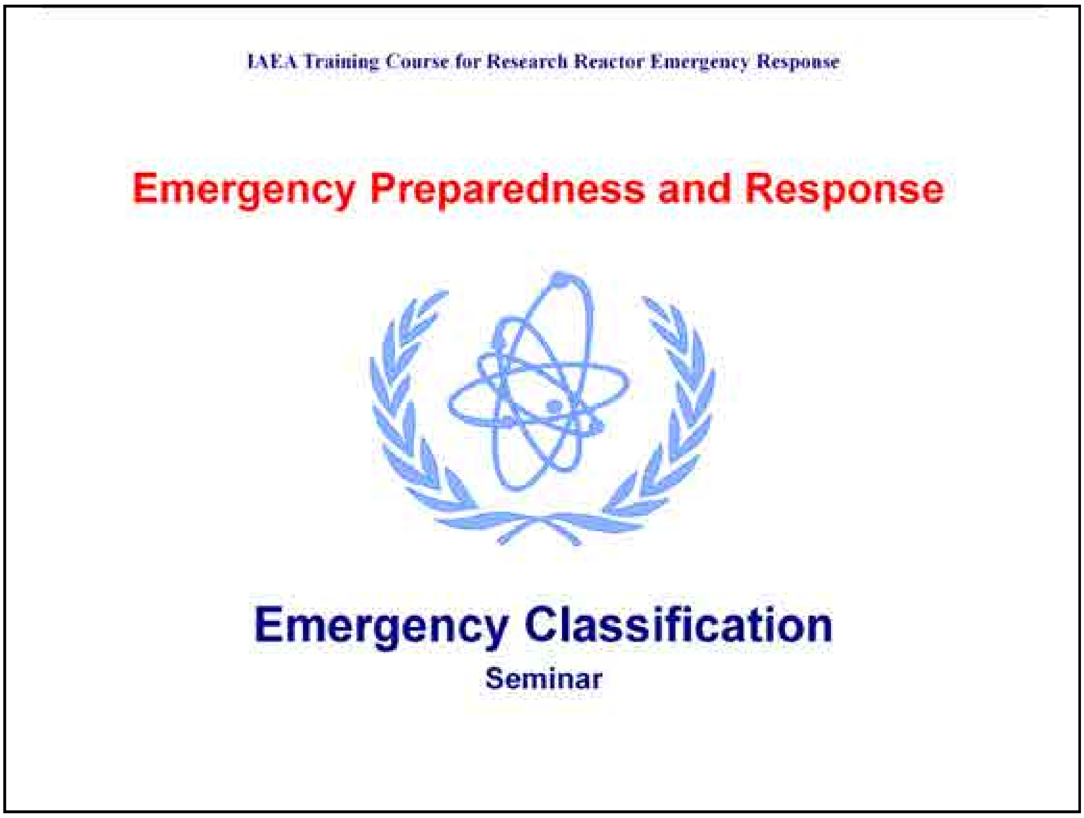
We then presented subsequent tasks in the emergency phase:

•work to priorities on the Emergency Response Priority list;

•maintain a log and record of immediate response actions;

•use the resources available, or call for assistance, and;

•provide timely and accurate information to the public and media.



Block 3: Emergency Preparedness and Response Overview

Module 6: Emergency Classification

Learning objectives: Upon completion of this module, the participants will:

- know the emergency classifications
- be able to use tools in IAEA EPR-RESEARCH REACTOR for emergency classification

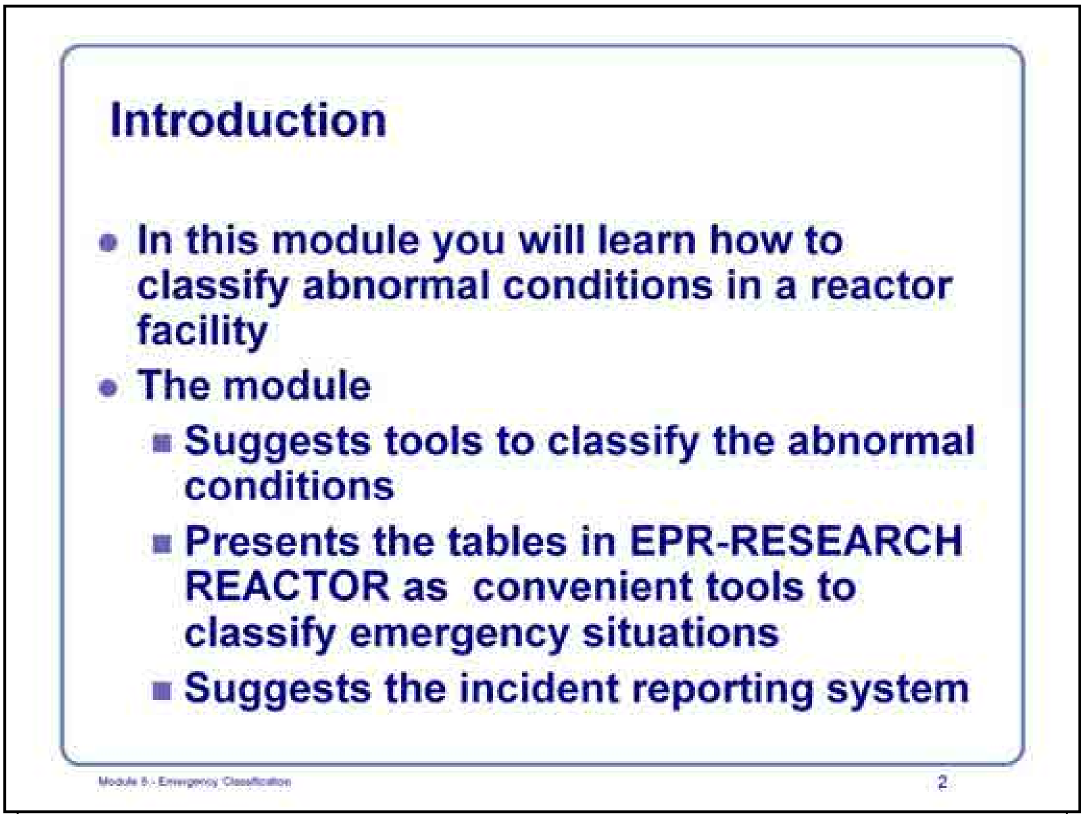
Activity: Seminar, questions and discussion

Duration: 1 hr

Materials and equipment needed: none

References:

1. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Response to a Nuclear or Radiological Emergency at Research Reactors, EPR-RESEARCH REACTOR, IAEA, Vienna (2011)
2. INTERNATIONAL ATOMIC ENERGY AGENCY, Preparedness and Response for a Nuclear or Radiological Emergency, Safety Standards Series No. GS-R-2, IAEA, Vienna (2002)

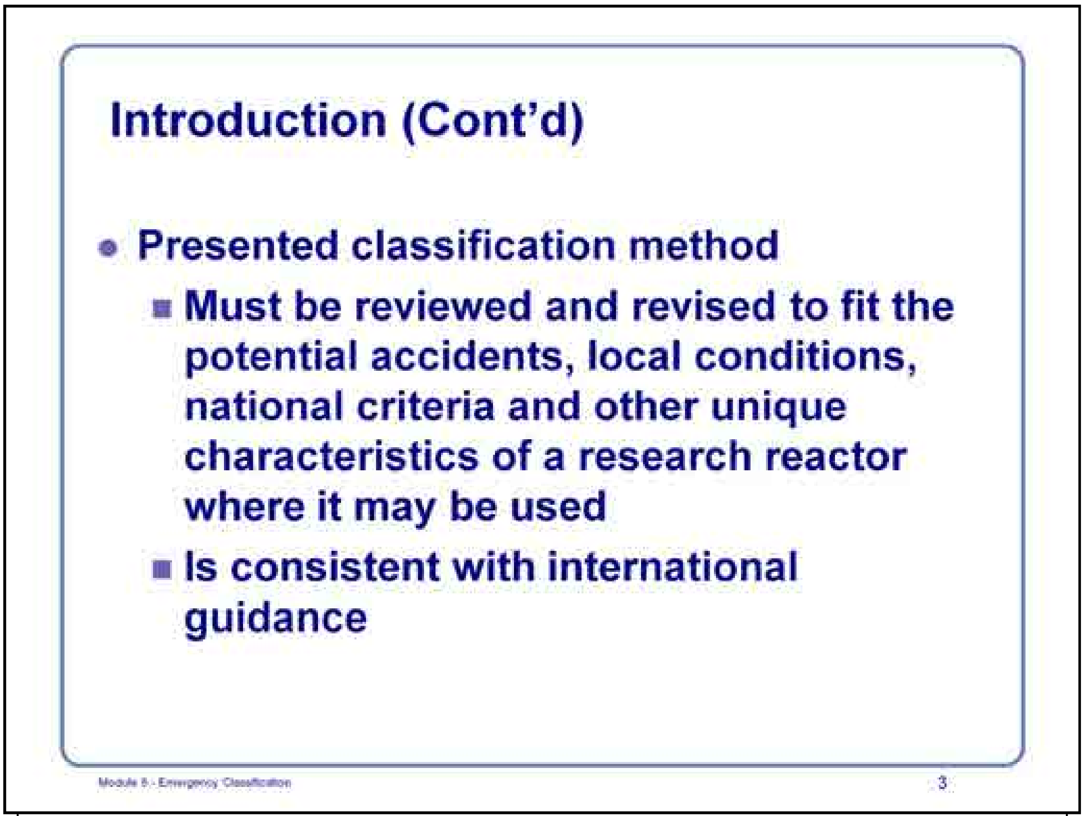


Lecture notes:

Each class of emergency should be associated with particular emergency action levels and with particular immediate actions to provide an appropriately graded response . In order of increasing severity, the four standard emergency classes should be described in qualitative terms:

- Alert
- Facility Emergency
- Site area emergency
- General emergency

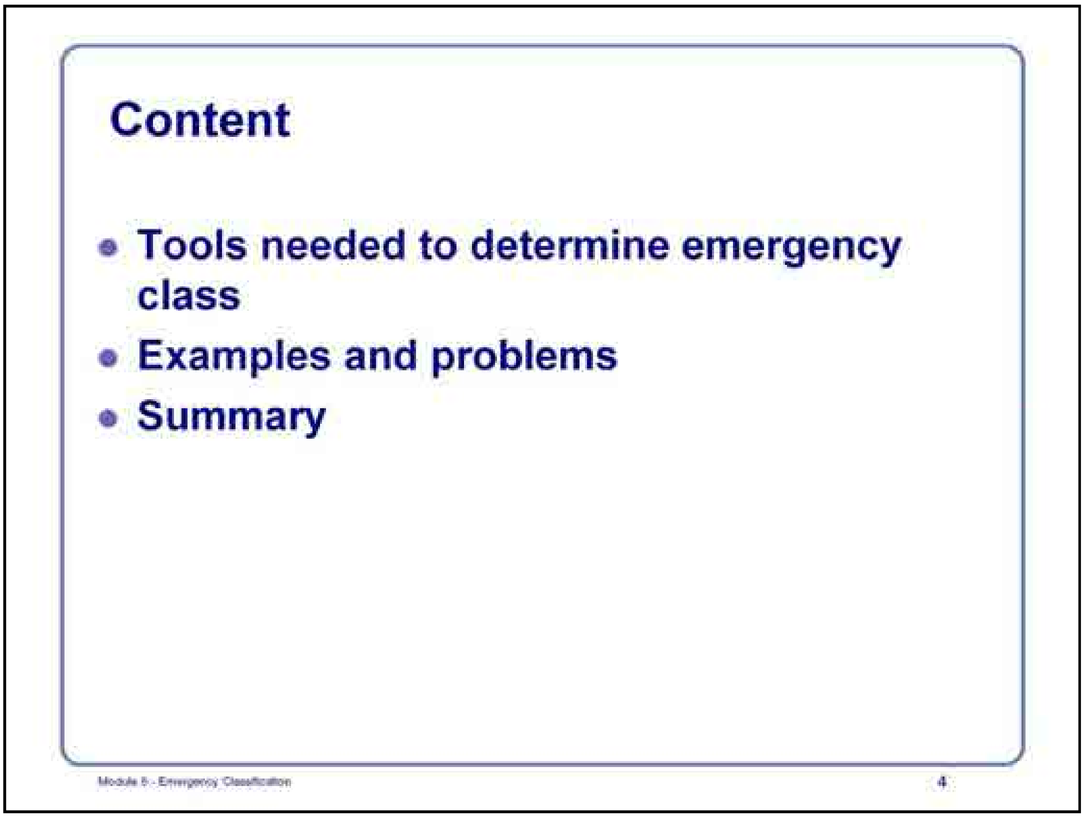
Because of the wide diversity in research reactors (power level, engineered safety features, site environment etc.) those condition which might initiate or signal a radiological incident having particular offsite consequences will vary widely among facilities.



Lecture notes:

Emergency response procedures describe four classes of emergency situations covering a spectrum of emergency conditions that involve the alerting or activating of progressively larger segments of the emergency organization. To provide for improved communication between the facility, state and local agencies and organizations, the most severe accidents are standardized

The classes of emergency conditions are distinct according to the severity of onsite and offsite radiological consequences. Each emergency plan should include only those standard classes appropriate for dealing with accident consequences determined to be credible for the specific facility. Most research reactors have potential emergency situations which may occur (e.g. personnel injury with contamination, fire, etc.) that have less severe offsite consequences than the least severe standard class. However, planning for onsite emergencies is important. Preparedness for these onsite emergencies should be accomplished by identifying them and including in the plan those elements of this standard commensurate with the postulated emergency situation.



Lecture notes:

Research reactor classification for the emergency response action level can be formulated from different point of view:

- potential emergency magnitude
- range of radiological consequences

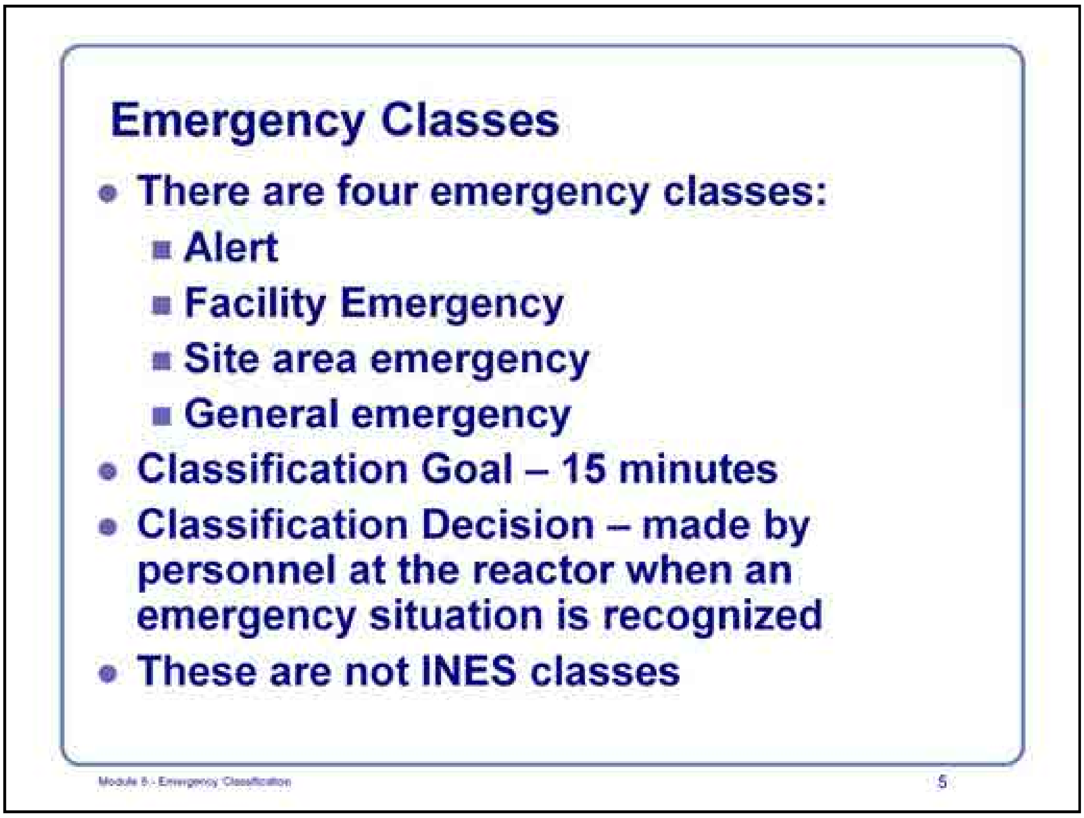
The first one depends strongly of the inventory of radioactive substances collected in the reactor core and/or spent nuclear fuel storage. It means depends of the reactor power and its operation history.

The second depends the scale of accident then the event generating the emergency situation.

Potential emergency magnitude considers the event character e.g. reactor power excursion, loss of coolant terrorist attack.

Emergency classification can be subjective, and that would be confusing if one site’s General Emergency was another site’s Site Area Emergency. The classification table is intended to standardize, to some extent, the classification process so the subjective nature is removed. A classification table also allows the emergency responders to immediately label the event in term of radiological consequences so the appropriate response is initiated more quickly.

The tables presented in IAEA EPR-RESEARCH REACTOR are useful for this purpose.



Lecture notes:

The table related to the emergency level classes is the main tool to classify the event and to make the Facility Response Manager understood to others who are asked to respond. It will be possible if the same classification has been used in the emergency planning and during the facility emergency training.

Nevertheless, the tables must be reviewed and revised to match site specifics and the emergency action levels should be replaced with a specific facility instrument readings, equipment status or other observable condition.

The use of the emergency classification scheme suggested in Table A.1 applies predetermined criteria to identify the level and scope of the radiological threat caused by the event.

Several items to note here:

Phone calls to managers not at the site to assign a classification should not be necessary.

The 15 minute goal for classification should not detract the attention of the operating organization from the first priority of regaining control of the reactor. IAEA requirements state that “The on-site emergency response shall be promptly executed and managed without impairing the performance of the continuing operational safety function.” This means that operating organization actions necessary to regain control of the reactor or reactor safety systems comes first. When all manpower resources are applied to this duty, additional manpower resources need to be assembled to initiate the emergency response. It is another way of saying that reactor emergency operating procedures are the first priority and emergency response procedures are second.

The classification level is associated with specific emergency response actions and those actions may not be correctly executed unless classification is promptly announced to all the responders.

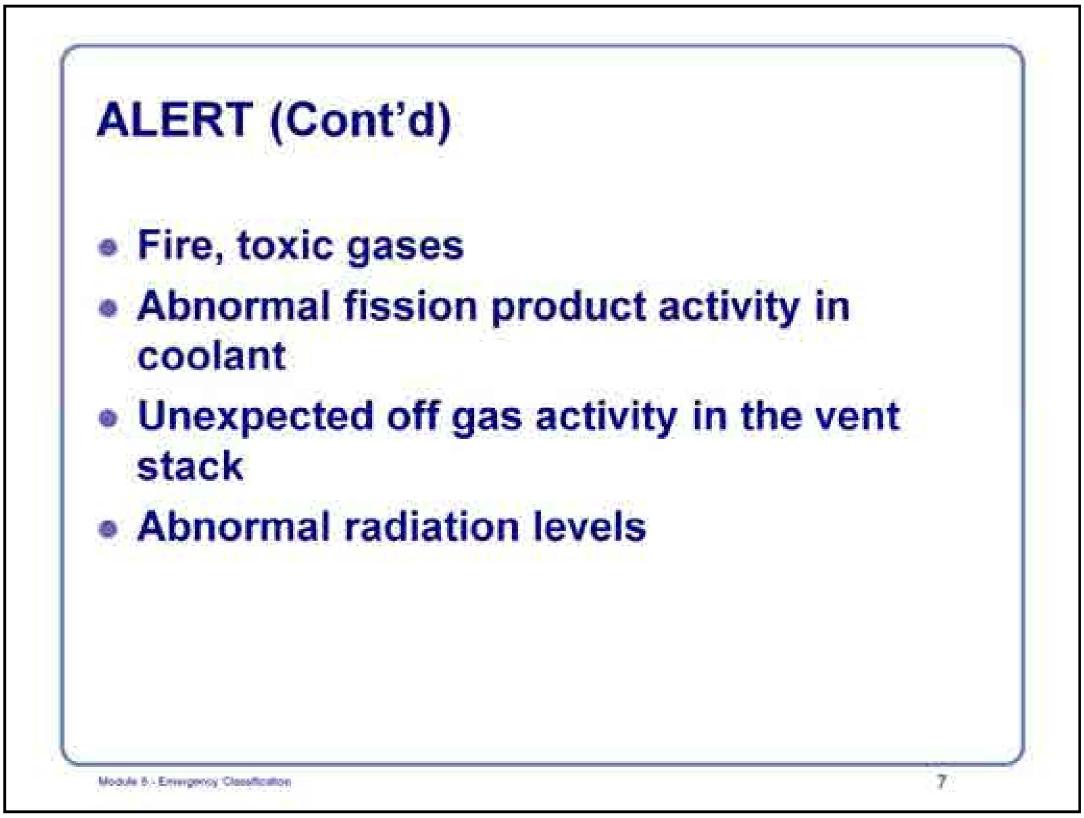
INES is a classification system that generates a rating only after considerable evaluation of the event, often days after the start of the emergency, and should not be confused with the classification that initiates the emergency response actions.

Lecture notes:

The less dangerous accidents need only notification to the Nuclear Regulatory Authority, to local authorities or to others which can be asked to participate into the emergency action.

An alert is appropriate when an uncertain or significant reduction in the level of protection for the public or for on-site personnel has occurred.

Notification of an alert may be initiated by either man-made events or natural phenomena that can be recognized as creating a significant hazard potential that was previously nonexistent. There is usually time available to take precautionary and corrective steps to prevent the escalation of the emergency or to mitigate the consequences should it occur. No release of radioactive material requiring off-site responses are expected. One or more elements of the emergency organization are likely to be activated or notified to increase the state of readiness as warranted by the circumstances, particularly if some support from off-site organizations is required. Although, the situation may not have caused damage to the reactor, it may warrant an immediate shutdown of the reactor. Reactor Emergency Operating Procedures will establish that response.



Lecture notes:

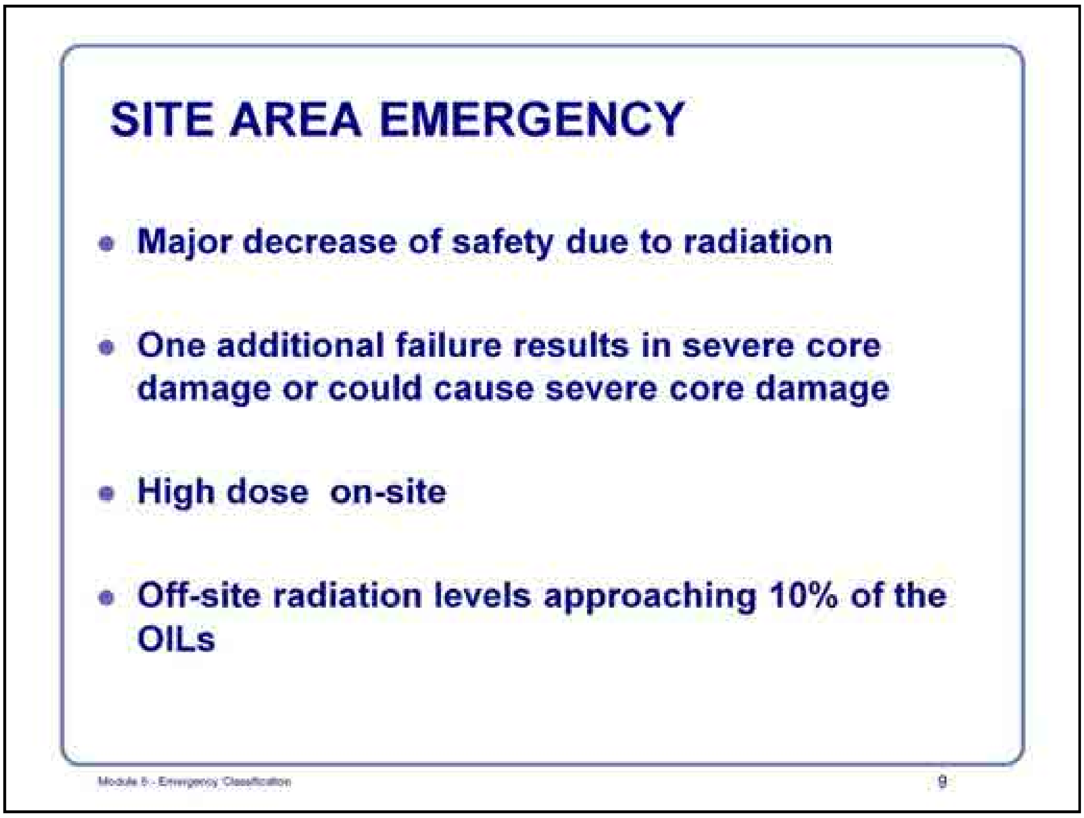
Situation that may lead to this emergency class include threats to or breaches of security, such as bomb threats or civil disturbance directed toward the reactor; small fires prolonged, unexpected nuclear fuel damage indicated by higher fission product concentration in reactor cooling water or higher then normal gas activity in the air of the ventilation stack. Natural phenomena such as tornados in the immediate vicinity of the reactor, hurricanes or earthquakes felt in the facility can also be reason to introduce the notification procedure.

An alert implies that there is an abnormal situation that could pose a risk to the on-site personnel. Events such as a small, well contained spill or a minor personnel injury usually do not create a risk to these individuals or to the public. Major injuries, especially with contamination, while perhaps not a risk to other personnel, do require coordinated action with off-site support and would appropriately be an Alert with a need for an emergency response team to efficiently control the response. The below class events may still be reportable depending upon local or national regulations, but are not serious enough to assemble any part of the emergency response team.

Lecture notes:

A Facility Emergency is activated in case of events involving a major decrease in the level of protection for on-site personnel. At this class the state of readiness of the on-site and off-site response organization is increased and additional assessments are made.

Events leading to an facility emergency would be of such radiological significance as to require notification of emergency organization and their response as appropriate for the specific emergency situation and may warrant protective actions within the site area. Under this class it is not expected that off-site response or monitoring would be necessary, except to verify no radiological risk to the off-site population. Substantial modification of reactor operating status is a highly probable correction action. Protective evacuation or isolation of certain areas within the operation boundary or within the site boundary may be necessary.

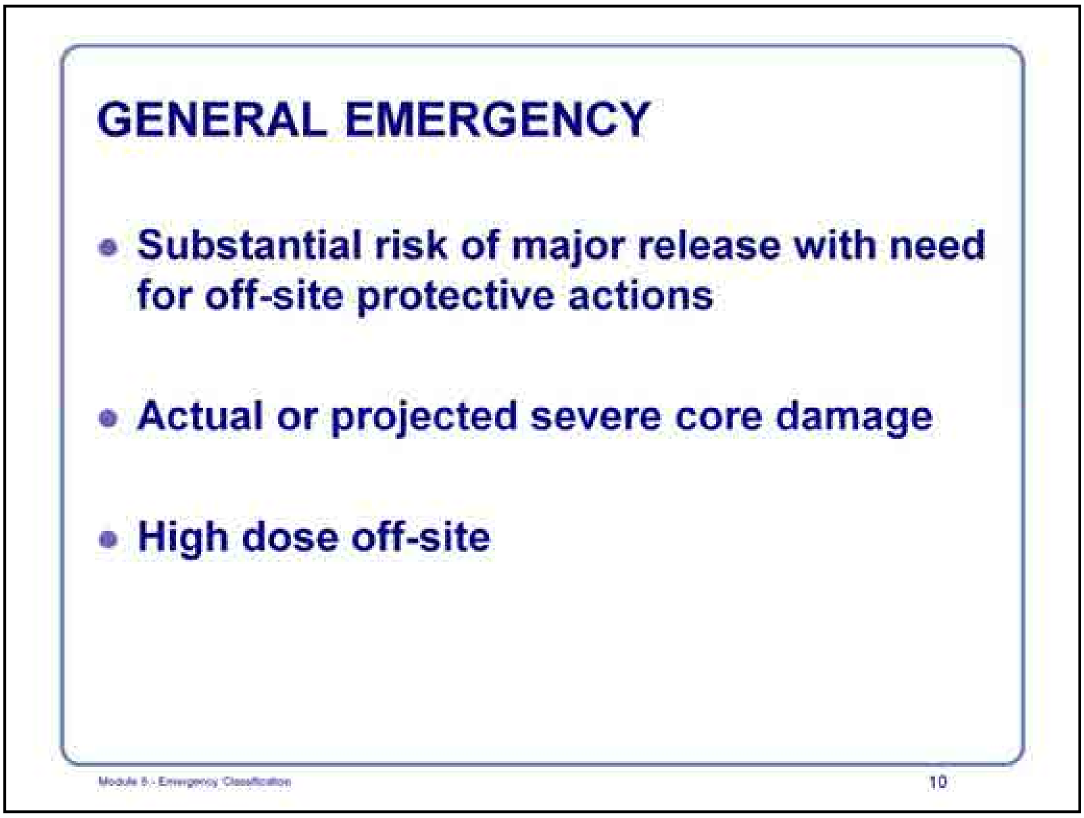


Lecture notes:

This is the lowest level of emergency that poses an off-site risk.

Site area emergency declarations are justified when events are resulting a major decrease in the level of protection for the public or on-site personnel. This includes a major decrease in the level of protection provided to the core or large amounts of spent fuel, condition where any additional failures in damage to the core or spent fuel or high doses on-site or doses off-site approaching the urgent protective action intervention levels. At this class action should be taken to control the dose to on-site personnel and preparation should be made to take protective actions off-site (within the UPZ).

A site area emergency may be initiated when events such as major damage of fuel and cladding and actual or imminent failure of other physical barriers containing fission products in reactor fuel or fuelled experiments have occurred actual or projected on-site radiation levels at site boundary of 0.1 mSv/h whole body. Monitoring at the site boundary and potentially in the off-site UPZ should be conducted to asses the need for off-site protective actions. Protective measures on-site may be necessary.



Lecture notes:

General emergency is declared when events are resulting in an actual or substantial risk of a release requiring implementation of urgent protective action off-site. This includes : actual or projected damage of the core or spent fuel or release off-site resulting in a dose exceeding the urgent protective action intervention levels. Urgent protective action may be recommended immediately for the public near the reactor when this level of emergency is declared. Decision should be based on prior evaluation of PAZ and UPZ potential exposures and OILs. Environmental monitoring is usually obtained to determine the need for urgent protective actions within the UPZ and to assess the need for longer term protective actions.

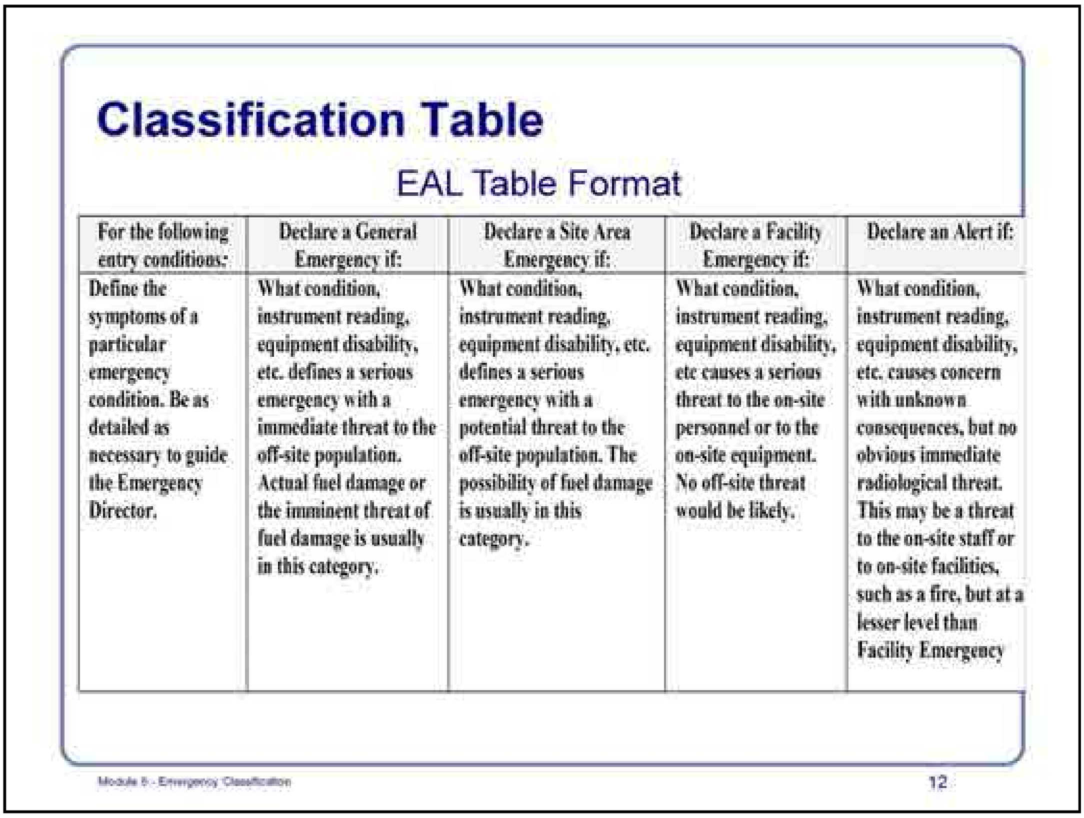
Upon declaring a General Emergency, evacuation, sheltering and thyroid blocking should be considered close to the reactor as pre-planned. The goal is to take action before a release.

In case of General Emergency declaration the nearby countries should also be notified.

Basis for the Classification Table

- The Table provided is an example, not a set of required conditions and associated classification criteria
- It shows a wide range of emergency situations with suggested classifications
- Make it your Table by
  - What are the emergency situations
  - What are the potential severity criteria, as detailed as necessary

Lecture notes:



For the following entry conditions:	Declare a General Emergency if:	Declare a Site Area Emergency if:	Declare a Facility Emergency if:	Declare an Alert if:
Define the symptoms of a particular emergency condition. Be as detailed as necessary to guide the Emergency Director.	What condition, instrument reading, equipment disability, etc. defines a serious emergency with a immediate threat to the off-site population. Actual fuel damage or the imminent threat of fuel damage is usually in this category.	What condition, instrument reading, equipment disability, etc. defines a serious emergency with a potential threat to the off-site population. The possibility of fuel damage is usually in this category.	What condition, instrument reading, equipment disability, etc causes a serious threat to the on-site personnel or to the on-site equipment. No off-site threat would be likely.	What condition, instrument reading, equipment disability, etc. causes concern with unknown consequences, but no obvious immediate radiological threat. This may be a threat to the on-site staff or to on-site facilities, such as a fire, but at a lesser level than Facility Emergency

Lecture notes:

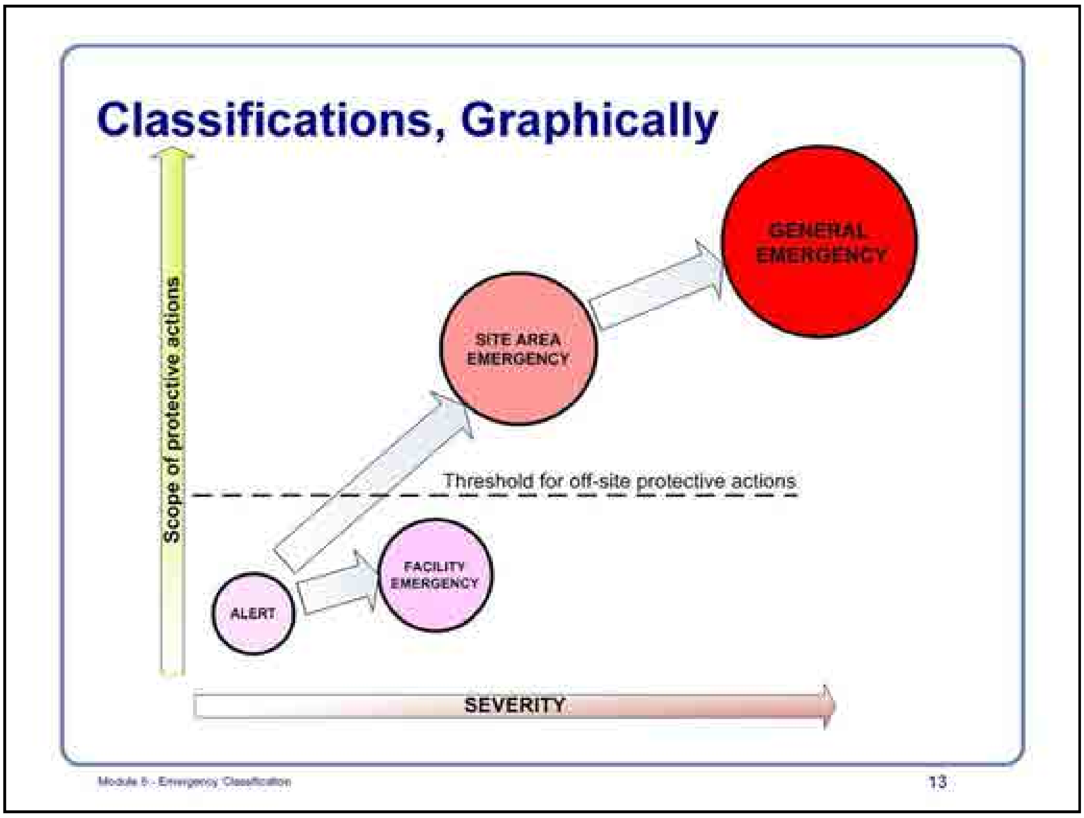
For research reactors of less than 2 MW power, strip off the top two classes.

Realize that there are often blurred lines between classes, and also realize that additional information on the emergency can cause a change in classification, in either direction.

The guidelines give suggested descriptions for the potential emergencies. The individual site can make the descriptions more detailed, specific values on specific instruments, for example, to suit their needs. One should consider just how rigid the descriptions should be. Some room for the judgement of the Emergency Director should be considered.

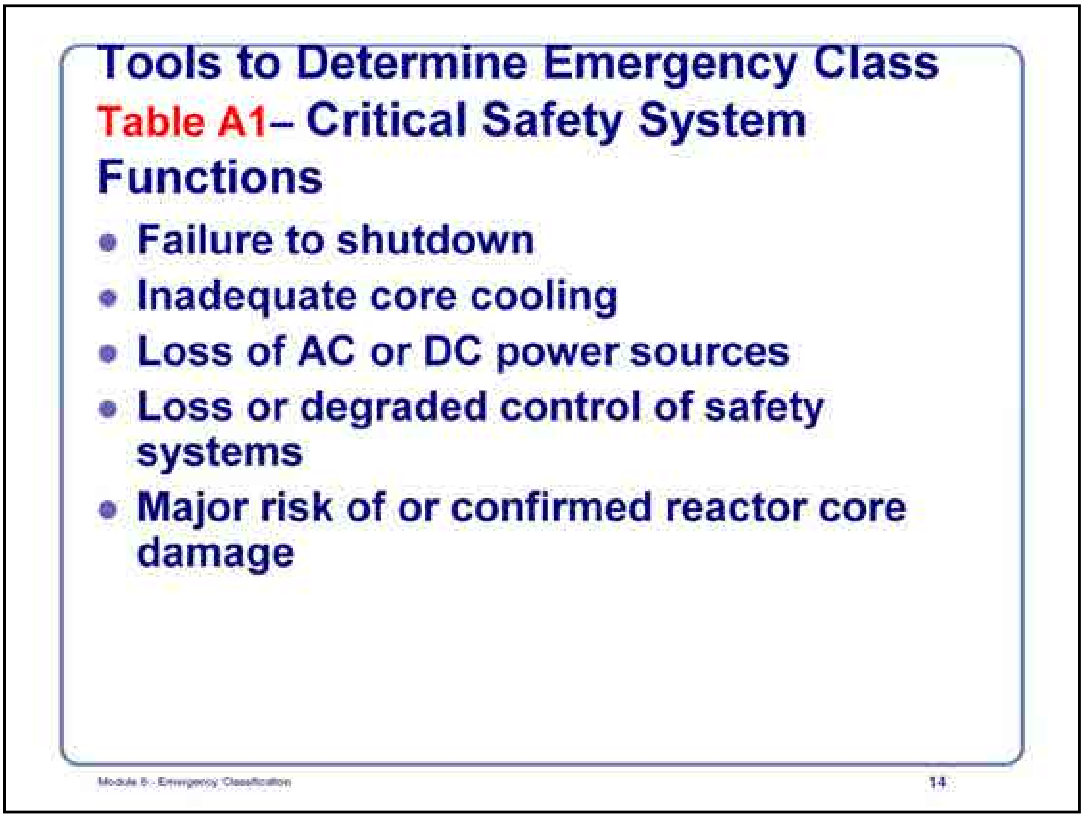
Note here that fuel damage shows up as a Site Area Emergency or a General Emergency, depending upon the potential for it to occur. For a Threat Category III site, this would be a Facility Emergency, at most, since the effects would be limited to the site itself.

Severity criteria for a particular entry conditions may use all four classes. It is also possible for some entry conditions to jump directly to Site Area Emergency when a more severe set of conditions than for an Alert threaten the off-site population. At small research reactors it is reasonable for some entry conditions to never become more severe than Alert or Facility Emergency.



Lecture notes:

Here is a graph for the classification categories. Note that some emergencies have Alert severity, then jump to Site Area Emergency severity with no Facility Emergency level of severity. That can occur if the severity change threatens the off-site population.

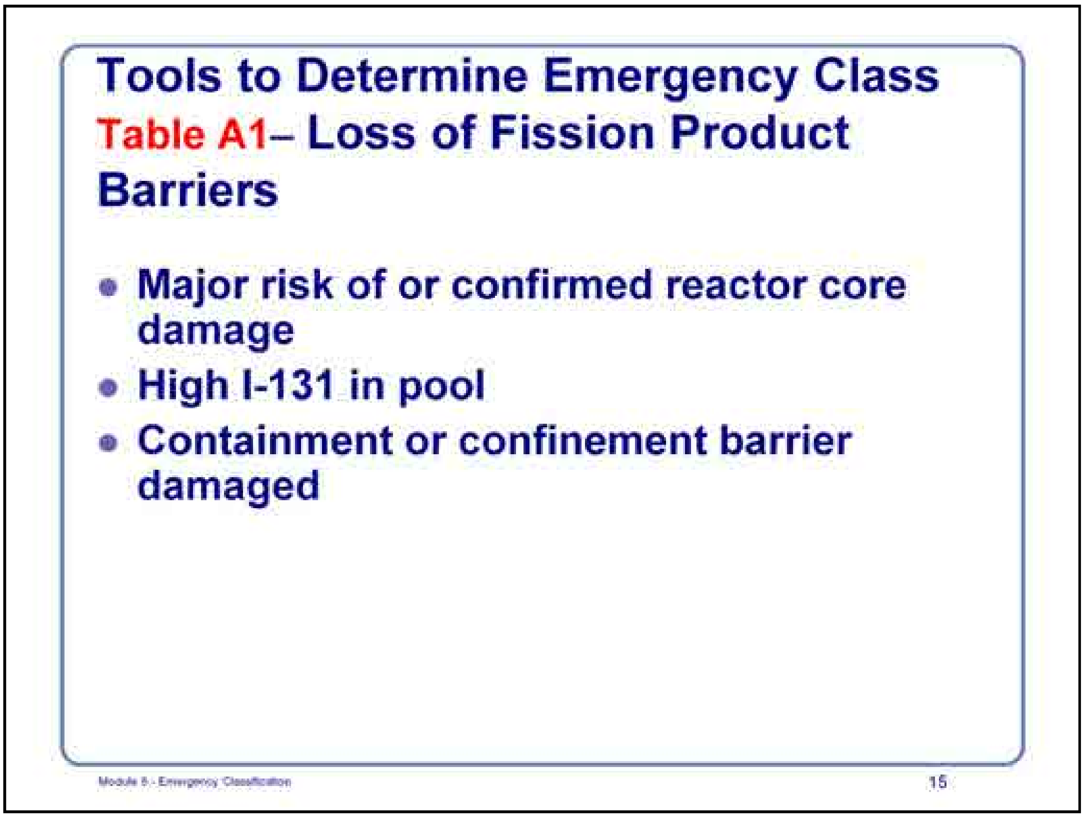


Lecture notes:

For this presentation the potential entry conditions have been organized in four categories;

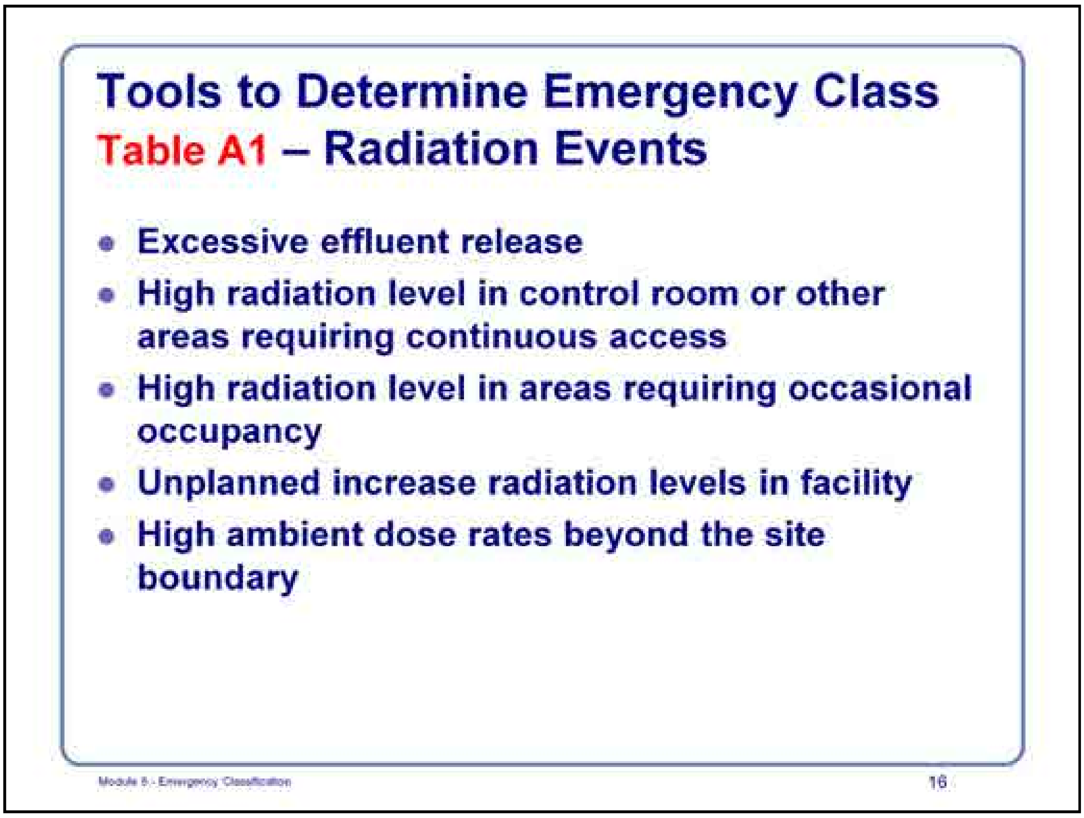
- Critical Safety System Functions, shown here;
- Loss of Fission Product Barriers;
- Radiation Events and;
- External and other Events.

It isn’t necessary to use the same wording as on the provided Table A1. The example Table A1 is there to provoke evaluation by the reactor site that is planning to build its own equivalent table.



Lecture notes:

These are the types of events in the category of Loss of Fission Product Barriers. The pool water is treated as a barrier because of the ability to retain many of the fission products if the fuel cladding was damaged. Also, I-131 in the pool confirms that that has occurred.



Lecture notes:

Abnormal radiation levels within the reactor facility as a measure of severity should be characterized by specific values, readings on specific instruments, for example. What may be a low level emergency when abnormal radiation levels occur in some areas where only infrequent access is required may be more threatening if those same radiation levels occur in the Control Room and threaten operator safety, or necessitate evacuation of the Control Room which may prevent monitoring the condition of the reactor and reactor systems.

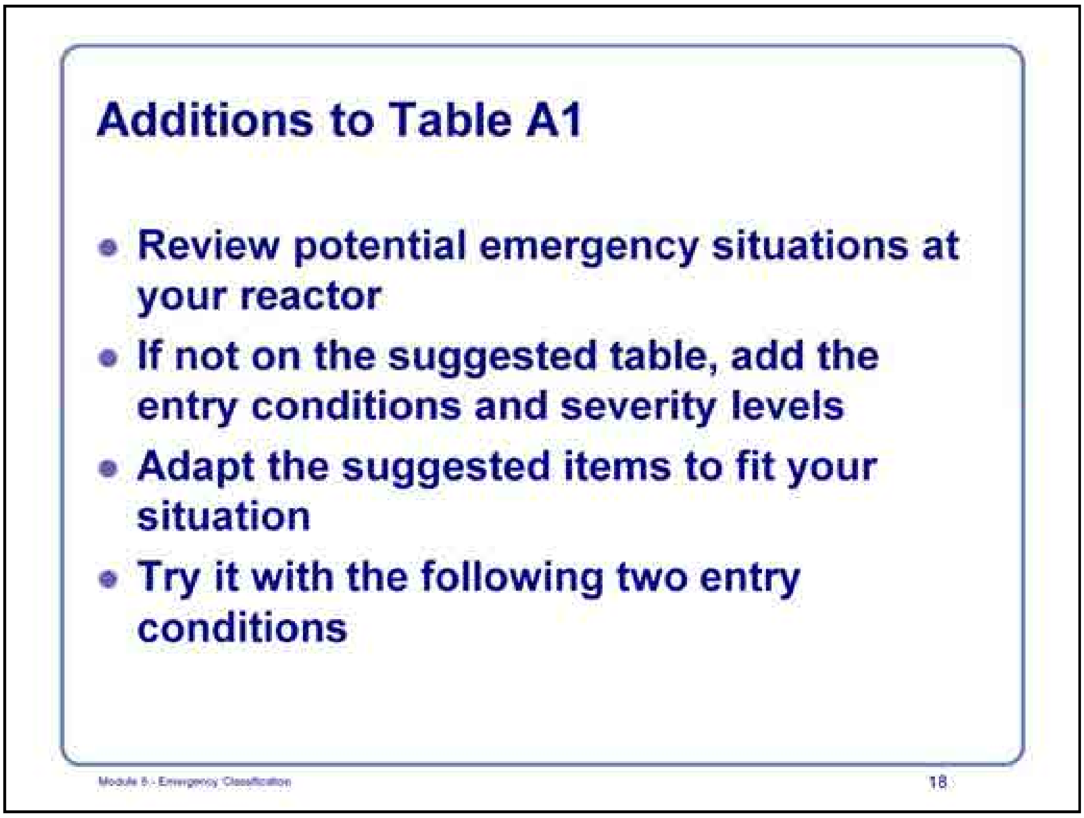
Another case to mention and comment is the unplanned increase of radiation level beyond the facility boundary. This could occur due to a release from the reactor. For example, an emergency originally classified as Facility Emergency should be elevated to Site Area Emergency or General Emergency if the environmental monitoring detects radiation levels above or approaching levels that require urgent protective action off-site.

Lecture notes:

The fourth category gathers events of several types, some of which may not involve, but threaten, damage to the reactor, hazard to the operators, or other risks.

It can be difficult to classify the reactor accidents based on natural events because the event magnitude can vary. The classification should consider the observed event consequences in the nuclear parts of the reactor facility. If a tornado, or high winds for instance, destroy the reactor ventilation stack the reactor may not be able to operate but it is no reason to declare a nuclear emergency. Further, anticipated severe weather should cause preventative actions that are intended to minimize the potential for damage that creates a more severe emergency.

The external events also require an evaluation of the effect of problems at neighbouring facilities, including non-nuclear ones. A reactor site near a large chemical plant may have more concerns with emergencies at the chemical plant that with the reactor. That evaluation needs some coordination with the emergency plan at the chemical plant, such as how the reactor operating staff are warned of releases from the chemical plant and the level of risk from the plant. For example, one research reactor facility judged its major threat was from a forest fire since the facility was completely surrounded by forest.



Lecture notes:

The Safety Analysis report that each research reactor should have can help define the accidents that are most likely to occur and the consequences. However, even low probability accidents should be represented in the Table to provide guidance to the facility. Accidents that were never expected have occurred and usually result in a confused, ineffective, and poorly considered response just because there was no guidance or recognition of the potential consequences. Listing those events on Table A1 may not provide all the guidance needed, but can help direct the emergency response team to a carefully considered emergency classification which can then trigger appropriate protective actions.

Example EAL Table entry

For the following entry conditions:	Declare a General Emergency if:	Declare a Site Area Emergency if:	Declare a Facility Emergency if:	Declare an Alert if:
Inadequate core cooling – Pool/tank level , such as pool or tank leakage greater than capacity of make-up water system, inadvertent drainage of pool/tank	Pool/tank water level is, or is projected to be, below top of active fuel for greater than *[insert site specific time period to cause release of fission products from fuel elements]* minutes.		Pool/tank water level is or is projected to be below top of active fuel.	Pool/tank water level decreasing over a longer time period than expected while systems are responding as designed.

[1] Inadequate core cooling is characterized by two kinds of entry conditions – Pool/tank water level and decay heat removal capability.

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Lecture notes:

Example EAL Table entry

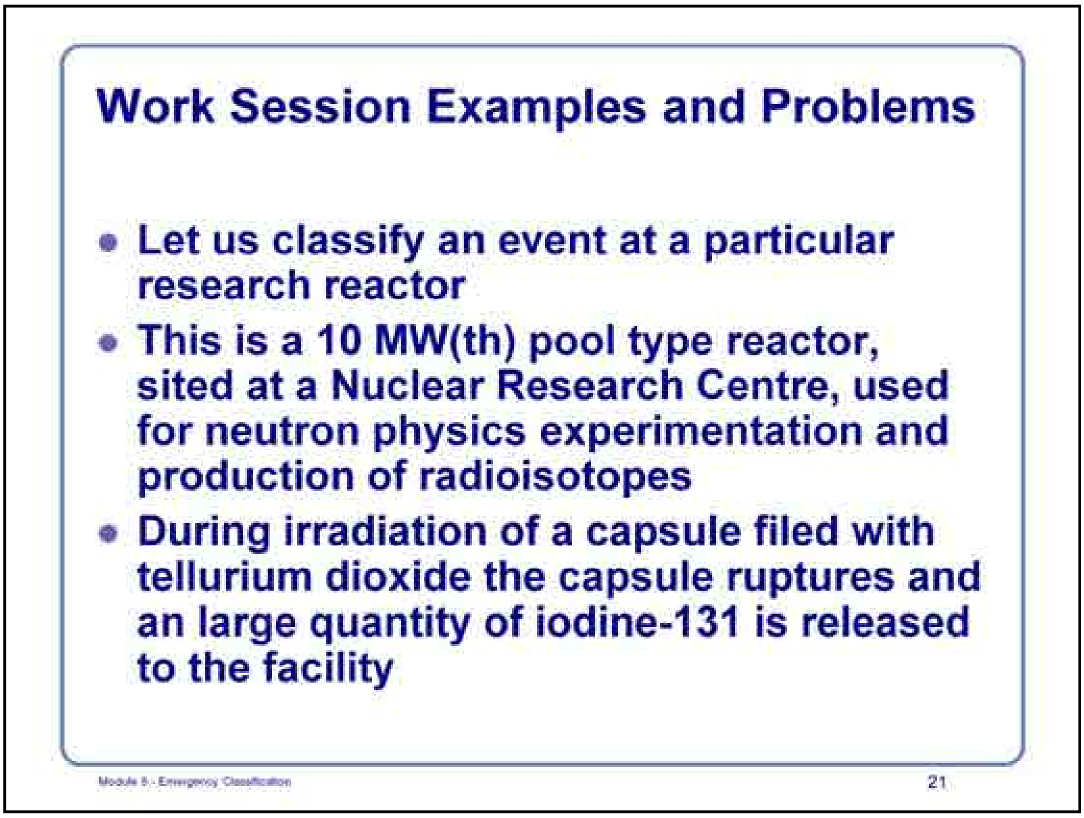
For the following entry conditions:	Declare a General Emergency if:	Declare a Site Area Emergency if:	Declare a Facility Emergency if:	Declare an Alert if:
Inadequate core cooling[1] – Loss of decay heat removal capability, such as failure of primary or secondary circulating pumps, failure of heat exchangers or valves required for decay heat removal, fuel channel blockage, loss of emergency core cooling system	Absence of ability to transfer decay heat to the environment for [*site-specific time for fuel temperature to exceed design values with only ambient losses available for decay heat removal*] and *Abnormal* increases *(100 - 1000x) in multiple radiation monitors* or other indications of imminent or actual core damage[2]		Actual or projected long term failure of the ability to remove decay heat to the environment potentially affecting the ability to protect the core	Unavailability of normal system for decay heat removal

[1] Inadequate core cooling is characterized by two kinds of entry conditions – Pool/tank water level and decay heat removal capability.

[2] Consideration of containment boundary status might be considered as further additional criteria

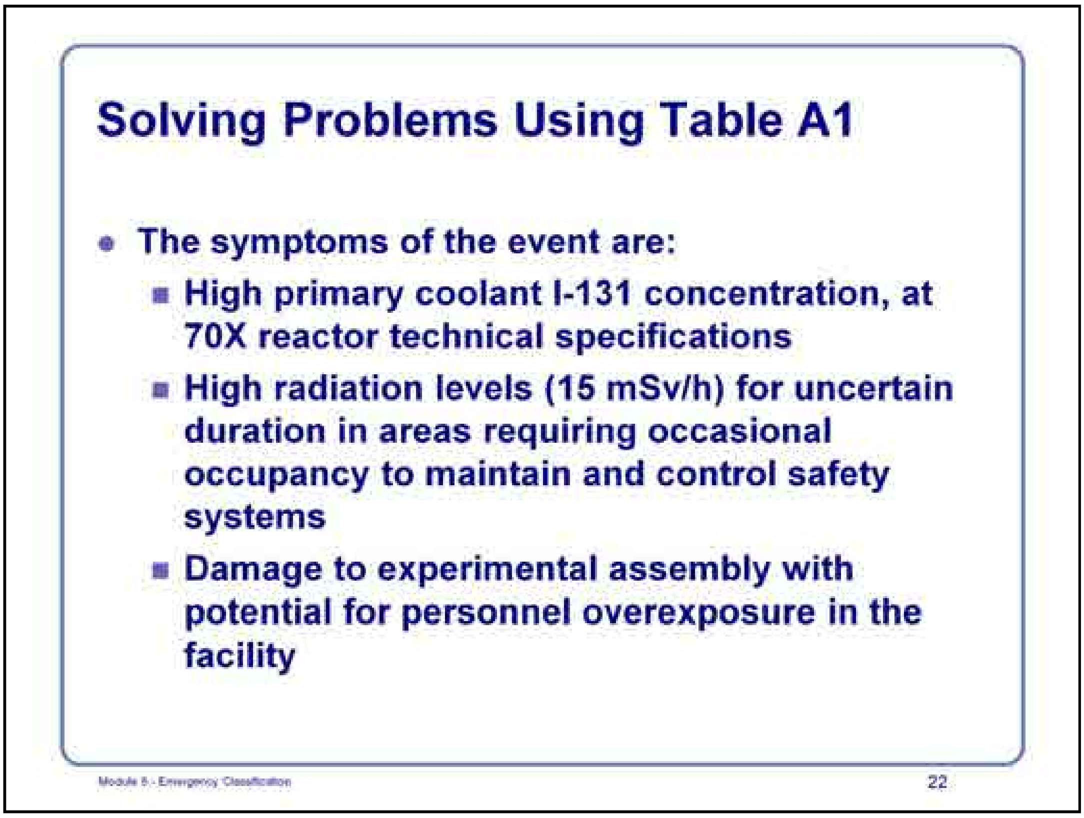
Module 6 - Emergency Classification 20

Lecture notes:



Lecture notes:

As an example of the use of the classification table in EPR-RESEARCH REACTOR, consider this facility and a failure of experimental hardware.



Lecture notes:

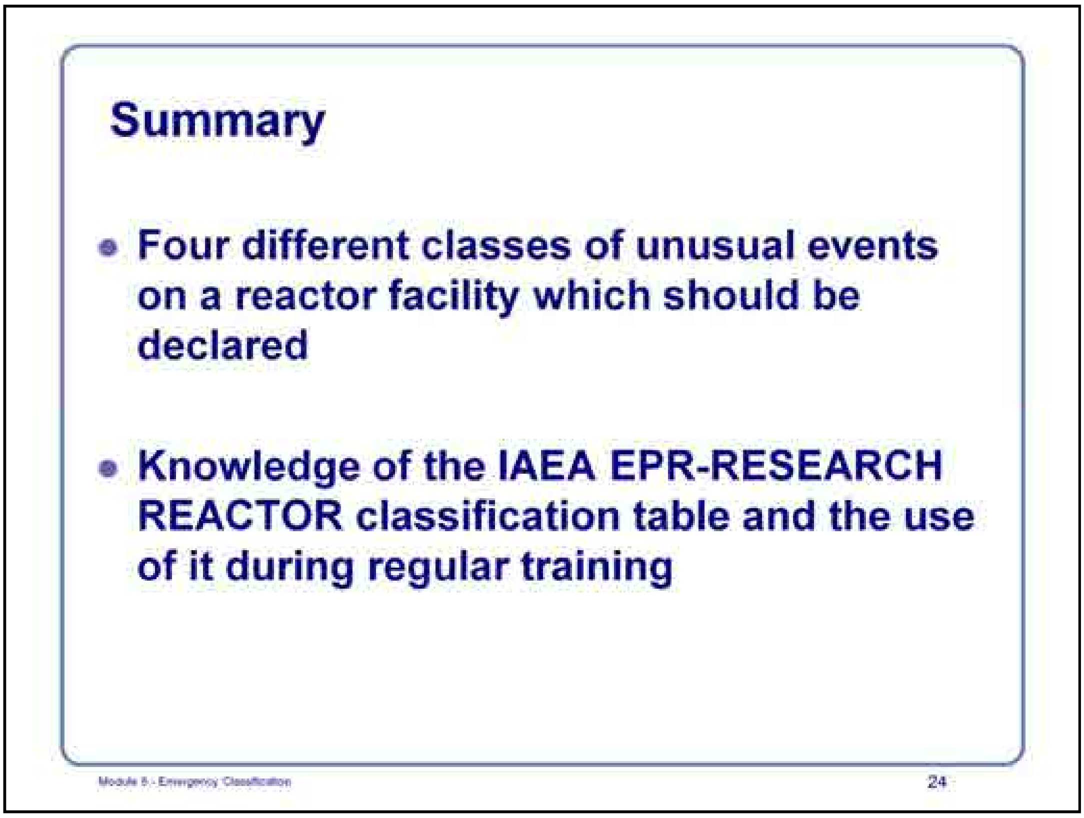
The observed conditions are as shown on the slide. The decision for the facility is to determine the appropriate emergency class for this event. The applicable decision assistance tool is Table A.1 in Part 1 of EPR-RESEARCH REACTOR. Let’s look at each observed symptom that the operators have available and determine if the table includes that condition. The result will be an emergency class assigned to this event and communicated to the off-site authorities.

Lecture notes:

Why Site Area Emergency?

High I-131 is only an Alert on Table A1. Experiment assembly failure is only a Facility Emergency. However, the highest applicable classification is the one that is assigned. In this case that is the >10 mSv/h in occasionally occupied areas, due to the uncertainty of the duration of that dose rate.

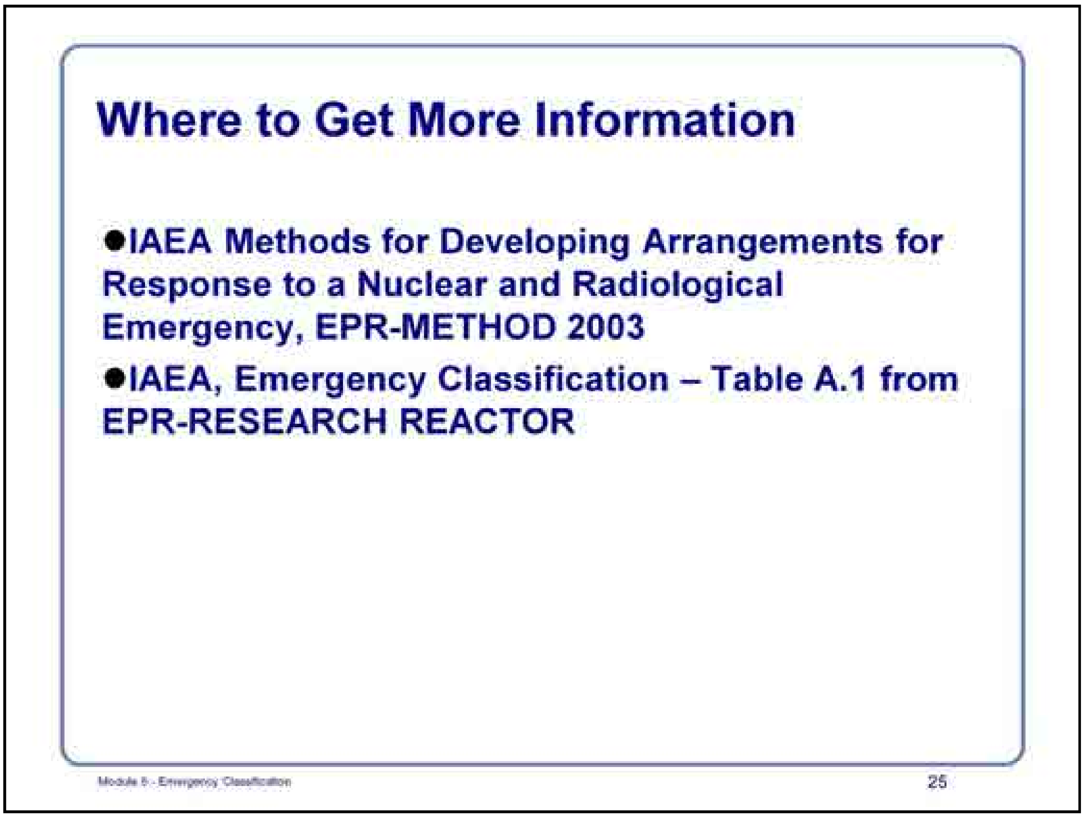
Also, consider that the emergency class will depend on how the details are developed in your version of the table. In this case, the emergency class determined from the observed condition and the decisions incorporated in the table, mean there is a threat to both the on-site and the off-site population. Your version of the table may assign a different class to the event depending on the evaluation of the level of threat to these two populations.



Lecture notes:

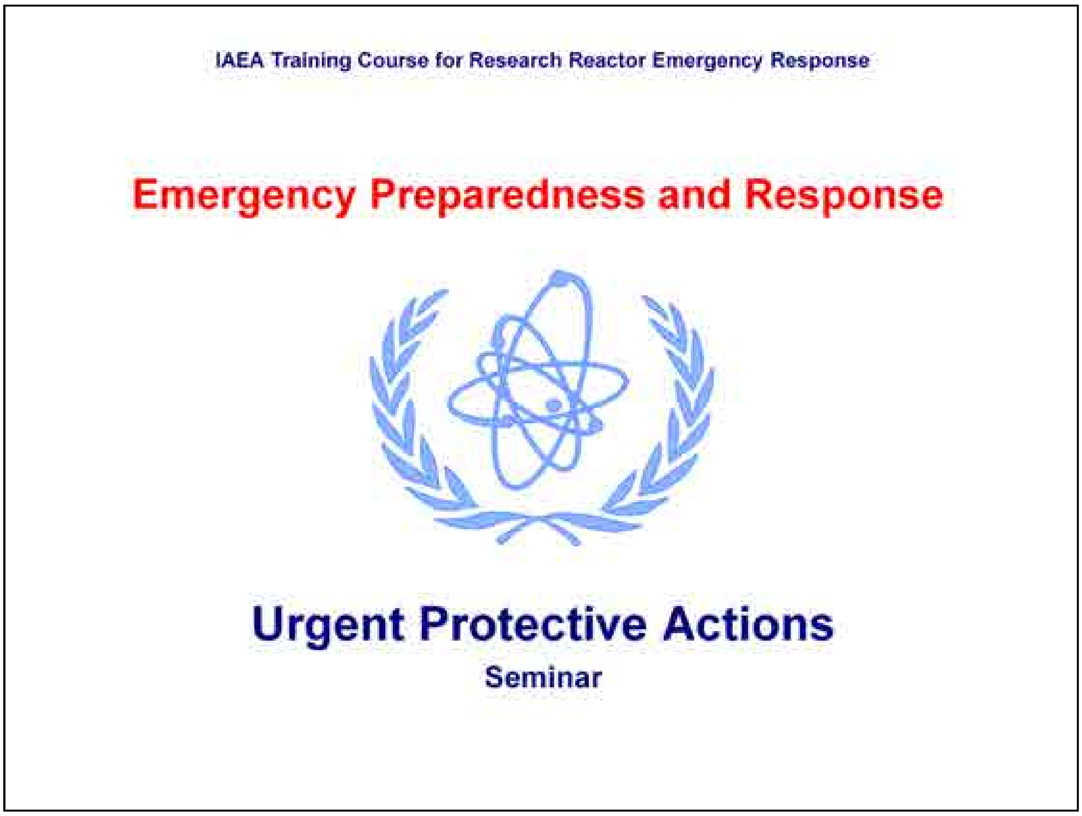
Let’s summarize the main subjects we did cover in this session.

- We need the emergency classification to make the emergency responses more standardized for all of the persons and organizations we predict to activate in case of an emergency
- We should also use the same emergency classification to activate response teams and to notify the regulators and off-site action participants
- Research reactors can be grouped for emergency planning and response variously. But the IAEA recommends use of four main emergency classes: ALERT, FACILITY EMERGENCY, SITE AREA EMERGECY, and GENERAL EMERGENCY.



Questions:

1. What is the emergency classification introduced for ?
2. How use the proposed classification in local situation ?
   - on emergency planning
   - on emergency response case
3. What will be the most practical method to classify an emergency case using the Table A1?
4. What are the emergency response classes recommended by the IAEA ?
5. Give an example of the reason to notify the regulatory body in your case about unusual event on your research reactor facility.



Block 3: Emergency Preparedness and Response Overview
Module 7: Urgent Protective Actions

Learning objectives: Upon completion of this module, the participants will:

- know human exposure pathways in nuclear or radiological emergency
- be able to list the elements of a protective action decision making strategy
- be able to list protective actions
- know the characteristics of specific protective action
- understand the role of intervention and operational intervention levels
- know the guidance values for limiting exposure of Emergency Workers

Activity: Seminar, questions and discussion

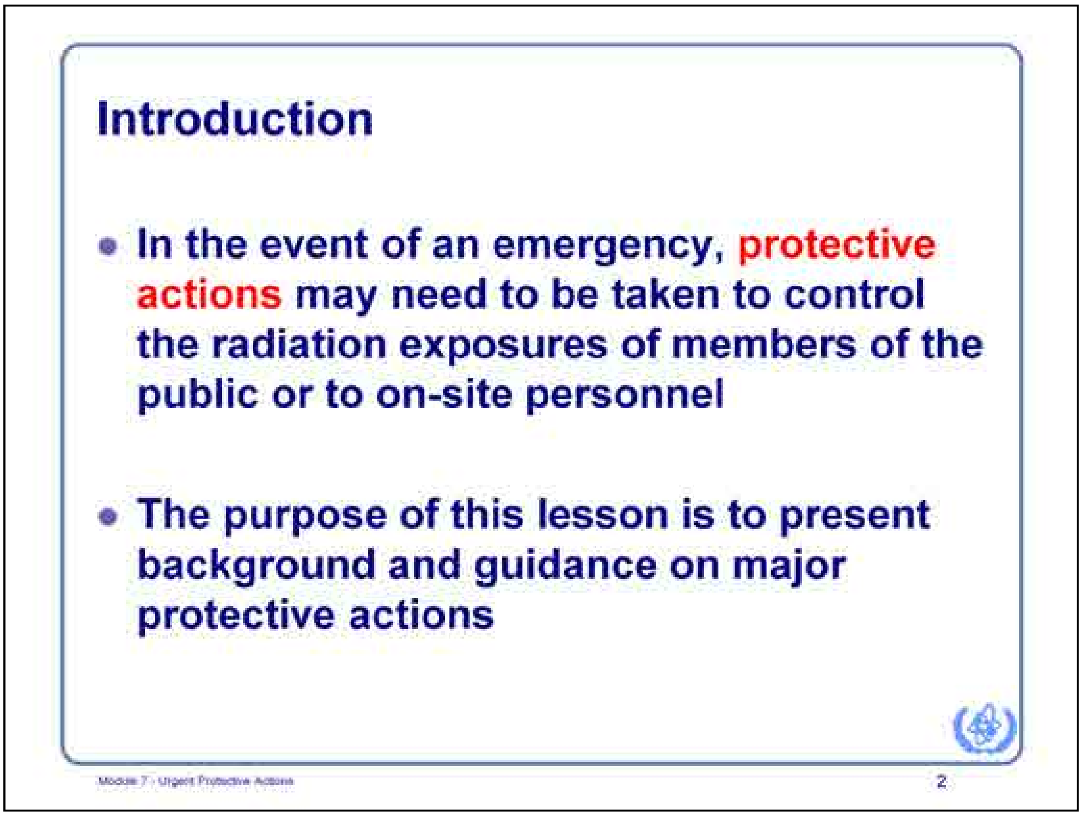
Duration: 1.5 hr

Materials and equipment needed: none

References:

1. INTERNATIONAL ATOMIC ENERGY AGENCY, EPR-METHOD 2003, Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency, IAEA, Vienna (2003)
2. INTERNATIONAL ATOMIC ENERGY AGENCY, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency, Safety Standards Series No. GSG-2, IAEA, Vienna (in preparation)
3. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Response to a Nuclear or Radiological Emergency at Research Reactors, EPR-RESEARCH REACTOR, IAEA, Vienna (2011)
4. JOURDAIN, J. R., HERVIOU, K., BERTRAND, R., CLEMENTE, M., A.,

Medical Effectiveness of Iodine Prophylaxis in a Nuclear Reactor Emergency Situation and Overview of European Practices, RISKAUDIT Report No. 1337, Châtillon, France (January 2010)



Lecture notes:

In recent years a number of accidents involving radioactive material have occurred that had, or could have had, consequences for the health of the general public. These have ranged from the major nuclear accident at Chernobyl in 1986 to accidental dispersion of medical and industrial sources and the re-entry into the Earth's atmosphere of satellites carrying radioactive material. Reponses to accidents differed between countries. Some protective actions that were taken may, in the most extreme cases, have detracted from rather than increased the well-being of the populations concerned and the quality of the environment.

Over the past decade considerable progress has been made in developing internationally recognized principles for decisions on protective actions and in providing quantitative guidance for applying these principles, notably by the ICRP, the IAEA, the WHO …

This lesson explains present international understanding regarding protective actions and numerical guidance related to the intervention.

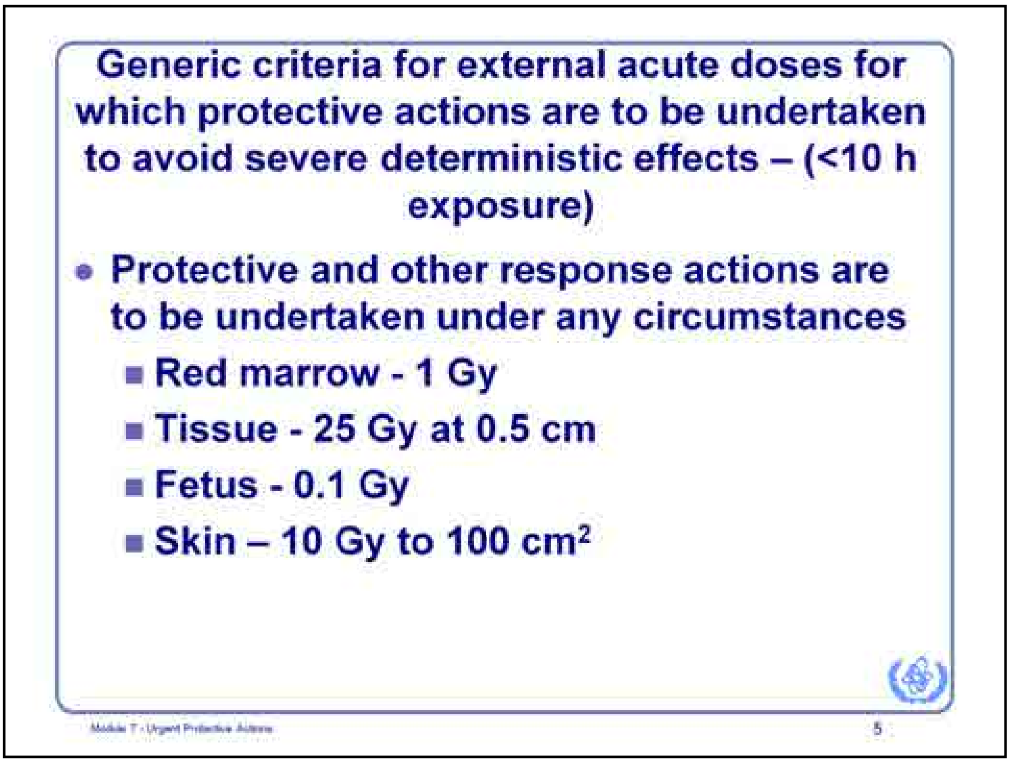
Lecture notes:

After short introduction we will look at the exposure pathways by which members of the public could be exposed to radionuclides. Then we will show how protection strategy relates to exposure pathways.

The body of the lecture will be devoted to major protective actions and their advantages and disadvantages. We will finish the lecture by discussing operational intervention levels, protection of Emergency Workers and a short lecture summary.

Lecture notes:

Emergency response programmes have three primary objectives. The first objective is to take actions at the source to mitigate or reduce the consequences. This objective is met by the reactor operators' actions to prevent or reduce a release of radioactive material. The second objective is to ensure that people will not receive doses high enough to result in sickness or death within weeks or months of the emergency. These are called deterministic, early, or acute health effects. Deterministic health effects result from very high doses received over a short time (hours to days). Each body organ has its own threshold dose below which deterministic health effects will not occur. In the case of a reactor emergency, keeping the early dose received by the red bone marrow below 1 Sv, for example, will prevent any early deaths. This is over 50,000 times the dose you normally receive in a few days. The third objective is to take reasonable actions to reduce the chance of people developing cancer years after the emergency. Cancers are called stochastic or late health effects. The normal risk of cancer is presumed to be increased by even very small doses. It is not practical or reasonable to reduce the additional risk of cancer from an emergency to zero. There is a point below which any further attempts to reduce the cancer risk resulting from the emergency is not justified. For example, it is unreasonable to relocate people from areas where the dose rate is less than that normally found in many areas not affected by the emergency.



Lecture notes:

Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency, GSG-2, based on considerable research, has established consensus criteria for:

1) These are the RBE-weighted absorbed dose delivered over the period of <10 h to an organ that will result in severe deterministic effects in 5% of exposed people.
2) Generic criteria for acute doses for which protective or other actions are to be undertaken under any circumstances to avoid or minimize severe deterministic health effects
   - External acute exposure (<10 hours)
     - Red marrow – 1 Gy
     - Fetus – 0.1 Gy
     - Tissue – 25 Gy at 0.5 cm
     - Skin – 10 Gy to 100 cm^2

If the dose is projected, take:

- Precautionary urgent protective actions immediately (even under difficult conditions) to keep doses below these generic criteria, public information and warning, urgent decontamination, etc.

If the dose has been received, perform:

-Immediate medical examination, consultation and indicated treatment

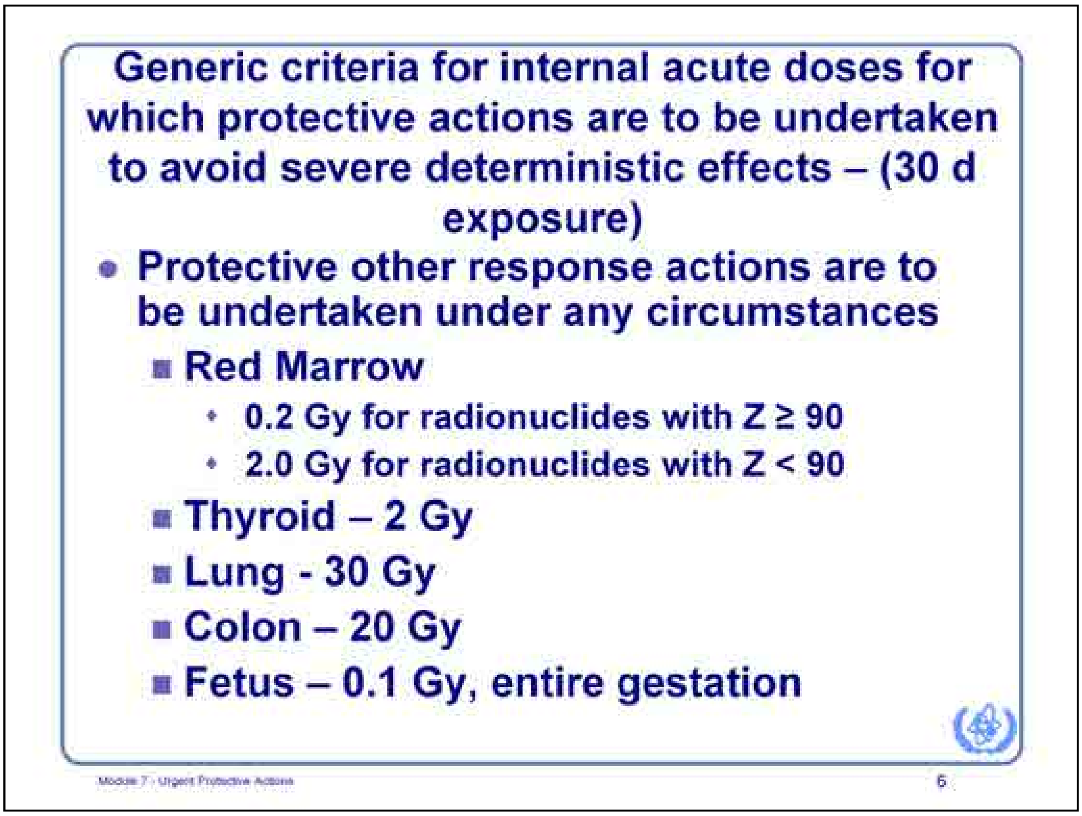
-Contamination control

-Immediate decorporation (if applicable)

-Registration for long term medical follow-up

Red marrow represents the average RBE-weighted absorbed dose to internal organs (e.g., red

marrow, lung, small intestine,
gonads, thyroid, etc.) and lens of eye from irradiation in a uniform field of strongly penetrating radiation.



Lecture notes:

1) These are the RBE-weighted absorbed dose delivered over the period of 30d (gestation period for a fetus) by the intake that will result in severe deterministic effects in 5%of exposed people.
2) Generic criteria for acute doses for which protective or other actions are to be undertaken under any circumstances to avoid or minimize severe deterministic health effects
    - Internal exposure from acute intake (30 d dose)
        - red marrow – 0.2 Gy for radionuclides with $Z \geq 90$, 2 Gy for others
        - Thyroid – 2 Gy
        - Lung – 30 Gy
        - Colon – 20 Gy
        - Fetus – 0.1 Gy over entire gestation period

If the dose is projected, take:

- Precautionary urgent protective actions immediately (even under difficult conditions) to keep doses below these generic criteria, public information and warning, urgent decontamination, etc.

If the dose has been received, perform:

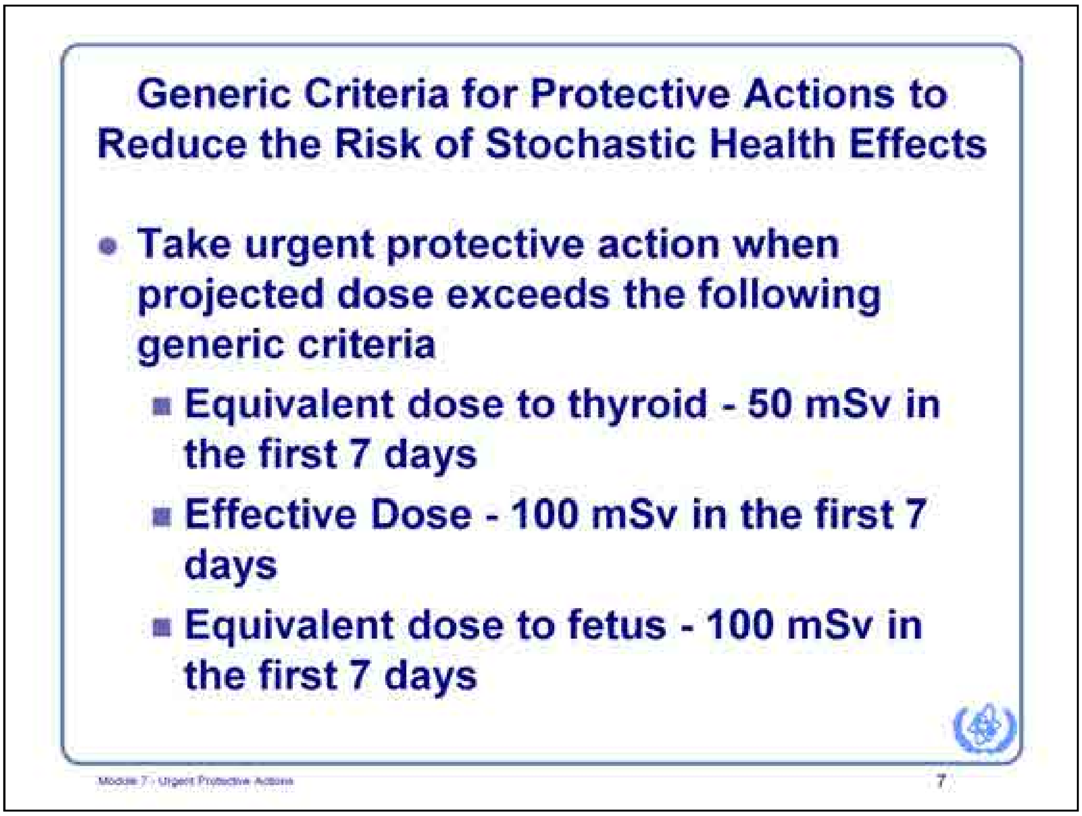
-Immediate medical examination, consultation and indicated treatment

-Contamination control

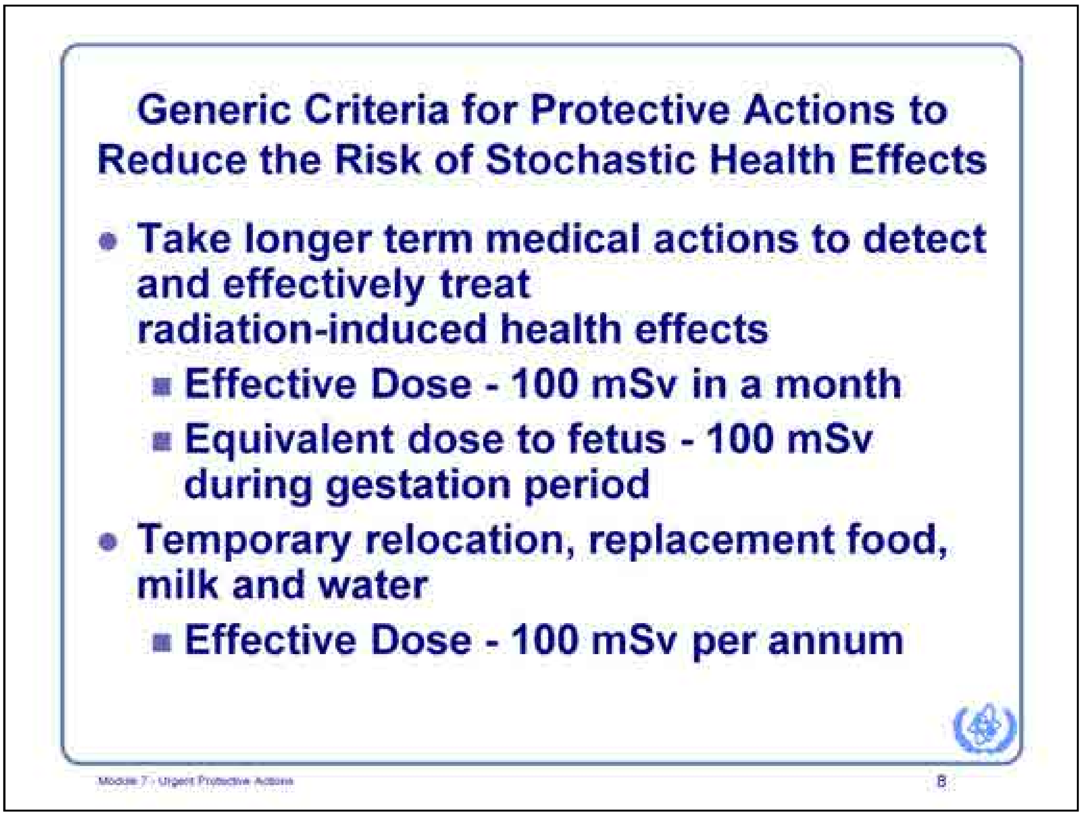
-Immediate decorporation (if applicable)

-Registration for long term medical follow-up

These are the RBE-weighted absorbed dose delivered over the period of 30d (gestation period for a fetus) by the intake that will result in severe deterministic effects in 5%of exposed people.



Lecture notes:

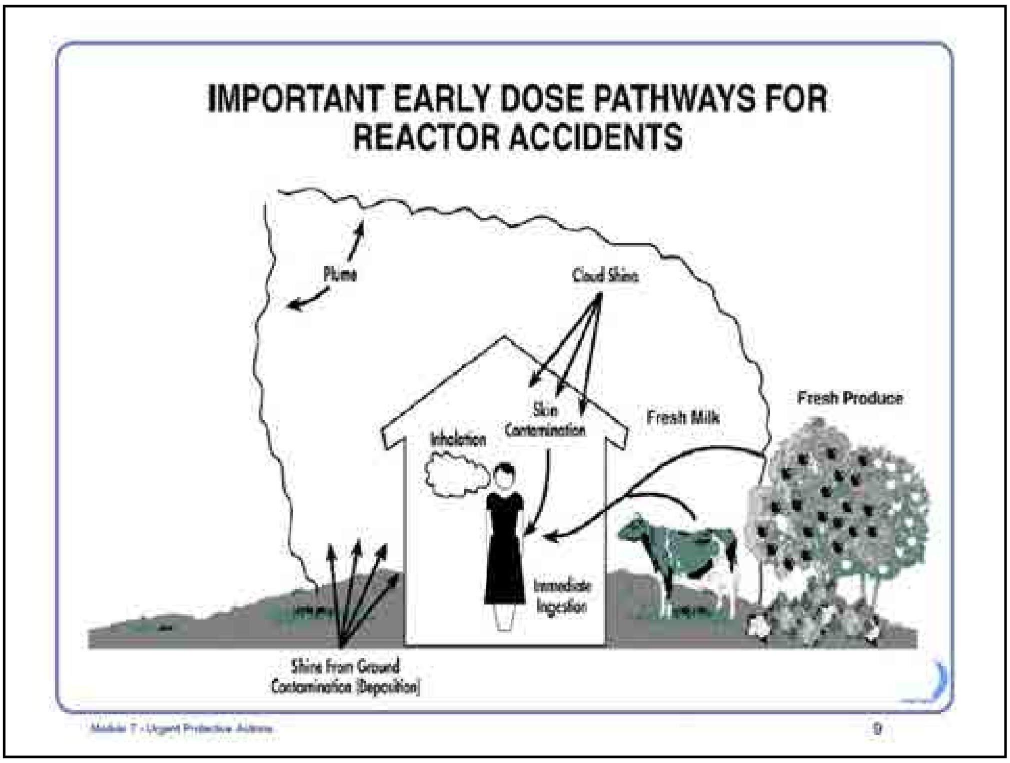


Lecture notes:

for >100 mSv equivalent dose to individual in a month - Screening based on equivalent doses to specific radiosensitive organs (as a basis for medical follow-up), basic counselling

for >100 mSv equivalent dose to fetus - Counselling to allow informed decisions to be made in individual circumstances

for >100 mSv equivalent dose to an individual per annum - Temporary relocation, decontamination, replacement of food, milk and water, public reassurance



Lecture notes:

The radiation dose received by the public during the first days of a reactor emergency comes mostly from five sources:

- external gamma radiation from the plume, called cloud shine,
- external gamma radiation from radioactive material deposited on the ground, called ground shine,
- inhaling radioactive material in the plume,
- external beta and gamma radiation from radioactive material deposited on the skin, and
- eating contaminated food and milk.

During a release the dose from cloud shine, ground shine, skin contamination and inhalation are the most important. After the plume has passed, the dose from ground shine and eating contaminated food and milk become most important.

Pathways, Phases, and Protective Actions

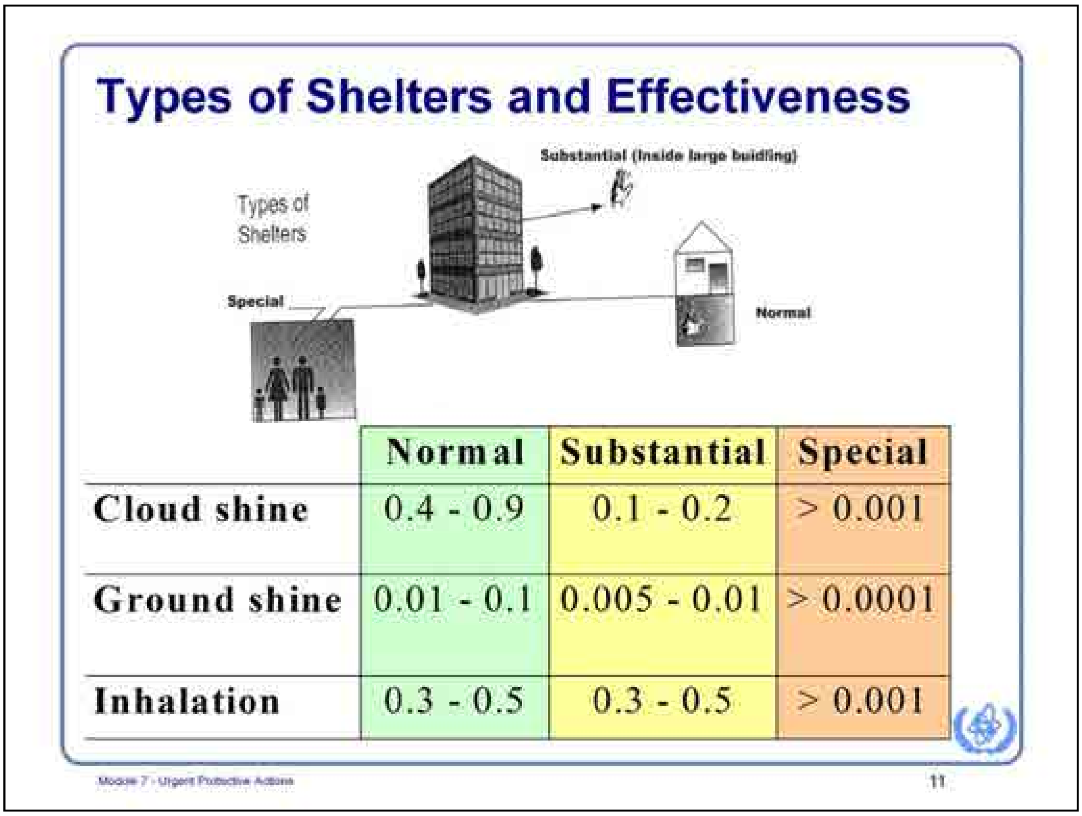
PATHWAYS	PHASES	PROTECTIVE ACTIONS
Cloud Shine		Sheltering Evacuation Control of Access
Plume Inhalation	URGENT	Sheltering Use of Potassium Iodide Evacuation Respiratory Protection Control of Access
Skin Contamination		Sheltering Evacuation Decontamination of Persons
Short Term Ground Shine		Evacuation Relocation Decontamination of Land and Property
Immediate Ingestion		Food and Water Controls
Long Term Ingestion		Food and Water Controls
Long Term Ground Shine and Inhalation of Resuspended Activity	LONG TERM	Relocation Decontamination of Land and Property Restricted Use

Module 7 - Urgent Protective Actions 10

Lecture notes:

Dose from cloud shine, ground shine, skin contamination and inhalation can be prevented or reduced by what are referred to as urgent protective measures. These are protective measures that must be implemented urgently or immediately to be effective and include sheltering, evacuation, decontamination of people and so called thyroid prophylaxis. Dose from ingestion can be reduced by restricting immediate consumption of locally produced food. The effectiveness of these actions in response to a reactor emergency will be discussed.

Long term doses from ingestion, ground shine or resuspension of deposited material can be prevented or reduced by temporary relocation of the population, decontamination, restriction on land use and food controls.



	Normal	Substantial	Special
Cloud shine	0.4 - 0.9	0.1 - 0.2	> 0.001
Ground shine	0.01 - 0.1	0.005 - 0.01	> 0.0001
Inhalation	0.3 - 0.5	0.3 - 0.5	> 0.001

Lecture notes:

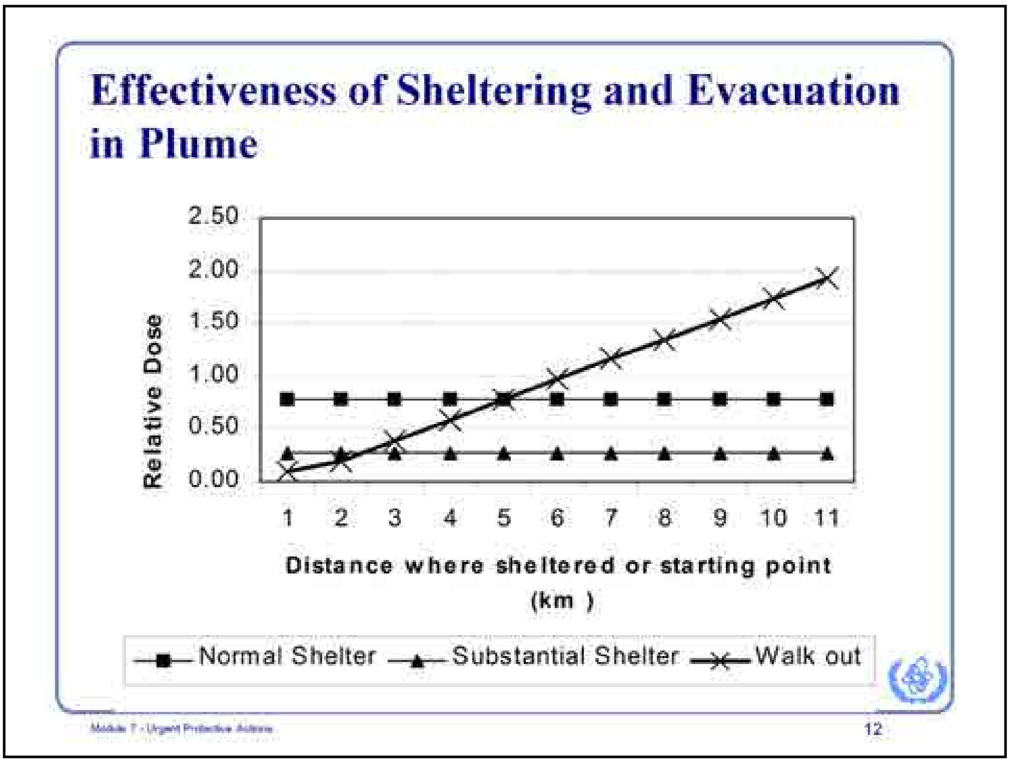
The effectiveness of sheltering (listed in figure) varies greatly depending on the structure, duration of the release and the exposure pathway. Because of the great variability of building structures, three classes of sheltering can be used when developing protective action strategies. These classes are:

Normal -Typical homes and their basements; Normal shelter does not provide adequate protection from an airborne plume close to the site. It is used if evacuation is impossible (e.g., very severe storm) when preparing to evacuate or in areas where evacuation is expected to be needed .

Substantial - Inside halls of large multi-story building or large masonry structures away from walls or windows, with estimated protection factors of about 10 from external and inhalation dose. This class may provide adequate protection for short periods. It can be used until monitoring can be conducted.

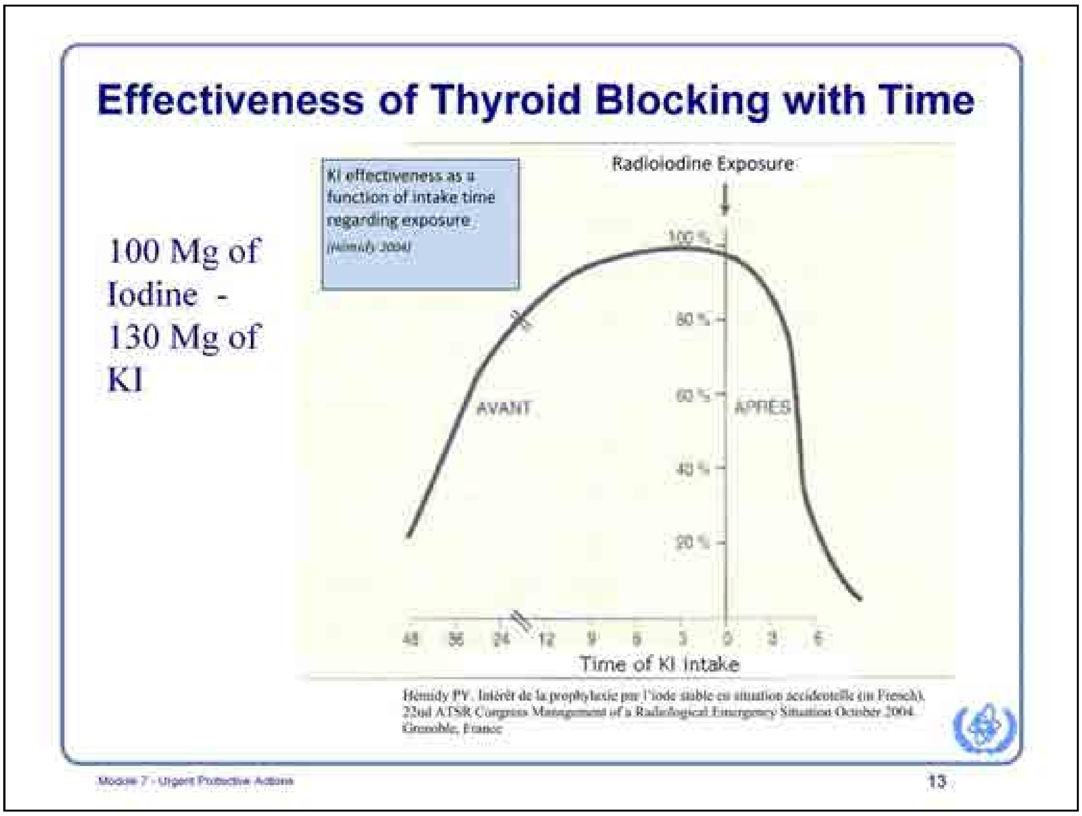
Special - Specially designed shelters providing a factor of more than 100 reduction from external and inhalation dose. This class provides adequate protection for the duration of the emergency.

Sheltering is easy to implement but in most cases can not be carried out for long periods. In addition sheltering can be used as a preparation for an evacuation. The people in an area of potential risk can be instructed to “go inside” and listen to their radios for further instruction while preparations for evacuation are being made. However, for very severe reactor accidents sheltering in a typical home may not be sufficient to prevent deterministic health effects close to the facility. Sheltering is not a long term protective measure. It is intended to be used until additional information can be obtained; therefore monitoring must be performed promptly anywhere sheltering is used, to locate and evacuate hot spots.



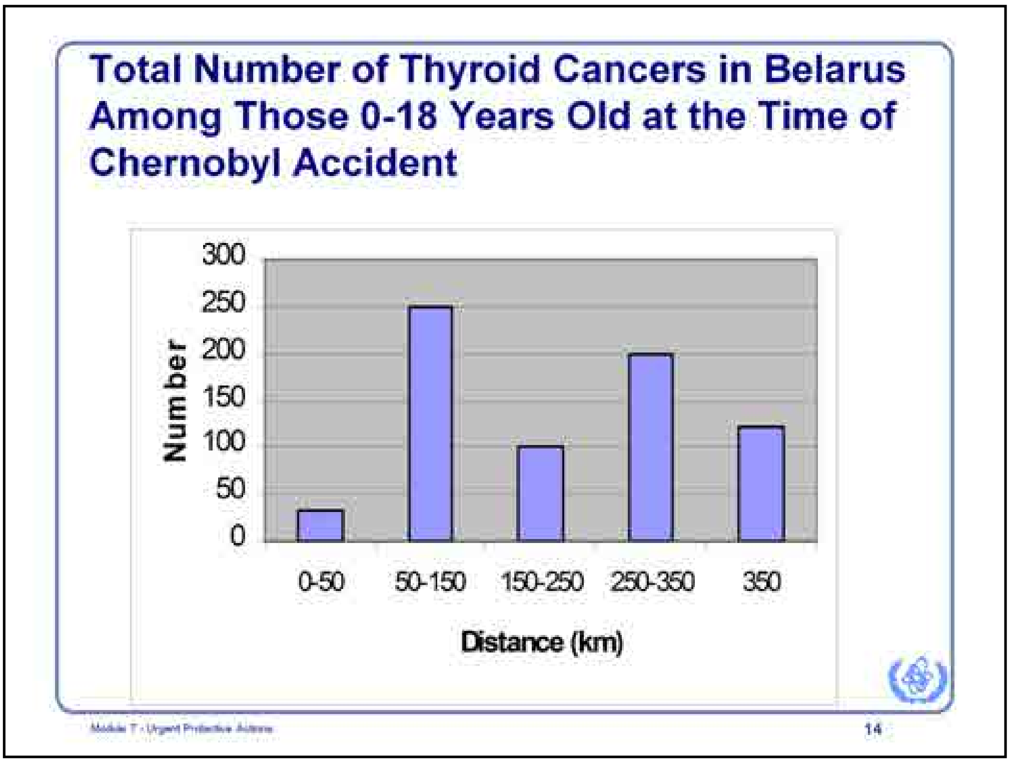
Lecture notes:

This shows the dose relative to that for normal activity for various sheltering and evacuation options. The evacuation is assumed to be at walking speed (4 km/h). This analysis assumes a continuous release lasting several hours. It also assumes the evacuee starts at the distance from the release shown on the x-axis and they stay in the centre of the plume forever as they walk away from the site. It also assumes that the people shelter at the distance shown for 4 hours. This shows that a person starting to walk out from within 5 km receives a lower dose than someone sheltered in a normal house close to site. The general conclusion of this and many other studies is that sheltering in normal homes close to the release is not as effective as evacuation even if the evacuation is conducted in the plume. This may not be true for all conditions such as a very short duration release or when conditions, such as severe weather, delay or hamper an evacuation.



Lecture notes:

When the fuel of a reactor overheats and the fuel cladding fails, large amounts of radioactive iodine can be released. This iodine can be inhaled or can be deposited on vegetables or concentrate in the milk of animals grazing on contaminated grass. Inhaled or ingested iodine will concentrate in the thyroid. High thyroid doses can destroy the thyroid and greatly increase the risk of thyroid cancer, especially in children. The ingestion of radioactive iodine can be prevented by not eating or drinking potentially contaminated food. The dose to the thyroid from inhalation can be reduced by taking stable (non-radioactive) iodine called thyroid blocking (iodine prophylaxis). The stable iodine will saturate the thyroid and reduce uptake of the radioactive iodine. As shown in this figure, thyroid blocking is more than 90% effective if administered before or at the time of intake of the radioactive iodine. Its effectiveness falls rapidly if given after intake. Thyroid blocking must be administered before or shortly after the release to be effective. Thyroid blocking only protects the thyroid and yet dose to the whole body (bone marrow) is the source of most of the early deaths from a reactor emergency. Therefore, care must be taken to be sure that the distribution of stable iodine will not delay evacuation or sheltering. For severe accidents, the dose from inhalation may be high enough to warrant thyroid blocking more than 100 km from the emergency. However, for practical reasons, distribution of stable iodine may be limited to a smaller area with the greatest risk. Thyroid blocking is generally considered safe. In response to the Chernobyl accident, the Polish government carried out thyroid blocking to about 18 million people and there were only two serious adverse reactions, both among adults with a known iodine sensitivity.



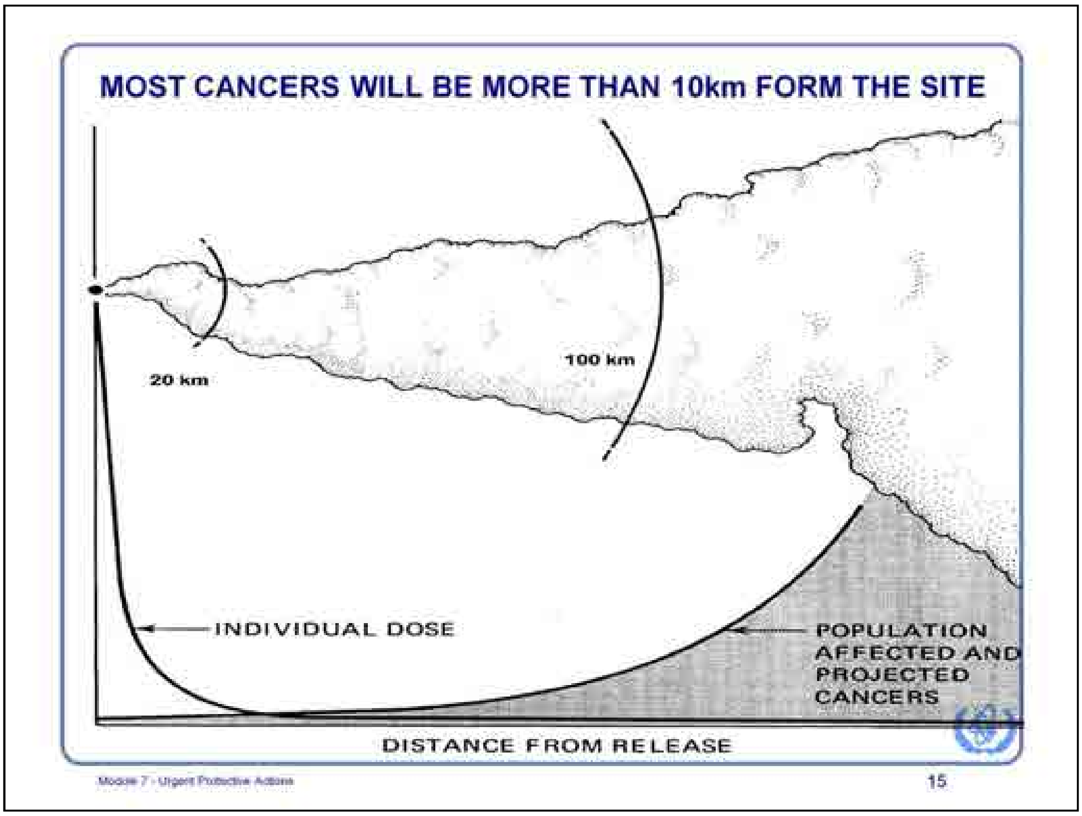
Lecture notes:

The Belarussian border is located about 7 km from the Chernobyl plant and the country was seriously affected by the emergency. Cows are typically grazing in Belarus at the time of year when the emergency occurred, and yet no efforts were taken to restrict the consumption of privately produced contaminated milk for the first days following the emergency.

Since 1990 there has been a significant increase in the incidence in thyroid cancer among Belarus children who were between 0-14 years old at the time of the emergency. The principal cause is the dose from eating food and drinking milk contaminated with radioiodine.

Most of these cancers were among children less than six years old at the time of the emergency and the vast majority were diagnosed in those living more than 50 km from the plant at the time of the emergency as seen in the figure.

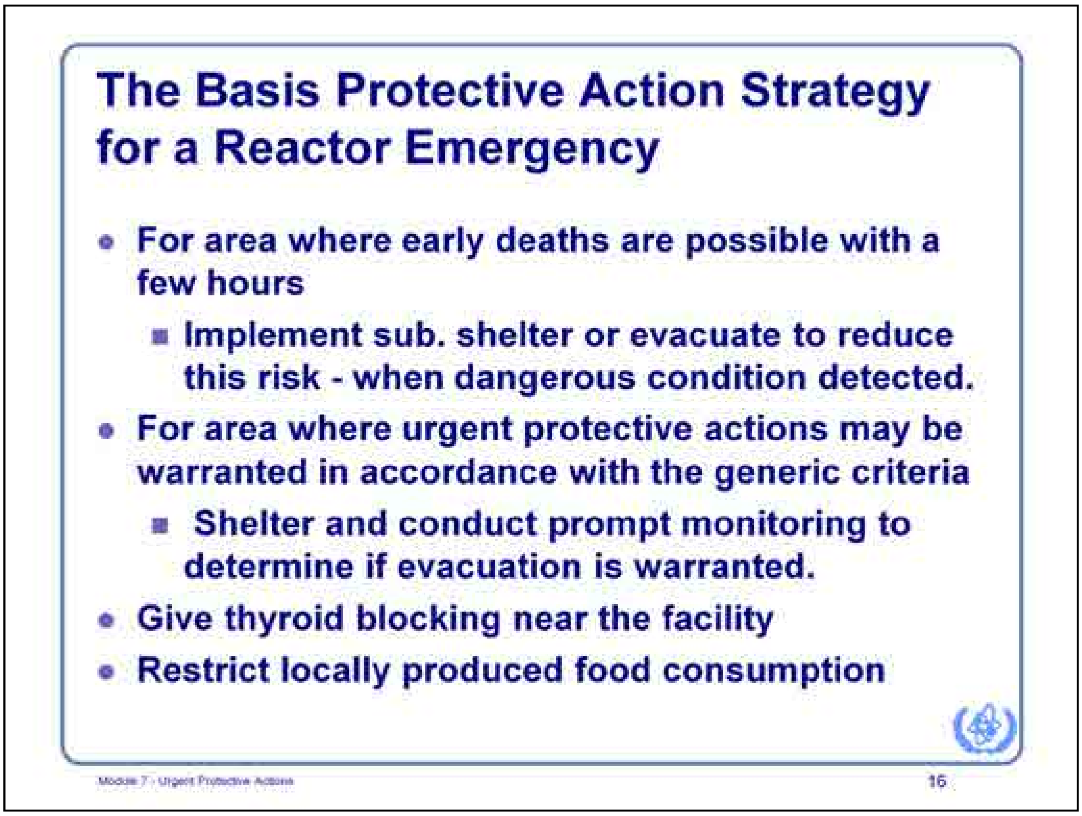
These cancers respond favourably to early treatment and to date only a few of the children diagnosed in Belarus with thyroid cancer have died as a result of the cancer. This shows the importance of identifying children who may have received high thyroid doses for medical monitoring 5-10 years after the emergency.



Lecture notes:

The most striking feature of the distribution of thyroid cancers in Belarus is that the vast majority of the thyroid cancers were diagnosed more than 50 km from the site.

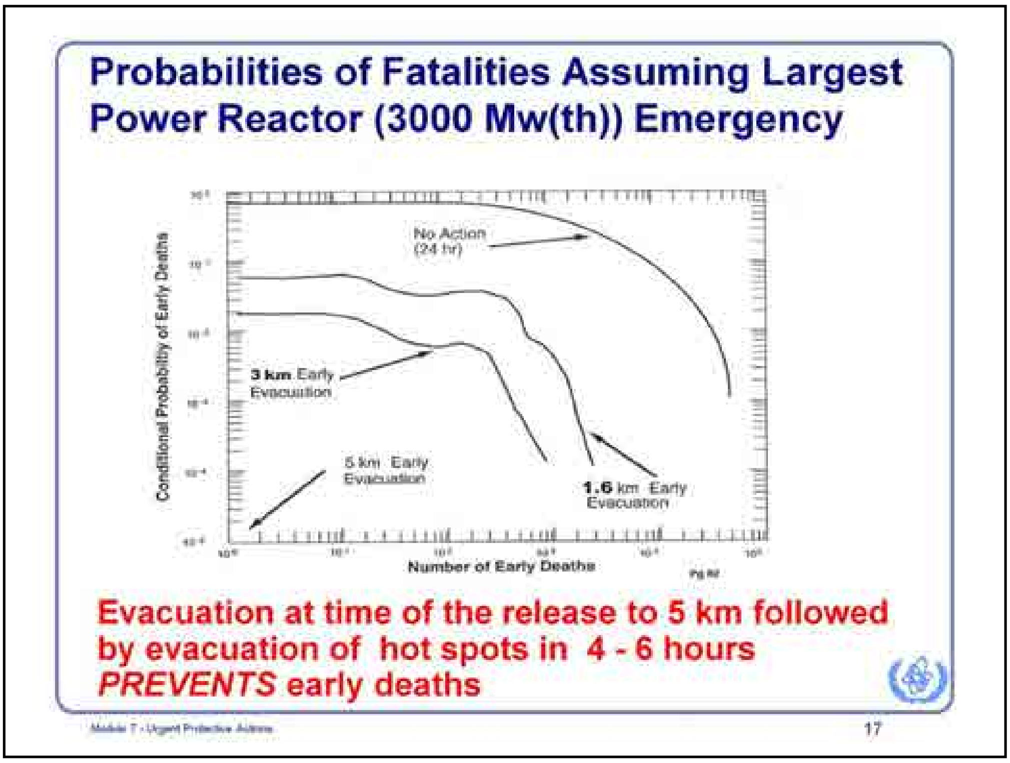
The distribution of the thyroid cancers in Belarus is consistent with the basic assumption that the numbers of stochastic effects (e.g. thyroid cancers) are primarily a function of collective dose and not the individual dose (The risk of cancer depends on individual dose; the number of effects depends on the numbers of people exposed and their doses - i.e.. collective dose.) The areas beyond 50 km received the vast majority of the collective doses (person Sv) and therefore the majority of the excess thyroid cancers



Lecture notes:

The basic strategy for taking unguent protective actions for a reactor emergency is:

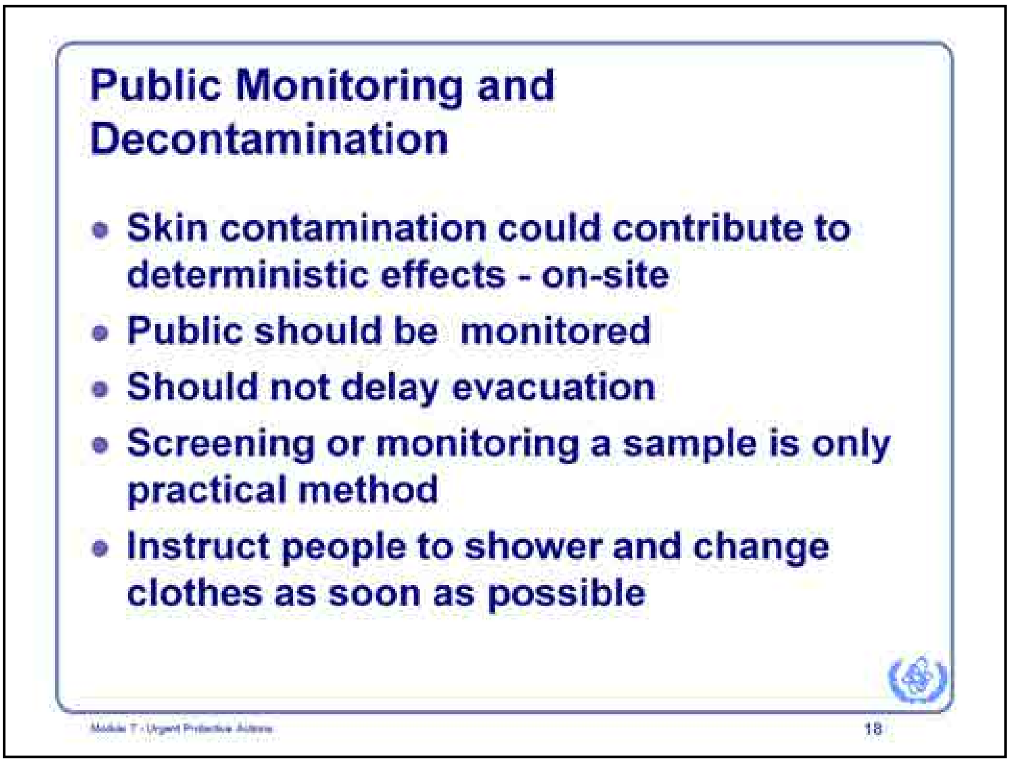
- For area where early deaths are possible with a few hours
    - Implement substantial shelter of evacuation to reduce this risk based on facility conditions. This would be done before or shortly after release and would be based on predetermined criteria indicting when dangerous conditions exist in the plant.
- For area where urgent protective action are warranted in accordance with GSG-2
    - Shelter and conduct prompt monitoring to determine if evacuation is warranted.
- Give thyroid blocking near the facility
- For a major release restrict consumption of locally predicted vegetables and milk until monitoring can be performed



Lecture notes:

This shows the results of an analysis of the effectiveness of the protective action strategy for the most severe reactor emergency considered possible. In this case the probability of various numbers of early deaths is displayed. This was done for a reactor in the U.S.A. with a high population density near the site. This figure displays the risk of early fatality when evacuation is taken early (starting 0.5 hours after start of release) out to radii of 1.6, 3 and 5 km and for no action (normal activity for 24 hours). The x-axis shows the number of early deaths and the y-axis shows the conditional probability (conditional on core melt and early containment failure). It is assumed that people will be relocated from hot spots (0.01Sv/h) within 6-12 hours.

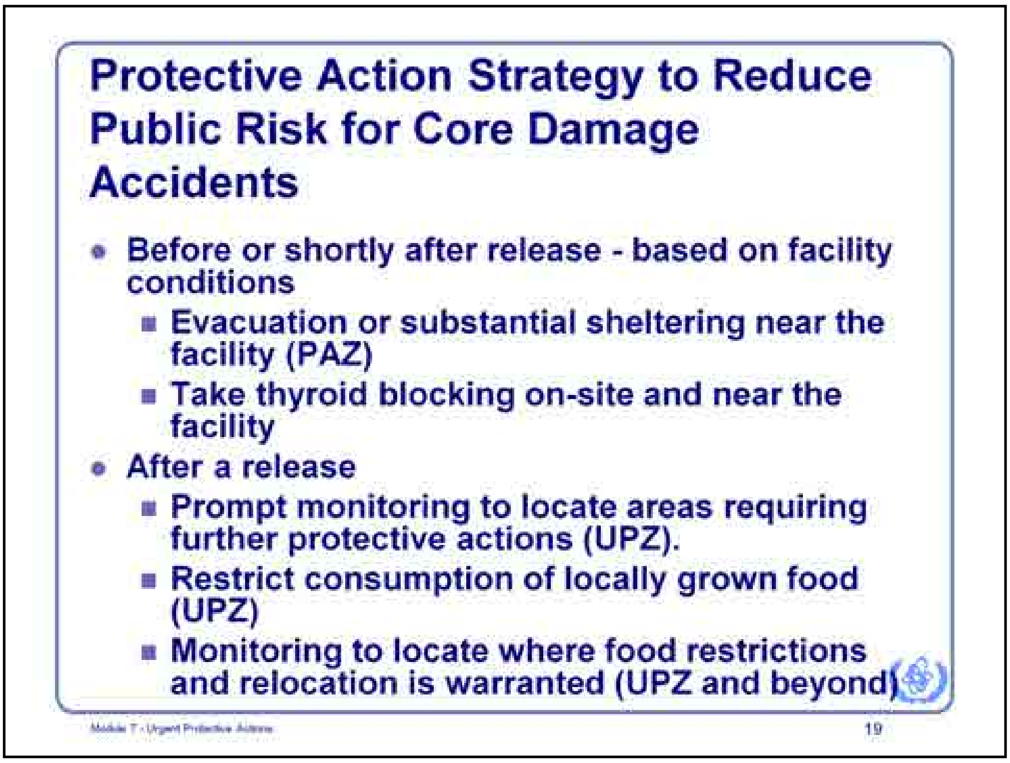
The results of these types of calculations are very uncertain; but, when used to compare various protective options, they are useful. This case shows a reduction of a factor of 10,000 in the risk of early fatalities when there is early evacuation of the area within 5 km of the plant. Once again this confirms the potential benefits of early evacuation (or substantial shelters) combined with prompt monitoring to locate and evacuate hot spots.



Lecture notes:

A major reactor emergency could result in significant skin contamination. Beta radiation from the skin contamination could be a major contributor to skin dose. Therefore, plans to monitor potentially contaminated people should be made. If significant contamination is detected, the people evacuating should be instructed to shower as soon as possible.

Levels of skin contamination that could result in deterministic health effects (> 1 Gy in 10 hours) produce gamma dose rates 5 to 10 times background within 30 cm of the surface (skin) contamination. Therefore, significant levels of skin contamination should be detectable if monitoring is conducted in a low background area. Serious health effects can be expected at levels 10 times this level (the GSG-2 acute exposure limit to avoid severe deterministic effect is 10 Gy to a 100 cm^2 area of the skin). Simply showering and changing or washing clothing should be sufficient to prevent future skin dose from resulting in deterministic health effects.



Lecture notes:

In summary, in order to substantially reduce the health risk off-site from a severe reactor emergency ***upon detection of actual or projected core damage***:

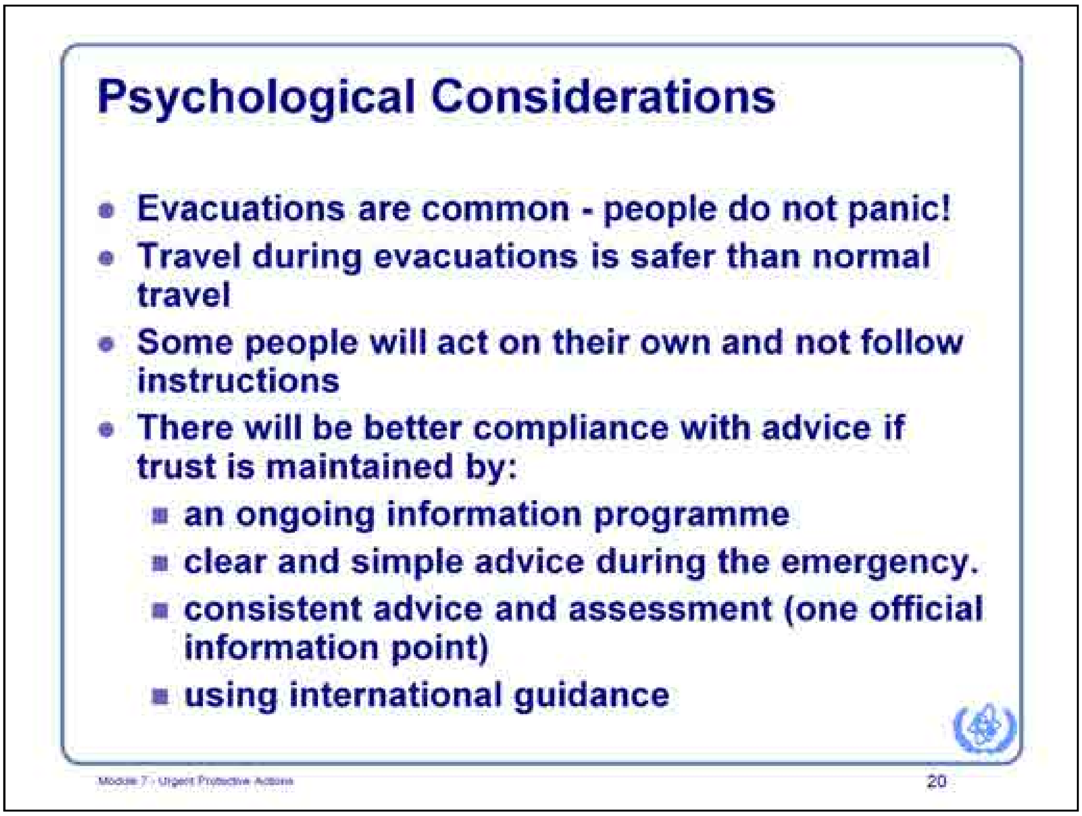
- Evacuate or provide substantial shelter for the people near the plant
- Provide thyroid blocking near the plant if it will not delay evacuation or sheltering.

After a release starts:

- Promptly monitor the area in the vicinity to locate where the dose from cloud or ground shine could result in deaths or injuries if the public is not evacuated or sheltered. Shelters should also be monitored to ensure they are providing adequate protection.
- Monitor evacuees for skin contamination
- Restrict eating potentially contaminated food, milk or water.
- After most of the release is over, monitor to determine where deposition levels still warrant restriction on food or where people should be relocated

How does the site and the local authorities decide on the affected areas?

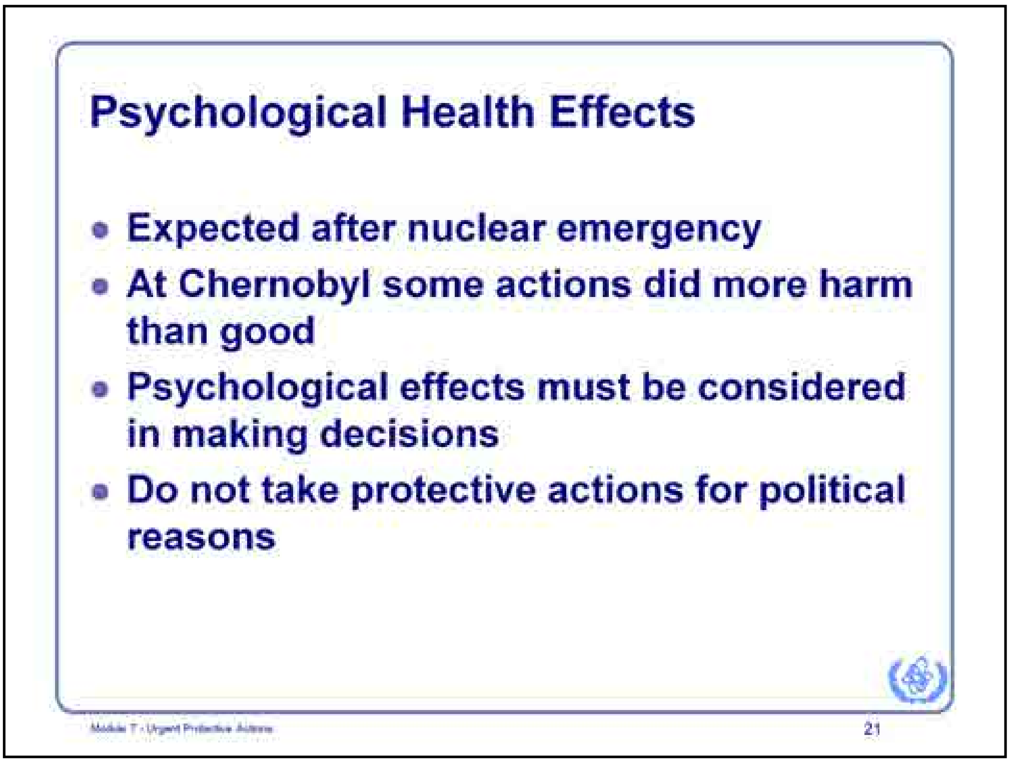
Expect responses that include pre-planned zones, UPZ and PAZ, for different scenarios, environmental monitoring results



Lecture notes:

There is a perception that people will panic and thus be a danger to themselves or others if advised to evacuate as a result of a reactor emergency. There is no evidence or research that indicates people will panic during an evacuation in response to a radiological emergency. Evacuation is a customary protective measure for accidents involving release of hazardous materials. Numerous evacuations are carried out annually throughout the world. The risks for evacuation are smaller than normal travel under similar weather conditions.

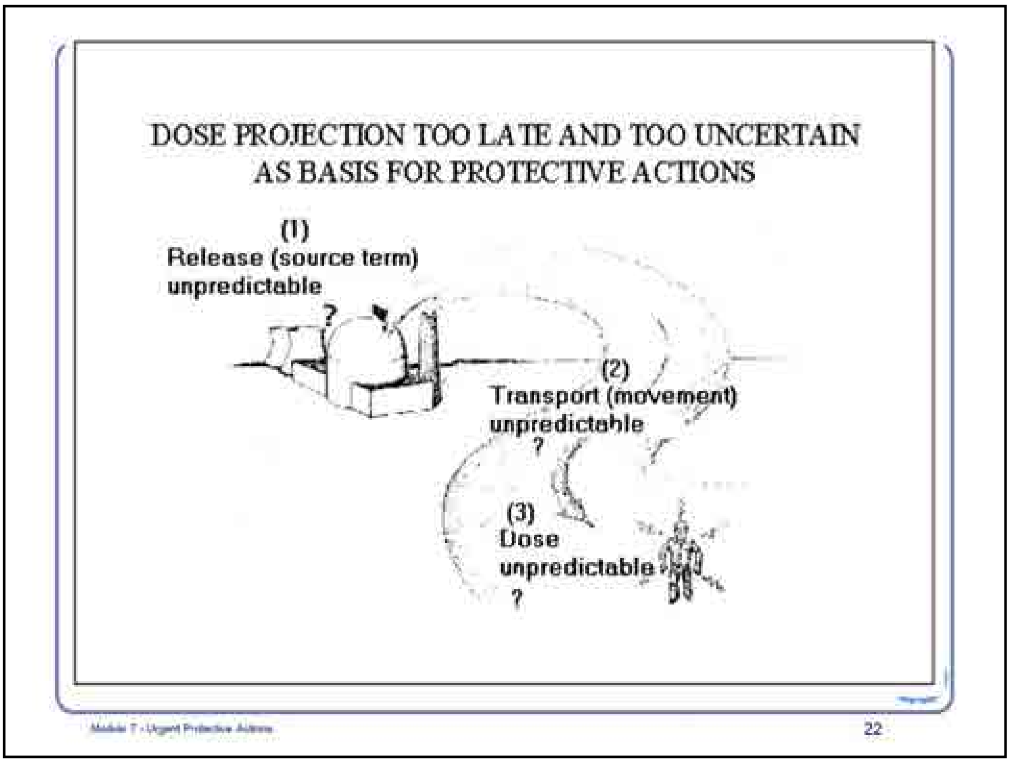
Psychological factors can also affect the implementation of protective measures. The compliance with imposed food restrictions was alarmingly low in some areas directly affected by Chernobyl. This was in part because of lack of information early in the event and conflicting information later. The severity of these psychological effects will depend, in part, on whether people have confidence that the authorities are competent and trustworthy, and have taken prompt and effective action to control radiation doses. In those areas near the plant, information on accidents and protective actions should be provided to the public as part of a routine education program. At the time of an emergency, be honest and provide clear, simple advice to the public based on internationally endorsed guidance. Efforts should be made to provide consistent advice and assessment to the public and media (press). This is best accomplished by having one source of official information within the country and co-ordinating protective action strategies with nearby countries in advance. This should increase the public confidence and compliance with recommended actions.



Lecture notes:

Psychological health effects will always accompany a nuclear or radiological emergency whether or not it has resulted in persons receiving significant radiation exposure. Some protective actions taken during Chernobyl to reduce the radiological health risks did more harm than good because of the resulting distress and anxiety caused. The impact on psychological health must be considered when determining protective actions. To minimize the potential for longer-term stress to affected population groups, it is essential to ***resist pressure to introduce protective measures for political reasons*** at levels that are well below those justified on radiological grounds. Every effort must be made to maintain public trust.

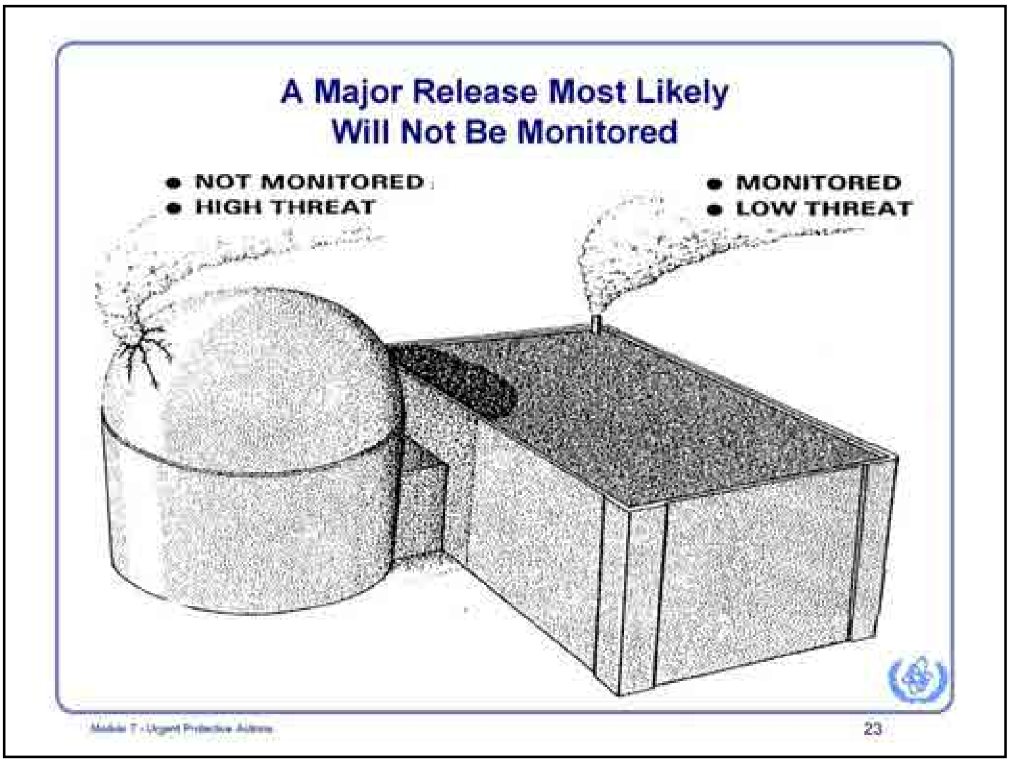
For example, actions after Chernobyl resulted in hundreds of abortions that were unnecessary because evaluation of received doses and medical counselling was not provided.



Lecture notes:

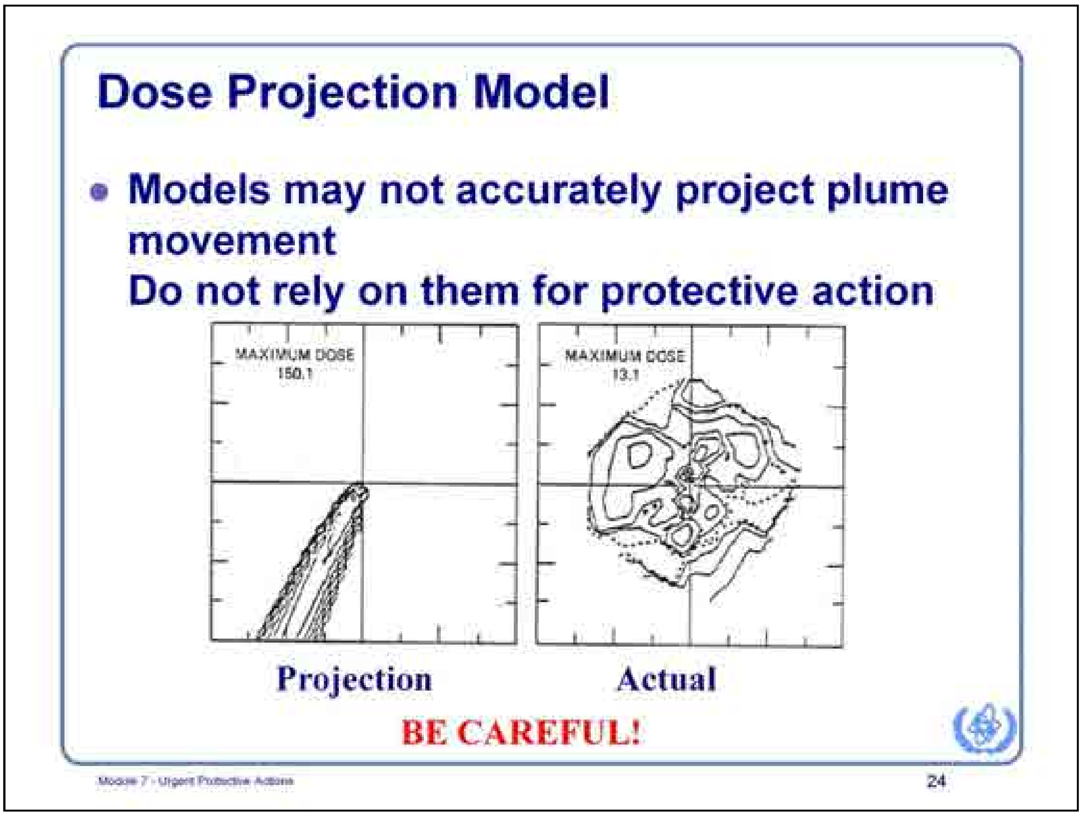
In the past, off-site monitoring and dose projections were the primary basis for taking protective actions. More recent studies and experience has shown that these methods may be too late or too inaccurate to be the sole basis for taking effective protective actions during the most severe reactor accidents.

Dose projection models appear to provide a useful tool until you examine all the sources of uncertainty. In order to be useful a dose projection must provide a reasonable estimate of the dose and timing at specific off-site locations. Making such a projection involves the following basic steps: 1) estimation of the size and timing of a release, 2) estimation of the movement of the release of material over time and 3) estimation of the resulting doses and health effects. It is very difficult if not impossible to perform these steps accurately and timely during a severe emergency.



Lecture notes:

Large releases will, in most cases, result from major failures of the containment after majaor fuel damage has occurred. These failures most likely will occur at a location that is not monitored by instruments that can measure the size of the release. In addition, the timing and duration of a containment failure or leak is not predictable. Releases from locations that are measurable in the control room are probably of little threat off-site. Since the duration and amount of a serious release will be unknown it may be impossible to project off-site doses with sufficient accuracy to be the primary basis for taking effective actions to protect the public.



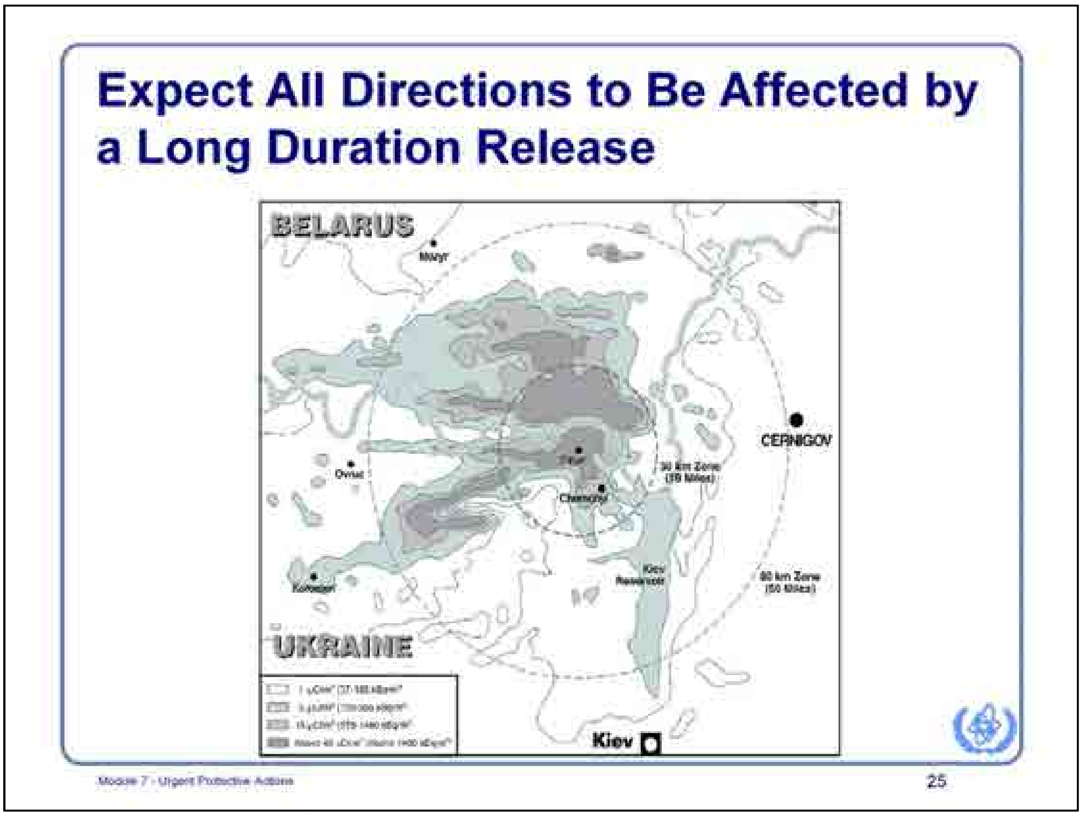
Lecture notes:

There are also significant uncertainties associated with projecting plume (release) movement and deposition during the course of the release. Typically, there is only one local source of weather and wind information (meteorological tower) in the site vicinity. The initial transport of radioactive material from a site after it is released to the atmosphere will be dominated by local conditions (e.g. hills, valleys, lakes and precipitation). This single source of weather and wind information cannot give a definitive indication of winds away from the plant.

Current dose models are not very accurate in assessing plume movement. Dose projection models give a very simple picture of a very complex situation. This figure shows a dose projection made with the model used by the US NRC during accidents and the doses actually measured during a field experiment.

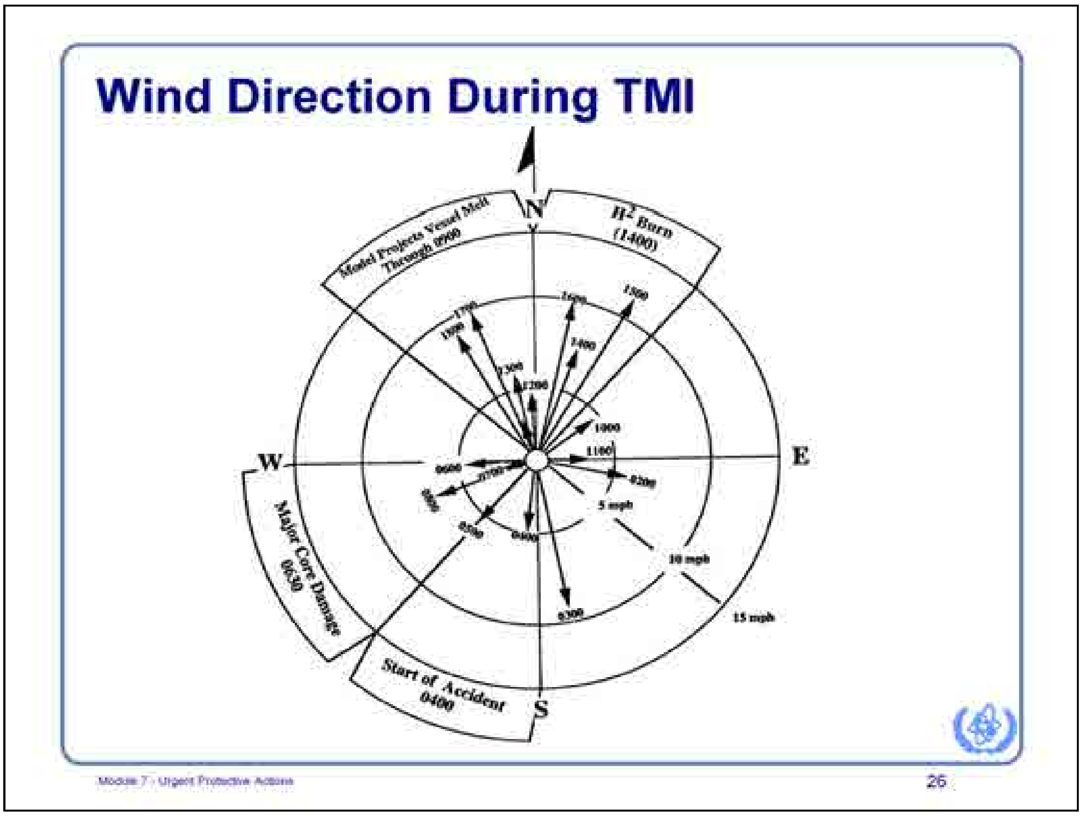
At best, early in an emergency, projected doses would be within a factor of 10 to 100 of the true dose, even if the source term (release rate and composition) were known.

The best use of these models is to establish the PAZ and UPZ. Even this use may not correctly identify areas where OILs are being exceeded. Environmental monitoring is the most accurate indicator. Even in that case, it is possible that the measured conditions are not the same over the entire area threatened.



Lecture notes:

The plume resulting from an emergency is relatively narrow, but for most accidents the release will last several hours during which the wind direction will most likely change. As a result it will be impossible to predict all the areas that will be affected by the emergency. In fact most reactor accidents have affected all areas near the plant as can be seen from the figure, which shows the contamination pattern from the Chernobyl accident. Consequently, urgent protective actions that are critical for preventing serious health effects should be taken in all directions around the plant.

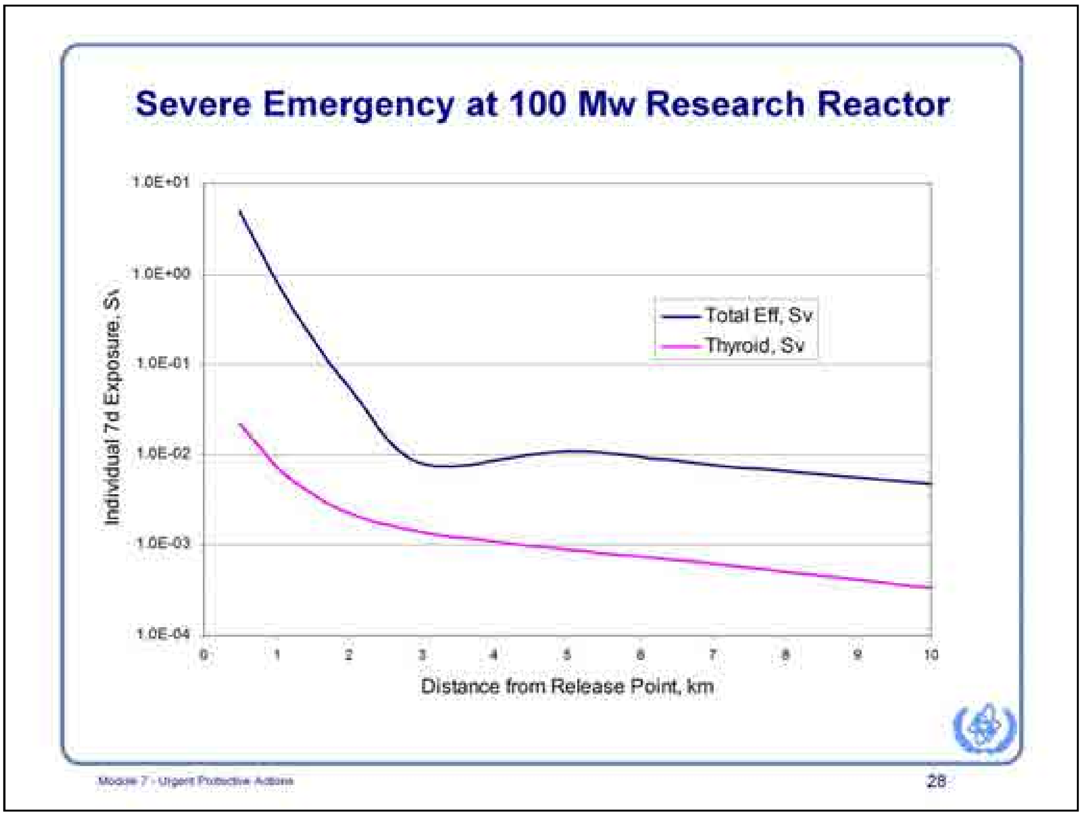


Lecture notes:

Chernobyl and other accidents have shown that during the course of an emergency, all the areas near the site may be affected. To emphasize this point, the wind direction during the first day of the emergency at TMI is displayed in the figure (actual conditions were reconstructed some time after the first day due to on-site computer failure at the time of the emergency). The arrows in this figure indicate the most prevalent wind direction at various locations surrounding the plant at the times indicated. The emergency started at about 4:30, and the core became uncovered at about 7:00. An evacuation of areas to the west of the plant was considered at about 8:00, but it was not implemented. By 9:00 the local wind direction had changed and was blowing toward the north! Inhabitants of the area to the north would not have been included if evacuation had been directed at 8:00. The wind changed to blow toward the northeast by mid-afternoon, when there was a hydrogen burn in the containment. By early evening, the wind was blowing toward the northwest, when it rained! The point is that winds shift frequently and are therefore unpredictable. To obtain substantial risk reduction an evacuation must include the entire area of the greatest risk (2-5 km) in all directions around the plant.

Lecture notes:

A prompt and effective response can be implemented if everyone knows what to do when the alarm sounds. There is no time to hold meetings to decide what to do. This is accomplished through the use of an emergency classification system. The emergency classification of an emergency will trigger immediate action by all response organizations. This will include activation and notification of the response organization, taking protective actions for the public, and notification of nearby countries of a potential release. For each emergency class, both on-site and off-site, response measures can be predetermined and incorporated into written procedures and training, thus making for a prompt and co-ordinated implementation. An emergency will be classified and action initiated based on predetermined plant conditions that indicate a high risk of a major release, i.e., core damage. For example, immediate action may be taken if high temperatures are detected in the core, thus allowing actions to be taken before any release starts. An emergency could also be declared if a radiological release is detected by environmental monitoring.



Lecture notes:

Calculated radiological consequences for a severe research reactor emergency. Core was completely melted, but most fission products were retained in the pool water or containment. Most of the total dose was due to cloudshine from the release. Weather conditions were mild day, 2 m/s wind, stability class D and no rain.

Rain and stability class E didn't change the total effective dose, but the thyroid dose increased by about 50%. An increase in wind speed to 7 m/s reduced the dose close to the release point, but increased the dose out to about 5 km.

Protective Actions by Emergency Class – before env. monitoring results

Protective Action	Class	
	Site Area Emergency	General Emergency
Evacuate or shelter non-essential personnel on-site	yes	yes
Provide responders with radiation protection	yes	yes
Prepare the public	yes	
Evacuate or shelter PAZ (Threat Category I only)		yes
Take thyroid blocking in PAZ and UPZ		yes
Monitor UPZ and take action where OILs are exceeded	Consider sheltering	yes
Restrict fresh food and milk		yes
Notify nearby countries		yes
Record names of exposed for follow up		yes

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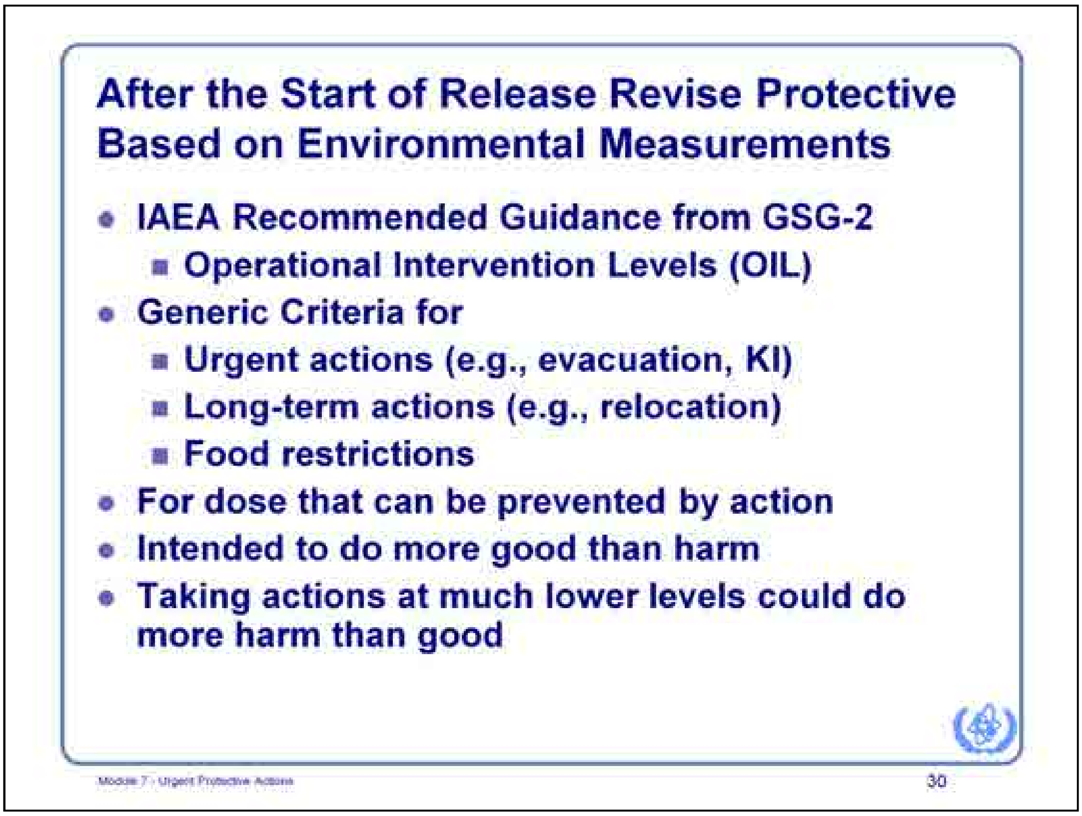
Lecture notes:

Protective actions are immediately taken only upon declaration of Site Area and General Emergencies. For Site Area Emergencies, non-essential personnel on the site will be evacuated or sheltered and the public and emergency workers prepared for further action. Upon declaring a General Emergency and if required based on environmental monitoring, evacuation, sheltering and thyroid blocking will be implemented within the PAZ and UAZ as planned. Sheltering could be initiated for a General Emergency before monitoring results are available. Access restrictions into the UPZ and PAZ should be implemented for a General Emergency or a Site Area Emergency. The goal is to take action before a release. All General Emergencies have the potential for a release affecting a very large area, therefore upon declaration of a General Emergency, potentially contaminated food should be restricted and countries within the food restriction distance and IAEA notified. Finally, for any emergency, implement a system to record the names of exposed individuals, especially children, to allow long term medical follow-up.



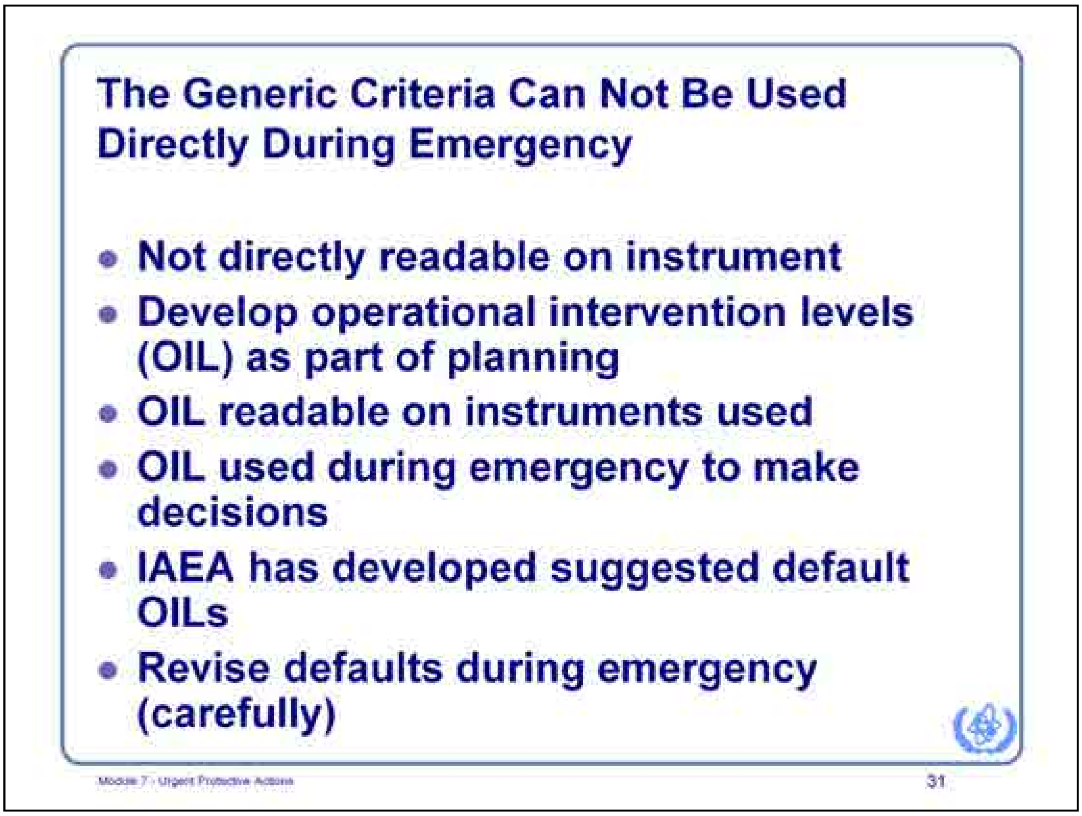
Lecture notes:

Once a release begins, the protective actions taken based on plant conditions (according to the emergency classification) may need to be revised based on environmental measurements.

These actions would first be directed at preventing deterministic health effects and secondly at reasonably reducing the risk of stochastic health effects. Deterministic health effects are prevented by keeping the total dose received below thresholds, e.g., keeping the total dose received to the bone marrow in a few days below 1 Sv.

GSG-2 recommends generic criteria for protective actions to reduce the risk of stochastic health effects as a basis for determining when protective action should be taken. These are repeated in EPR-RESEARCH REACTOR as Table C.2 in Part 1 and Table B.3 in Part 2. The values will be shown shortly.

In establishing the international guidance, an attempt was made to balance the pros and cons of taking action. For example, the guidance for evacuation is set at a level where the reduction in the risk of cancer is more important than the penalties and risk of an evacuation. Taking actions at values substantially lower than this international guidance or considering doses that can not be prevented may actually increase the risk to people.



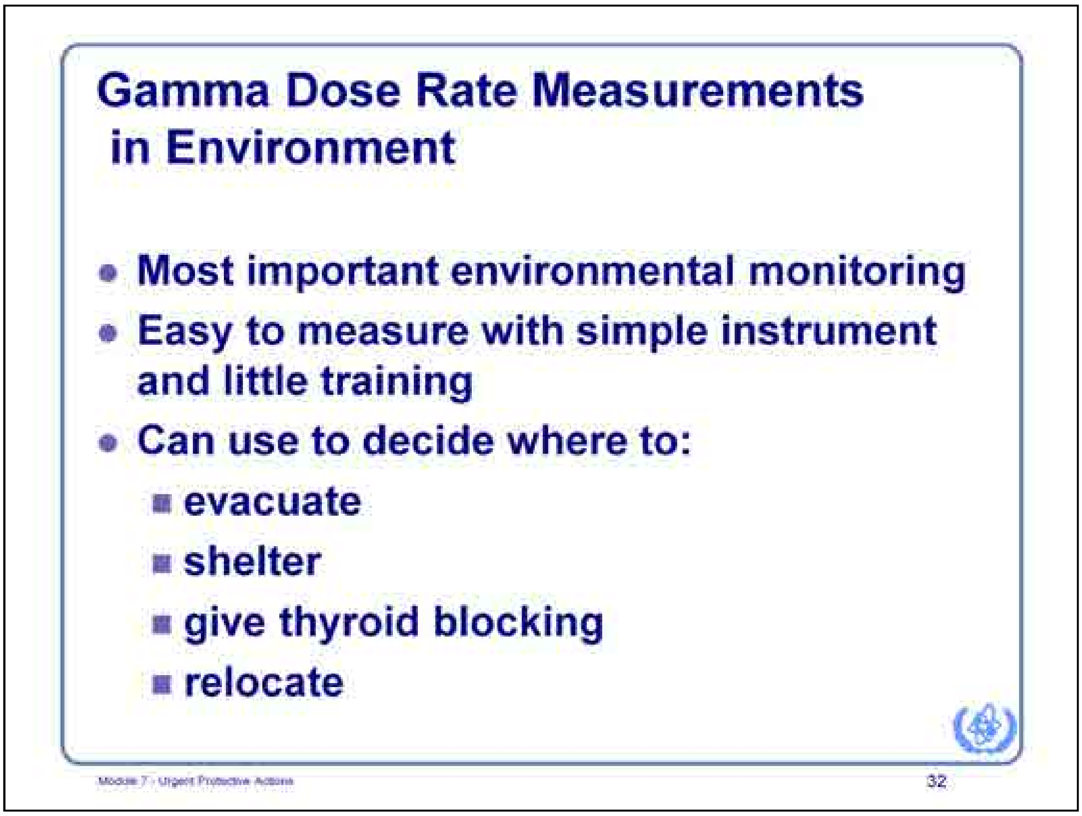
Lecture notes:

The generic criteria are not values measured by instruments in the field and must be calculated or determined in the laboratory. Since there will be no time during an emergency to perform such calculations, this guidance cannot be used directly as a basis for taking protective actions early in the emergency. Operational intervention levels (OILs) should be used during an emergency to decide promptly if protective actions are warranted. For example, areas with dose rates greater than 1mSv/h indicates evacuation is warranted.

Default OILs recommended by the IAEA in GSG-2 and repeated in EPR-RESEARCH REACTOR have been developed carefully and considered a large set of radionuclides, including a mixture of fission products. Action at the OIL is expected to protect all members of the public.

Procedures are available to make the OILs specific to the characteristics of specific instruments. This step should be performed as a preparedness action and the instrument-specific OIL table attached to the instrument.

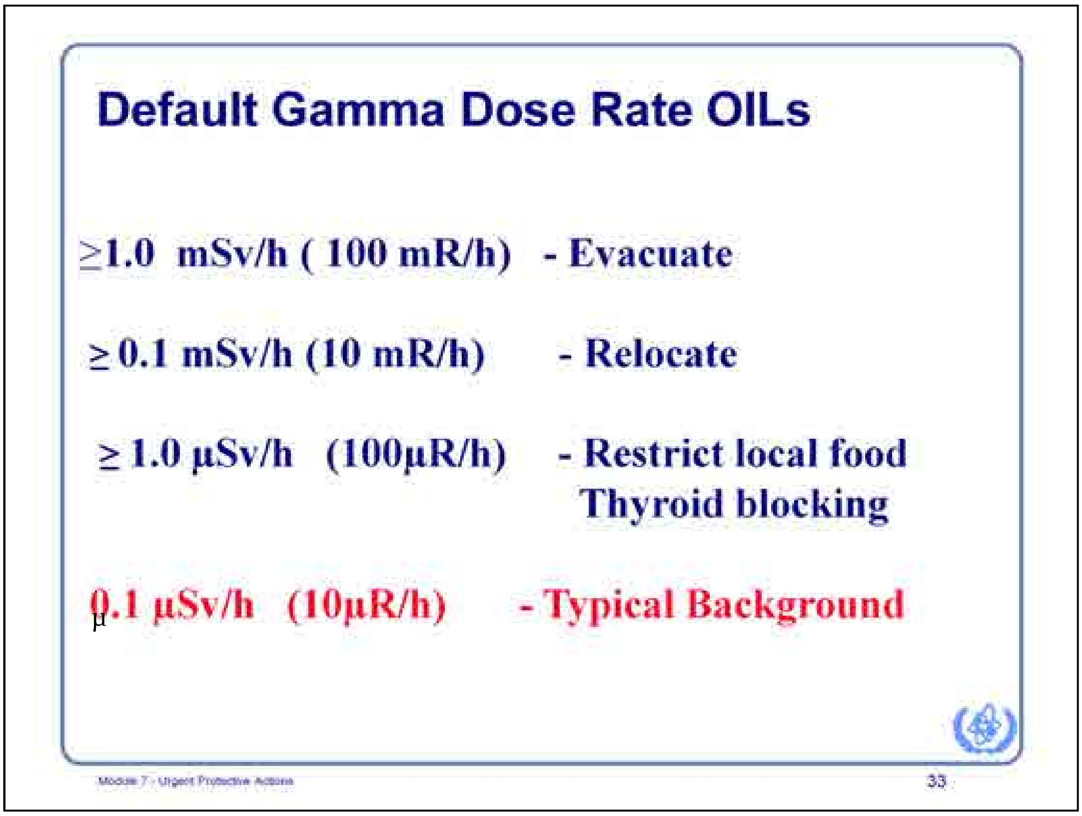
When the inventory of radionuclides is known from detailed environmental surveys, the default OIL values may be recalculated. A sudden change in the criteria for protective actions may cause confusion and create distrust among the population so any such change needs to be done only if there is a substantial benefit.



Lecture notes:

Gamma dose rate measurements are the most important environmental measurements made early in an emergency. Gamma dose rate is easy to measure with simple instruments by teams with only minimal training. Gamma dose rate measurements can answer the most important questions of indicating where deterministic health effects are possible and where urgent protective actions are warranted. For a mix of fresh fission products, only measuring gamma dose rate is adequate.

The default OILs now recommended by the IAEA GSG-2 are based on this type of measurement.



Lecture notes:

OILs for gamma dose rates are provided in GSG-2 guidance for determining when evacuation, sheltering, and food restrictions are warranted. Evacuation is warranted at 1 mSv/h (100 mR/h), and relocation at 0.1 mSv/h (20 mR/h). These levels can be easily detected using standard gamma survey instruments. The OIL for thyroid blocking is based on presence of fission products in ground contamination, and if foodstuffs are contaminated but there is no readily available replacement.

Immediate consumption of locally grown food or milk from grazing animals should be restricted in any area with gamma dose rates above background (e.g., 100-500 nSv/h) if reasonable (e.g., restriction will not result in food shortages). These restrictions should remain until the food or milk has been tested. Since background dose rates are variable the gamma dose rate OIL in the GSG-2 guidance is set at 1 µSv/h (1000 nSv/h) to be clearly above background.

Lecture notes:

This OIL comes from INTERNATIONAL ATOMIC ENERGY AGENCY GSG-2, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency.

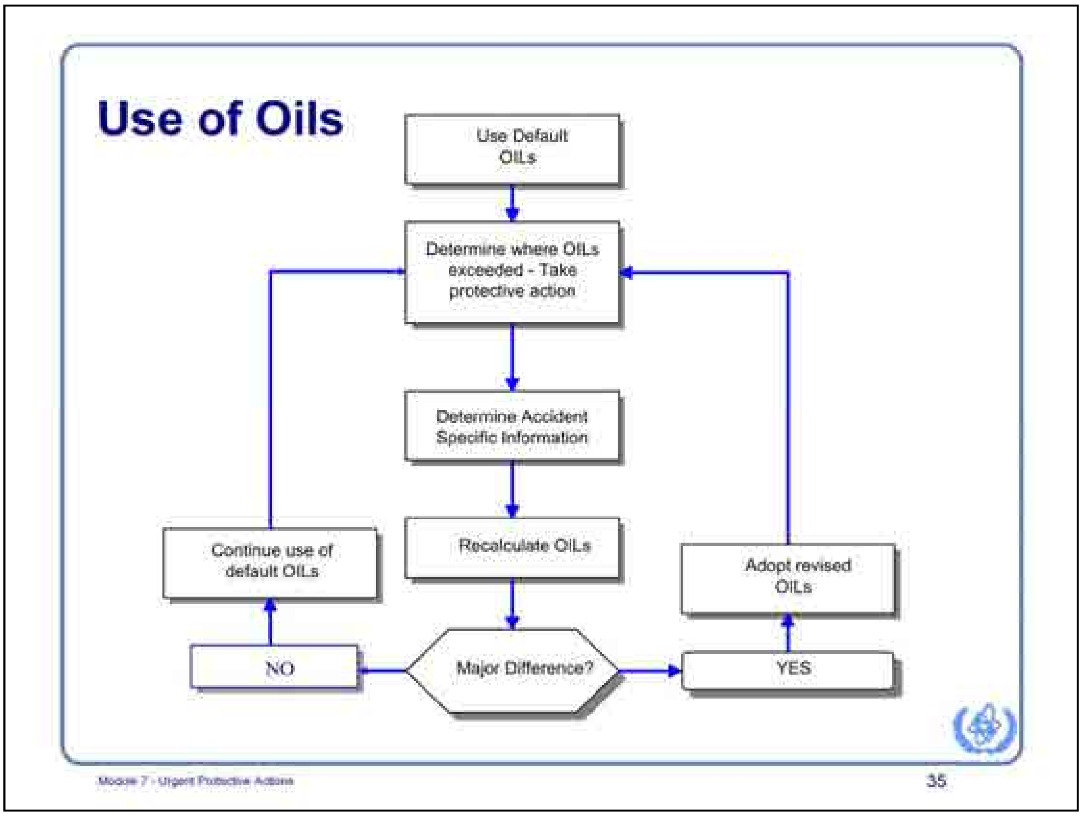
Emergency personnel entering an emergency area where a spill or airborne release has occurred needed to be checked on leaving the contaminated area for personal skin and protective clothing contamination. Their equipment and vehicles should also be checked.

Also, persons working or living in the affected area may become contaminated and where is suspected, they need to be monitored for skin and clothing contamination. This can be done in-situ or at designated contamination control or assembly points or on arrival at evacuation centers where whole body surface contamination monitors are advantageous for rapid and sensitive personal contamination monitoring.

For persons who require urgent medical attention and who may be contaminated, priority should be given to their medical condition and its treatment even if this means that first aiders, ambulance officers, paramedics or other medical staff may became contaminated as a consequence. If medical personnel use their standard personal protection procedures for handling bleeding patients, this will assist in contamination control.

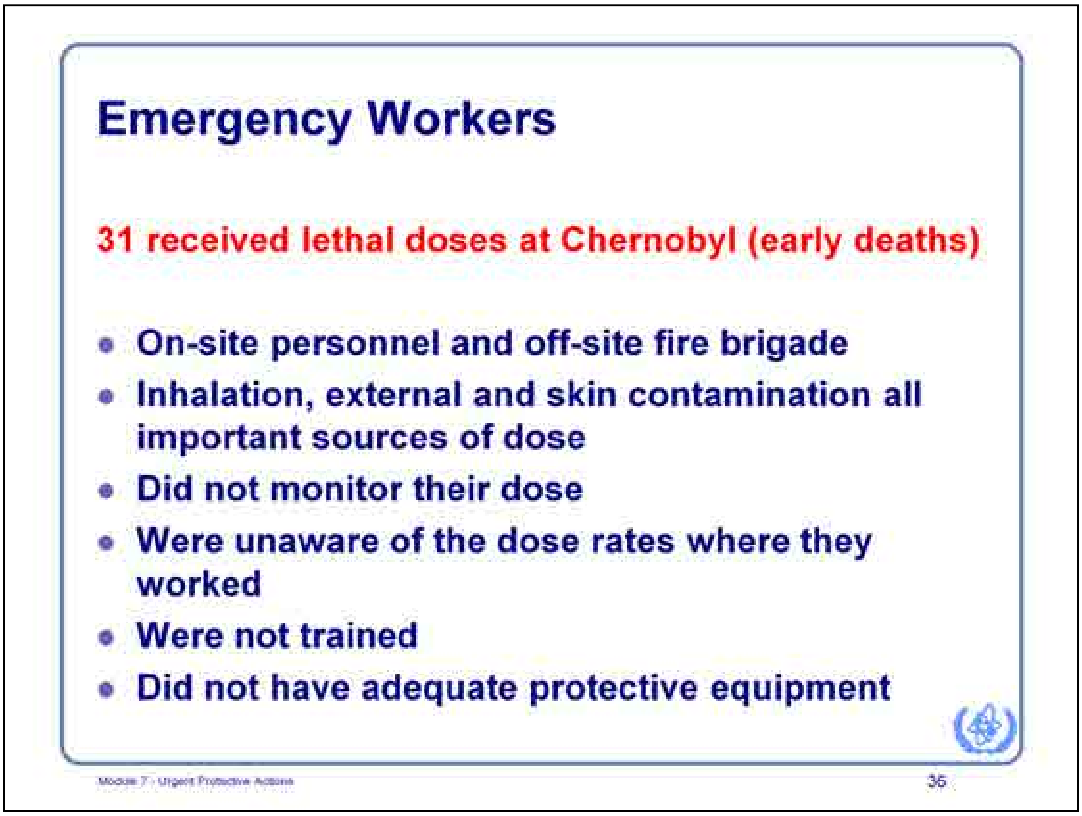
The contamination monitoring instruments used should be appropriate for detecting and measuring the contaminants in question to within specified skin and clothing contamination limits.

Be aware of the fact that most contamination monitors saturate quite early.



Lecture notes:

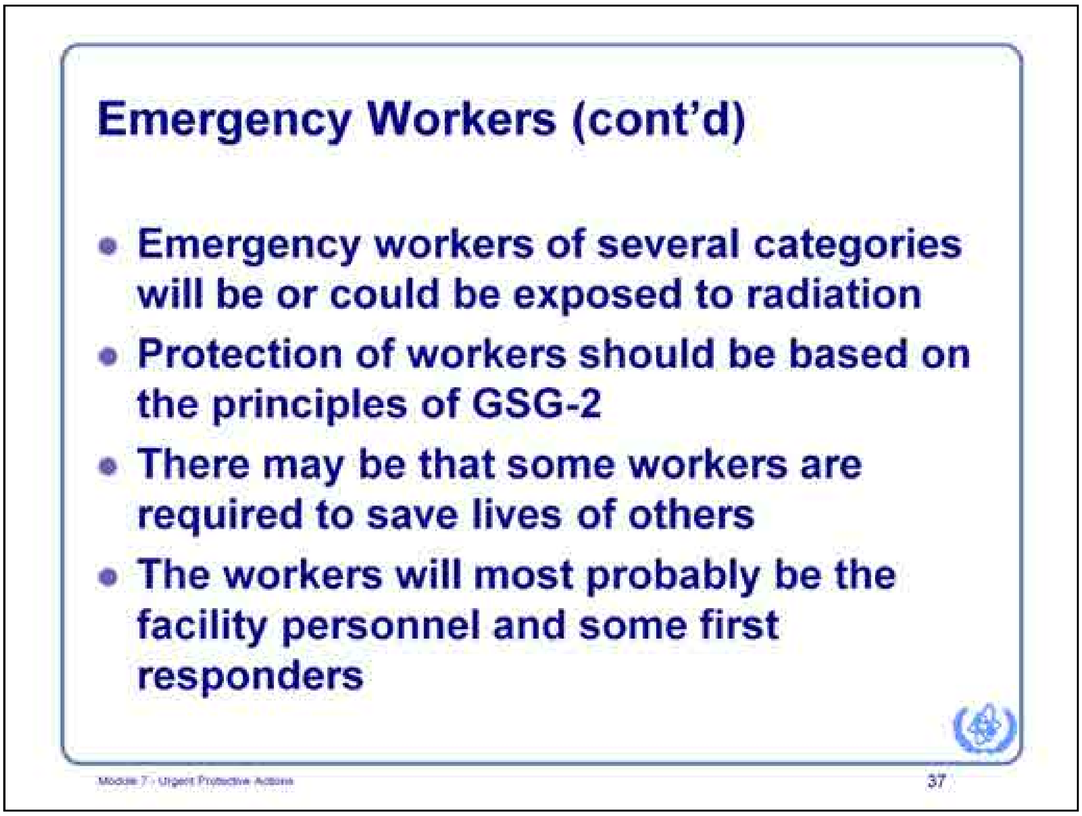
This summaries the use of OILs during an emergency. Initially the default OILs, developed during planning before the emergency, will be used. This will allow immediate assessment of environmental data. As soon as specific information about the emergency (e.g., isotopic mixture of a release) is known the OILs should be re-calculated using these new data. If the recalculated OILs result in considerably different protective actions then they should be adopted. These new OILs will then be used to assess environmental data and determine where protective action should be taken. The off-site authorities must be consulted before applying revised OILs to avoid confusion of the conditions requiring implementation or relaxation of protective actions in off-site areas.



Lecture notes:

During first few days of Chernobyl, 31 emergency workers and plant staff received lethal doses. This was a result of them not monitoring their dose and not being properly trained or equipped. Inhalation and external exposure were important sources of dose. Burns to the skin resulting from radio-iodine contamination was also a major contributor to many of the fatalities.

To prevent such tragedies in the future, the protection of emergency workers must be part of any emergency planning. All workers with the potential for receiving very high doses must continuously monitor their dose and be provided with training and protective equipment. This must include off-site personnel who may respond on-site such as fire brigades.

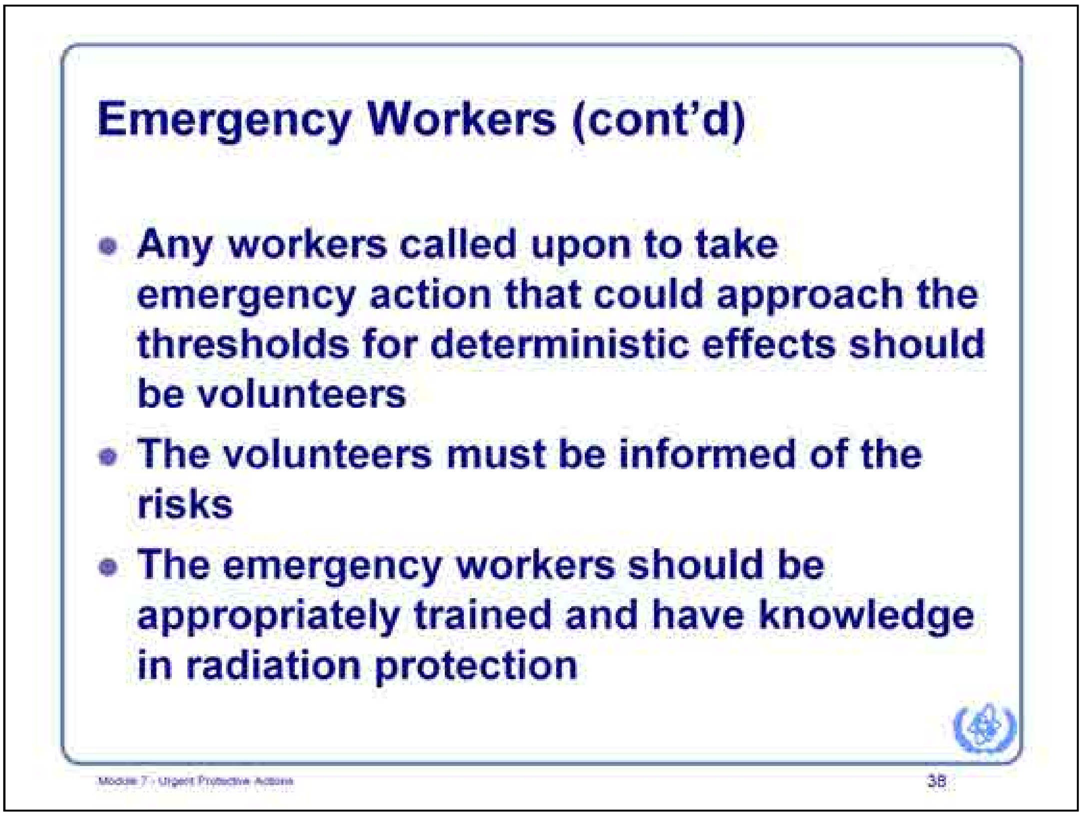


Lecture notes:

An emergency intervention on research reactor is potentially the most dangerous for the action participant i.e. emergency workers.

During and after a nuclear or radiological emergency, there will be a number of reasonably distinct circumstances in which workers of several categories will be or could be exposed to radiation. It is helpful to distinguish those circumstances because different control regimes should be applied in each case. In this module the circumstances are categorized primarily by the purpose of the work being carried out, ranging from immediate action to save life, through the implementation of urgent countermeasure or longer term recovery operation, to work not directly connected with emergency. In addition, a discussion is presented of the types of workers concerned.

The different circumstances of exposure are characterized by broad ranges of doses, dose rate and time duration. In general terms, the concepts and provisions to be applied to the protection of workers under those different circumstances should be based on the standards of DS379 and GSG-2, with note taken of its specific recommendation on the topic (see slide "Where get more information").



Lecture notes:

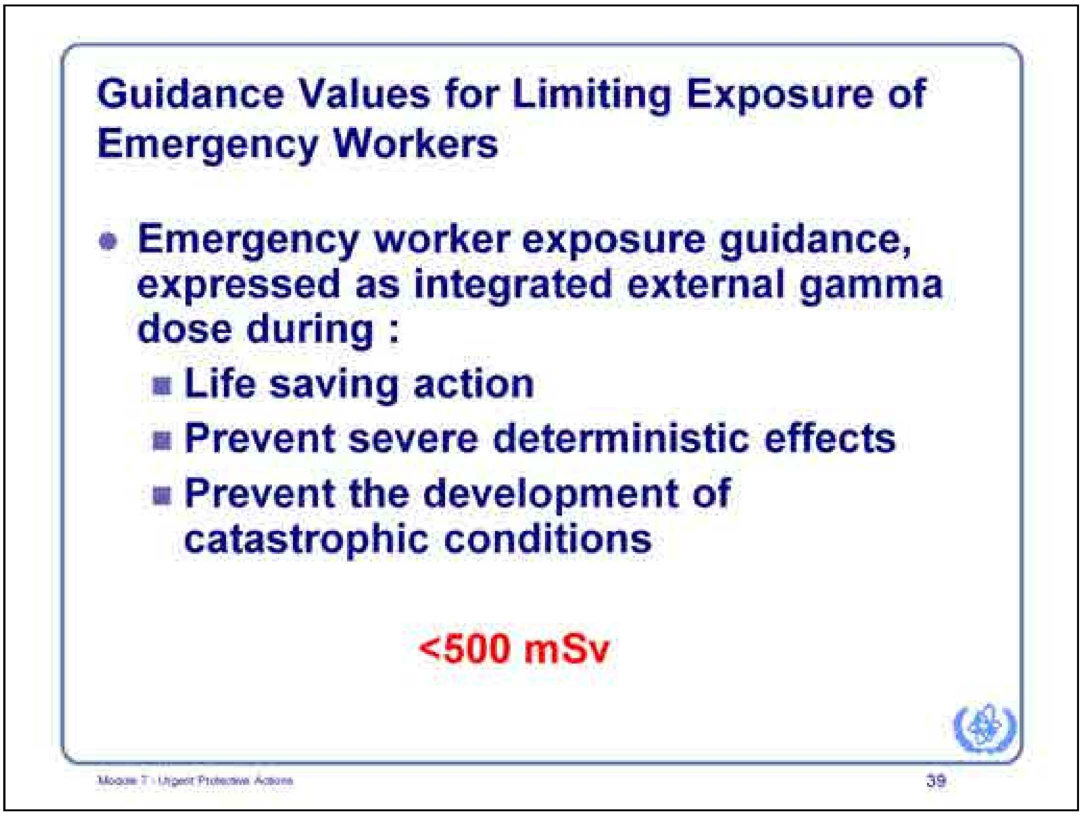
During and immediately after an emergency, there may be circumstances in which action by some workers are required save the life of others who have been or will be affected by the emergency and to prevent serious injuries. Action may also be required to bring and maintain the facility under control and to prevent or restrict release of radioactive material to the environment. It is unlikely that situation of the kind mentioned in the following slides will allow sufficient time to carry out an optimization of protection. Moreover, the individual dose limits will not be relevant in these situation.

Since the action are likely to be closely associated with the reactor facility or the installation at which emergency occurred and will often need to be taken rapidly, the workers taking them will most probably be the facility personnel. They should therefore have the training in radiation protection and should be familiar with protective measures such as respiratory protection, exposure time, distance from sources and shielding. The major potential exceptions are emergency service workers called to the scene of the emergency. Those workers are likely to include, firemen and medical personnel, and possibly workers from the other professions, depending on the particular circumstances. Provisions should be made for prior training of and provision of information to groups of such workers who may be required to assist (e.g. local fire brigade) and for making available the necessary protective equipment and dosimetry.

Any workers called upon to take action that could entail there receiving doses could approach the thresholds for serious deterministic effects should be appropriately trained volunteers and provided with information on the risk associated with different dose levels.

Emergency interventions that may cause doses to workers in approach of the thresholds for severe deterministic effects have a high degree of justification when they are aimed at saving human life or preventing very large individual doses to members of the public well above the thresholds for serious deterministic effects.

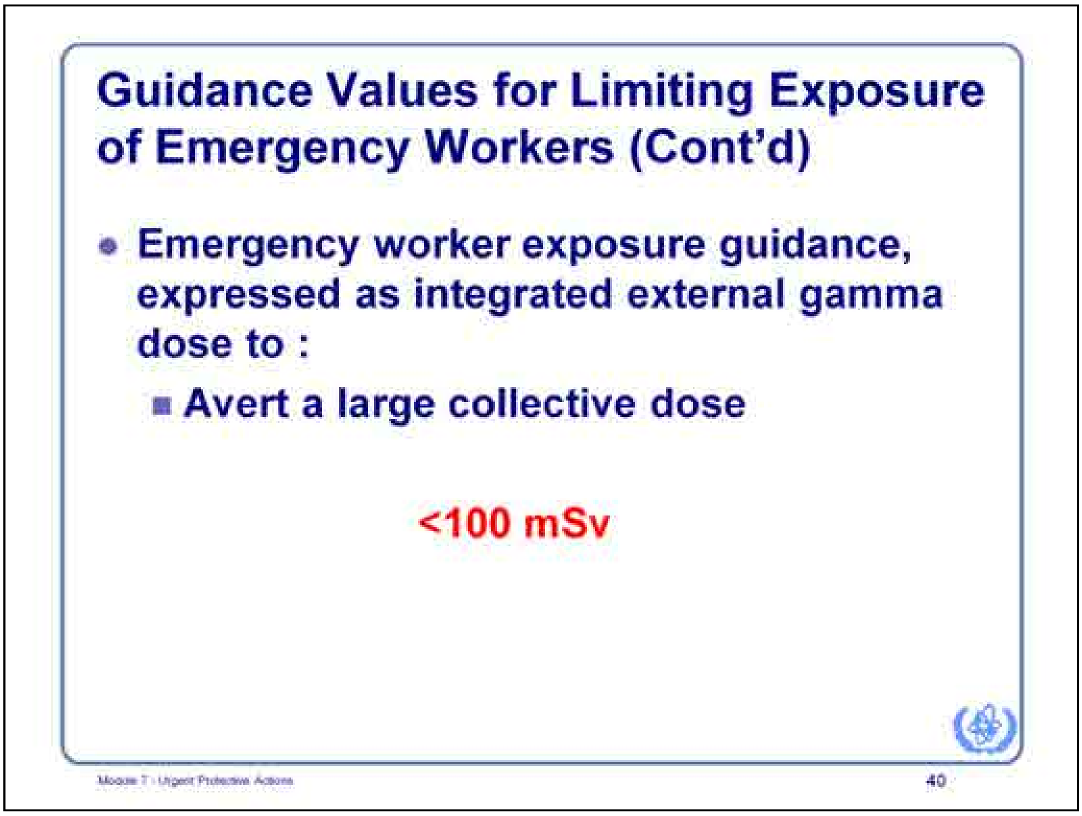
Intervention aimed only at protecting property, for example by preventing the destruction of or damage to an installation, but which will not mitigate radiological consequences, can not be justified on radiation protection grounds.



Lecture notes:

Emergency worker dose guidance should be given as an integrated external dose on a self reading dosimeter. Emergency worker should take all reasonable efforts not to exceed this value. These values have been calculated to account for the inhalation dose from a core melt assuming that the thyroid blocking has been taken. It should be noted that skin contamination can also be major source of dose and can lead to deterministic health effects for worker in highly contaminated areas if they are not provided with adequate protective clothing. Emergency workers turn back doses are are to serve as a guidance and not limits. Judgment must be used in their application.

These dose can be exceeded if justified but every effort should be made to keep dose below this level(thresholds for deterministic effects). The emergency workers should be trained on radiation protection and understand the risk they face.

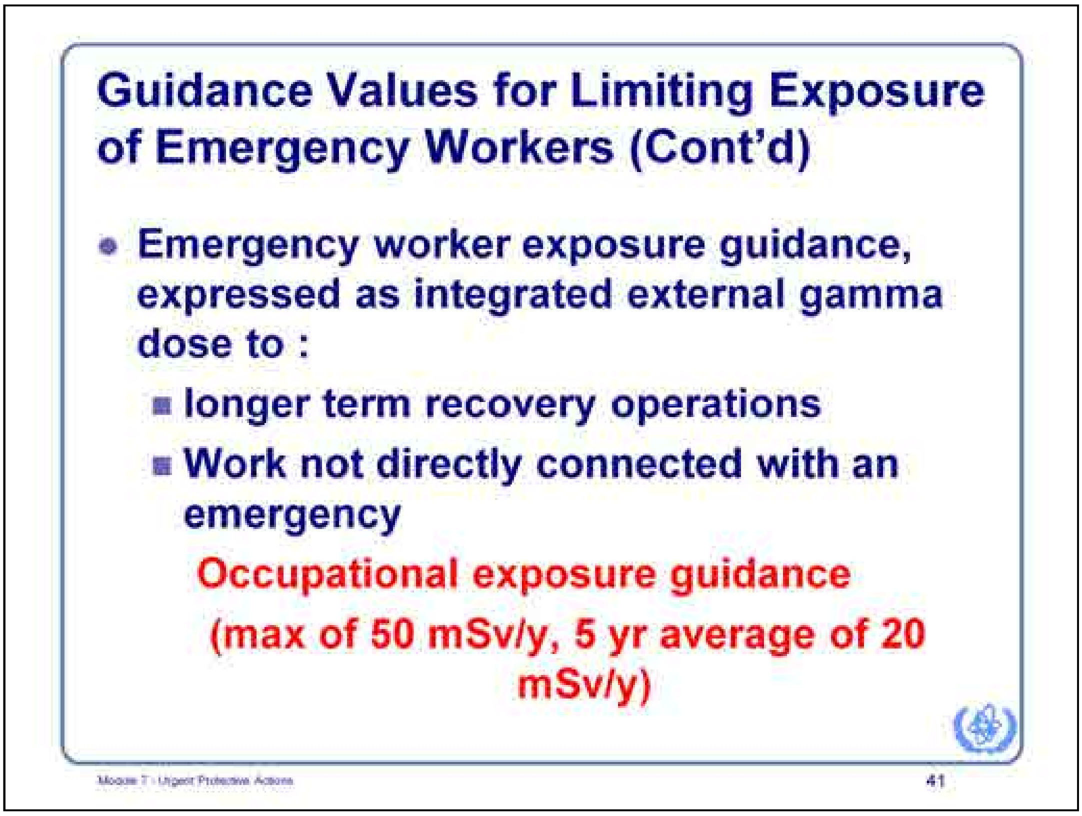


Lecture notes:

When intervention is aimed at preventing an escalation of an emergency that may entail substantial individual or collective doses to public, it would be probably still be justified by the expected benefit from the mitigation of the consequences. However, it this circumstances workers should not be exposed in excess of the thresholds for serious deterministic effects.

Intervention aimed only at protecting property, for example by protecting the destruction of or damage to an installation, but which will not mitigate radiological consequences, cannot be justified on radiation protection grounds.

Even when a radiation source has been brought back under control, there will be other urgent and necessary tasks to perform at the reactor site to maintain essential services and to ,safeguard other items of the facility or equipment. Those may be carried out by the workers normally employed at the facility. They may also be performed by workers who are not normally exposed to radiation.

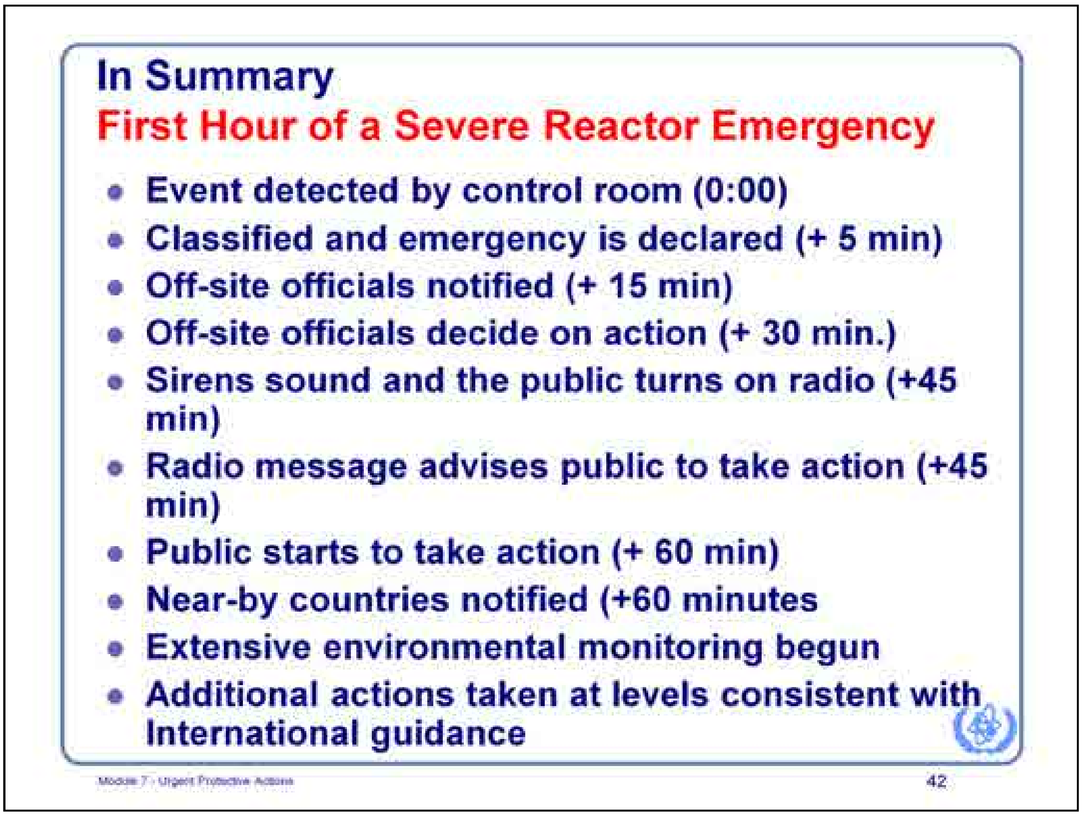


Lecture notes:

Once the situation after an emergency has been brought under full control and essential facility site services have been re-established, recovery operations may take a relatively long period. These operations are likely include decontamination, repairs the facility buildings, waste disposal and all the other industrial operations necessary either to restore the situation to normal or to leave the site in a state that may endure more or less indefinitely. This also includes the cleanup of the site and the surrounding areas.

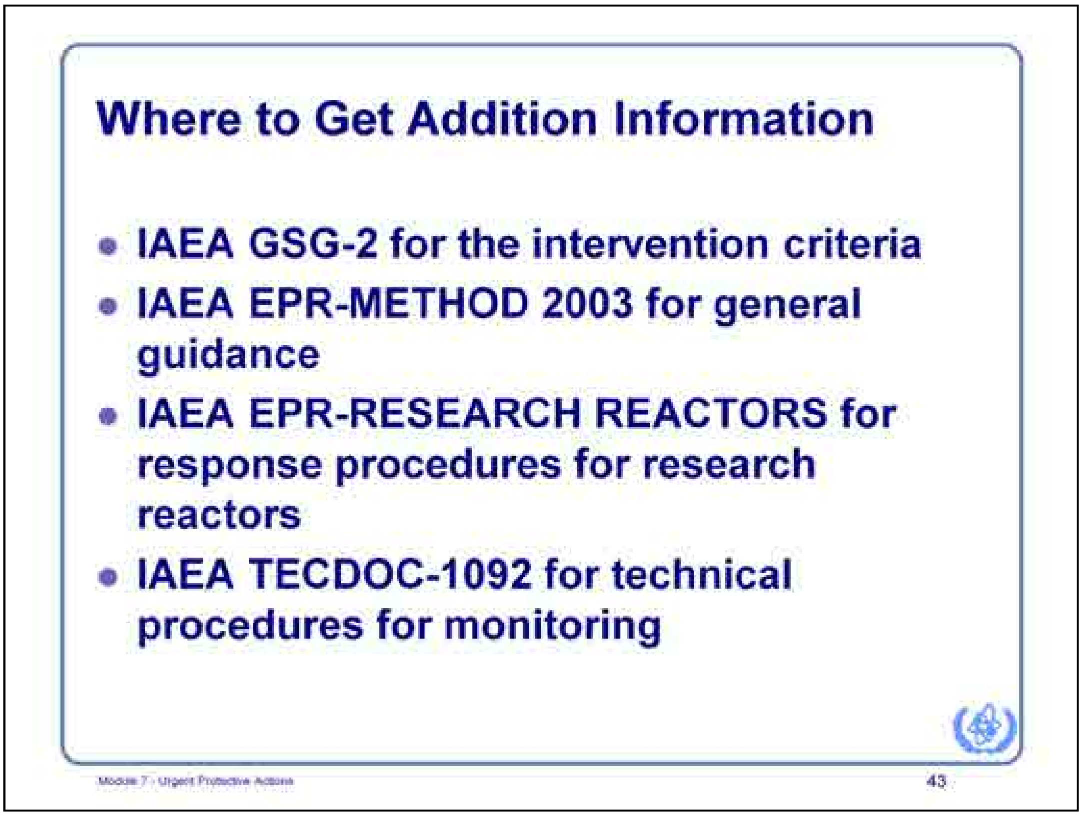
These operations, although made necessary because of an emergency, present no inherent features that are different of those of normal operations in terms of the radiological control regime required. The action needed can be carefully planned, workers can be trained and medical supervision and dosimetry services can be provided. The workers required can be brought in or employed especially for the purpose.

Over the period and for the recovery operations, the workers participating should not be treated differently from those carrying out similar tasks, e.g. maintenance of installation or in the facility or site decommissioning operations. The full system of radiation protection should be applied.

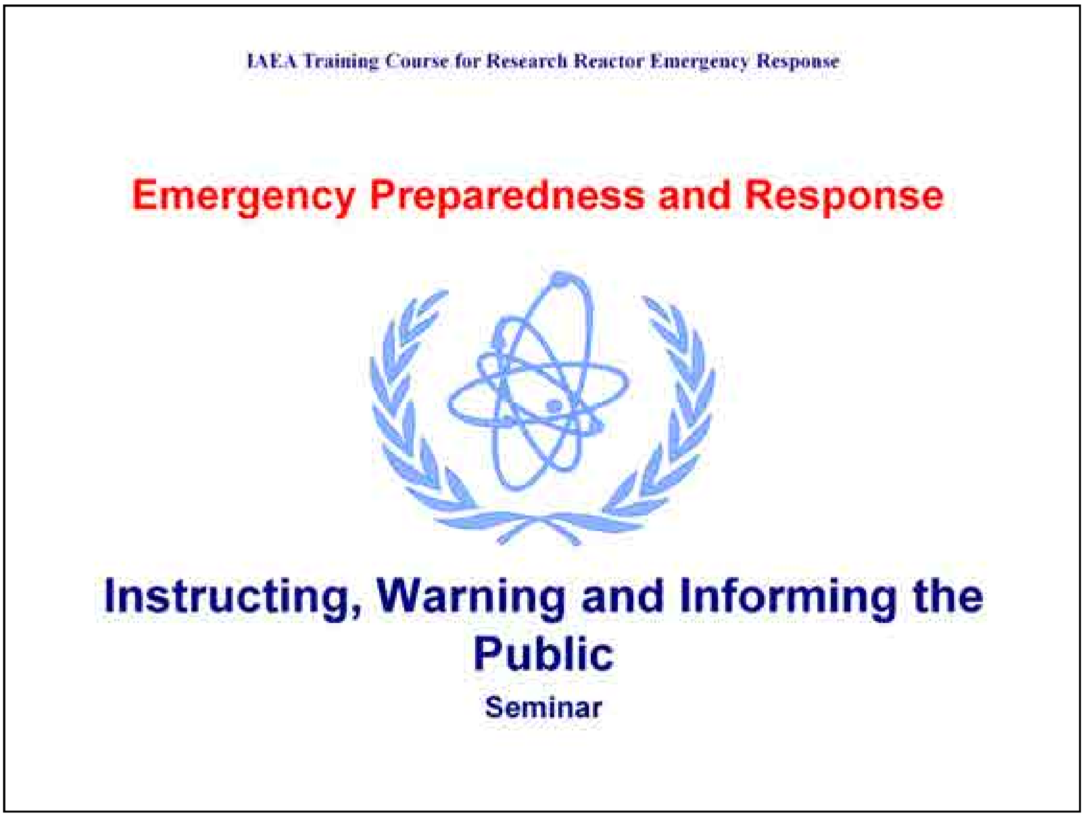


Lecture notes:

Our goal should be to act locally and internationally in the event of a severe reactor emergency to take appropriate protective actions to protect workers and the public. For severe accidents, actions must be taken promptly - there is no time for meetings or other time consuming activities. The control room staff will detect and classify the emergency as a General Emergency within a few minutes. They will immediately notify off-site officials of the event and its classification. The off-site officials will implement their predetermined protective actions. Someone living near the plant should receive a warning and instructions on the actions to take within 1 hour of detection of a General Emergency. All the nearby countries should be notified quickly and extensive environmental monitoring begun. Based on the monitoring, all the countries take additional actions at similar environmental levels that are consistent with international guidance.



These documents are all available for download from the IAEA Publications Web page.



Block 3: Emergency Preparedness and Response
Module 8: Instructing, Warning and Informing the Public

Note: This file contains several hidden slides!

Learning objectives: Upon completion of this module, the participants will:

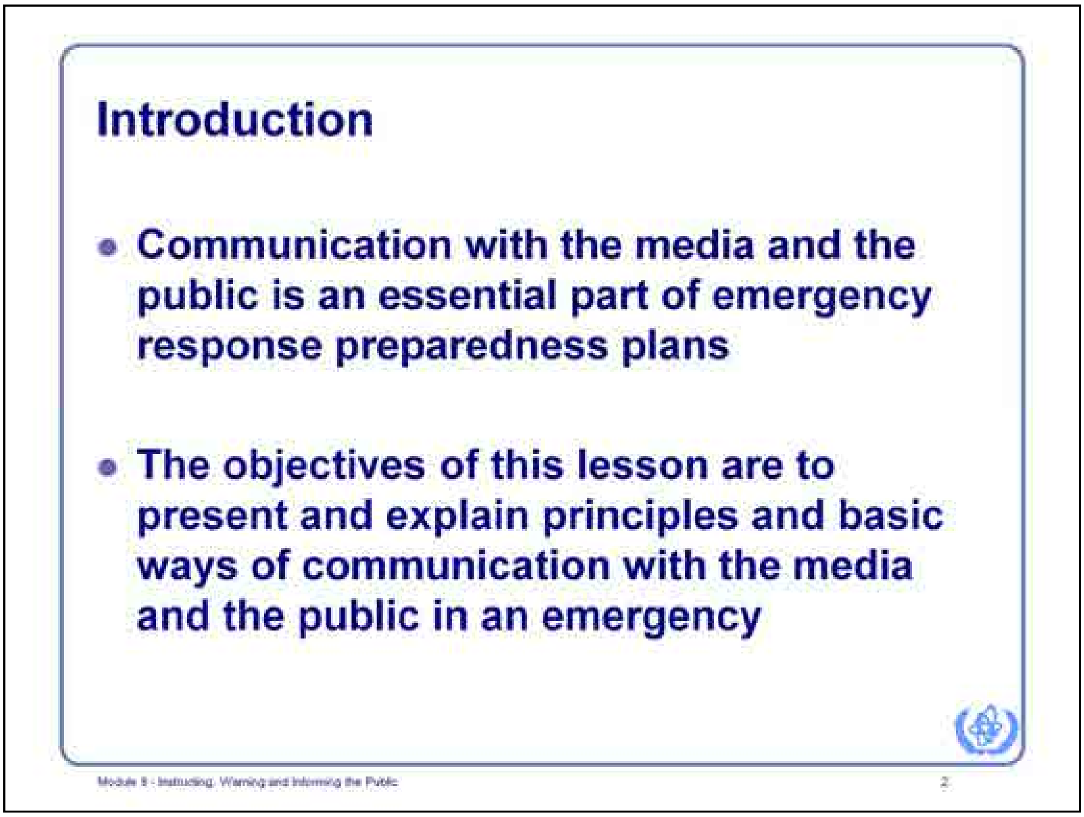
- know why it is important to communicate with the media
- know the basic ways of communication with the media and the public in an emergency
- be able to determine when and about what to inform
- become aware of basic principles of communication
- be familiar with the communication methods and means

Activity: Seminar, questions and discussion
Duration: 30 – 45 minutes

Materials and equipment needed: Optional - Media Briefing/Interview Planner Worksheet (one copy for each student)

References:

1. INTERNATIONAL ATOMIC ENERGY AGENCY, Communications on nuclear, radiation, transport and waste safety: a practical handbook, IAEA-TECDOC-1076, IAEA, Vienna (1999)
2. INTERNATIONAL ATOMIC ENERGY AGENCY EPR-FIRST RESPONDERS 2006, Manual for First Responders to a Radiological Emergency, IAEA, Vienna (2006)
3. INTERNATIONAL ATOMIC ENERGY AGENCY, Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency, EPR-METHOD 2003, IAEA, Vienna (2003)



Lecture notes:

Experience has shown that failure to have adequate arrangements in place and the commitment of resources at the time of the emergency, can seriously hinder actions to bring the emergency under control, the implementation of longer term restorative measures and the credibility of the Authorities.

The objectives of the lesson are to explain the ways of communication with the media and the public in an emergency, to explain when, how and about what to inform and finally to give some basic principles of communication.

Lecture notes:

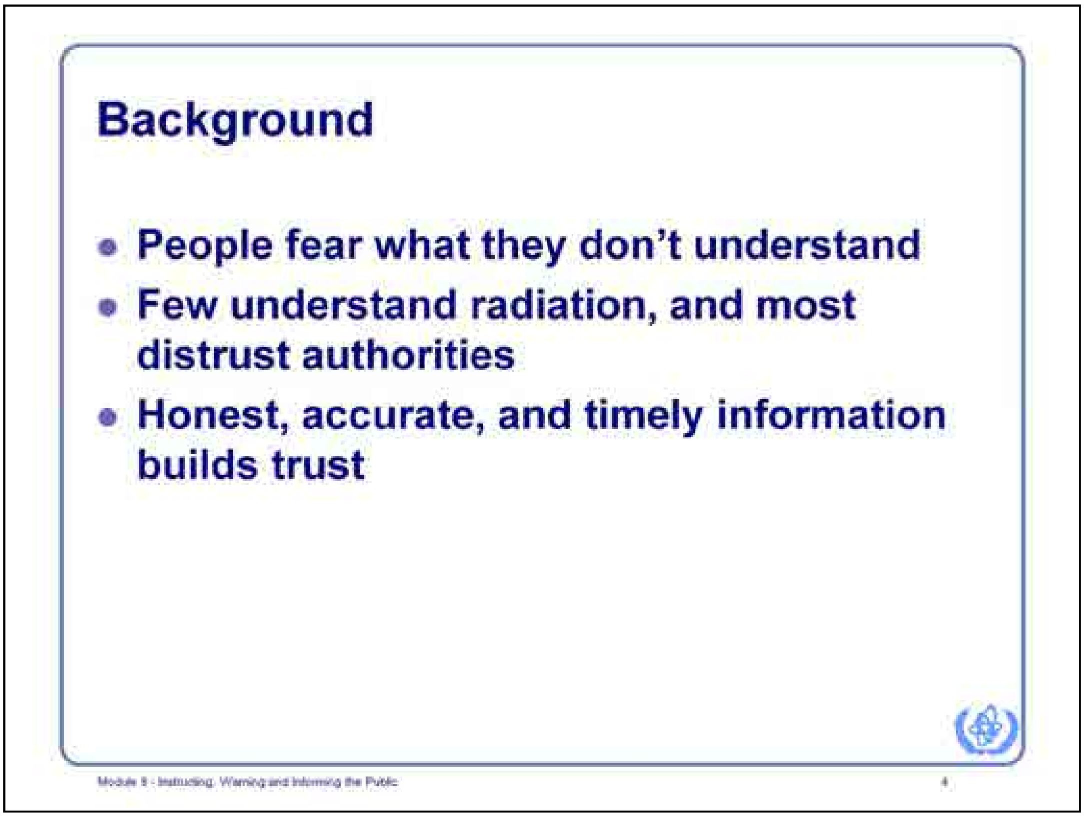
Communicating with the public and the media is an essential part of a good emergency response. In this module, we will examine why. We will explain why media communications is the best way to get to the public in an emergency. We will also discuss how to communicate and how to foster a constructive relationship with the media

There are several basic principles of communication we will discuss which if used increase the chances of you getting your story out successfully.

We will focus on two methods to communicate with the media and the public – the media briefing or interview and the press release.

This module includes a worksheet developed to help you organize information for a media briefing or interview.

Appendix VII of TECDOC-1162 (page 156) will serves as the basis for this module.



Lecture notes:

All radiation emergencies perceived, as being dangerous will receive an immense amount of media, public and political attention. In general it is not the actual risk that drives this attention but the perceived risk. Slow, non-informative and uncoordinated response by officials and operators to this media and public attention has resulted in confusion during the response, and significant psychological, economic, and political damage. Since the media is often the primary source of information for the public during an emergency, provisions must be in place to immediately address the public and the media interest during an actual or perceived radiation emergency.

Lecture notes:

Hidden slide

The importance of effective communications with the media in emergency response cannot be overlooked. In any significant incident, media interest will be high. News is a 24 hour activity. You may even find that the media finds out about an incident before the government response agencies. With the advent of 24 hour news, seven days a week and the internet, you can be sure that if there is a radiological incident of any significance, there will be media interest. That is not all bad! Like it or not, the media plays an important role in getting information out to the people and helping to form opinions.

As emergency responders, if you deal with the media in an appropriate way, you can use the media to increase public understanding of the incident, get the word out on protective actions, and give the public confidence in the work you are performing.

This will only happen however if the media effort is coordinated and information is provided by those designated to deal with the media.

Why Inform the Public?

- Provide correct information to public
- Ensure the appropriate public response

- Maintain credibility
- Responders can focus on response
- Reduce the psychological impact

Lecture notes:

Appendix VII (pages 156-158) of TECDOC-1162 briefly discusses why it is important to communicate with the media.

If you do not get the facts out to the media, who will? The media will get the story out – it is better to have them report it with your facts and details than for them to rely only on their own sources.

By providing information to the public – the public will be aware of what is going on , how it impacts them, and what actions they may have to take and you are restating the expected response to the protective actions appropriate to the emergency. People are less likely to take unnecessary protective action if they are kept informed and reassured that they are not in danger.

Official information can directly put an end to speculation and rumor.

By showing that your organization is on the job and responding to the challenge, you can build trust and credibility in the effort.

If you organize and give the media timely information, provide them a designated area, and work with them in obtaining coverage, this will allow your response organization to focus on their immediate response tasks without worrying that the “responsible” media will interfere (there may be some journalists out to make a name for themselves and will not cooperate).

By providing accurate and timely information to the public, they will have the sense of knowing what has happened, why it happened, when things will return to “normal” (if they will) – this can reduce the psychological impact an emergency has on individuals.

This is especially true with radiological accidents which do not happen frequently, are not understood well by the public, and are man-made. (Source: 1995, Emergency Public Information Pocket Guide, Emergency Management Laboratory, Oak Ridge Institute for Science and Education)

Lecture notes:

There are several ways to communicate with the public. We can do it directly or indirectly. Direct communications involves the use of a system to “talk” to the public. For example, this includes warning systems such as sirens, the use of well-placed community people who have the trust of segments of the population (e.g. priests, doctors) or special public audiences. Not all of these are effective during an emergency.

Indirect methods involve the use of an intermediary such as the media. As we will see, this is one of the most effective ways.

Lecture notes:

Hidden slide

The use of sirens, sometimes coupled with special loud speakers for instructions, is wide-spread around nuclear power stations. The major drawback is cost. Also, the verbal instructions are often difficult to understand, and the message does not always reach everybody, e.g. deaf persons of people working in noisy environments.

There are also new systems coming out that allow visual and audible messages to be sent directly to the home or office telephones. These systems are being implemented in some parts of the world and are still more or less experimental.

Truck with loud hailers can be a useful way to reach the population, as was the case in TMI. However, they do have a tendency to create panic and are not effective at reaching everyone.

Lecture notes:

Bottom line: the media is often the first to be at the scene of an emergency and, thanks to radio and TVs, is usually the first to report the emergency. If not properly managed, the media WILL report news, but this news may not necessarily be accurate, as was the case at Tokaimura, where the media created confusion regarding sheltering distances an even mislead the population by saying at some point that an explosion had destroyed the roof of the facility.

Also one should not discount the Internet as both a source of news for the public and a rapid rumor spreading mechanism. The IAEA maintains a Web site and process where information releases can be posted and reactor facilities have access to that system through the State’s Competent Authorities.

Lecture notes:

To communicate effectively with the media, you need to understand how the media works!

Lecture notes:

If there is a radiological incident, the media will be interested in the following:

- What happened? What are the consequences?
- Who is responsible?
- Who will pay for losses?
- How much will be received for the losses?
- Extent of injuries/deaths?
- Is water/food/air contaminated?
- Who will take care of evacuated homes?

(source: 1999 IAEA Communications on Nuclear, Radiation, Transport, and Waste Safety: A Practical Handbook)

They will want to interview, speak with eyewitnesses and first responders about what they saw. They will want to know the extent of response, what assistance is being provided, and any acts of heroism.

The media also like specific numbers and statistics, especially when verified.

All media have deadlines, all want access to the scene, and interviews with response leadership (Emergency Manager and On-Scene Controller).

You don't have to provide access to the facility and the responders and you may not know the answer to every question asked.

Lecture notes:

Hidden slide

The media have gained an unprecedented profile in our day-to-day lives. They are everywhere, and they know everything, often before the authorities find out. With this prominence comes a power of information which is difficult, if not impossible, to rival. Therefore, the media cannot be controlled; do not even try.

Emergency plans should recognize this fact of life and build on it. The need to deal with the media in a prompt, accurate and effective manner should be an important component of every emergency plan. Dealing with the media during an emergency is not an exercise in “public relations”; the aim is not to “massage” the facts so that authorities look good. The media want facts, not public relations. And they want it fast! If journalists do not get the information they want from the authorities, there is a good chance that they will find it somewhere else; and it may not be right. Journalists have a job to do, and they will do it. The best way to ensure that the information they publish is accurate is to give them the accurate information!

The media should be educated. They can be a great communications tool during an emergency for conveying information to the public. They can be allies if treated fairly and diligently.

It should be remembered that very few journalists have the necessary technical background to understand all the technical issues. The task of communicators and spokespersons is to bridge the technical gap.

In practice, there should be only one spokesperson for each emergency organization. This will ensure consistency of information, but should not delay that information.

The media should be monitored to detect any false information and steps taken to rectify it as quickly as possible.

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Lecture notes:

The following “Fundamental Principles of Communications” are found on page 157 of TECDOC-1162.

Organizations that communicate well are more effective over the long-term than those who remain silent and obscure information.

Less can be more: people look for depth, not breadth.

Communication is a job for ***trained communications experts*** who work indirect consultation with technical nuclear professionals. The communication function should be placed at the ***executive level*** within the organization to facilitate information exchange and co-ordination.

Communication must be on-going and predictable. It is not possible to establish trust with silence or with communication only when there are problems.

The foundation of trust is openness, even when the information is an embarrassment. A Regulatory Authority must develop and protect its credibility just as it protects public health and safety.

Use terms that are simple and easy to understand and avoid “insider jargon.”

Build ***evaluation methods*** into the programme and ***annual budget*** and use the audience’s need for information to guide the programme.

Lecture notes:

In preparing these and other communications one should be clear what the target audience is. For small scale accidents it may be restricted to the workforce and possibly their families, while for large scale accidents it will be the general public, although there will be groups who are particularly affected and may need to be addressed separately.

Communication will obviously need to be maintained throughout the emergency and may be necessary for some time after: this will be particularly so in the restorative phase after an emergency with widespread consequences. There will also be a need to communicate what is being done to prevent re-occurrence of such incidents.

For large scale accidents it may be necessary to produce leaflets and other documents targeted at the public and specifically on the circumstances and consequences of the emergency. Experience from previous accidents such as the on in Goiânia, Brazil indicate that significant resources may have to be committed to meeting this need, and may need to include:

- “hot lines for people to telephone;
- meetings with interested groups;
- with increasing access to the Internet, placing material on a dedicated Web site may help.

Lecture notes:

The release of information is your opportunity to get your message out to the media, as opposed to reacting to their questions. Think about whether you would rather have time to prepare a correctly worded statement that addresses the key points of:

What is the problem

What are the risks to the public

What is being done, or has been done, to correct the problem

or would you prefer to respond without a prepared statement to shouted questions from a group of reporters, some of whom may not be at all sympathetic to your problem and who may assume that since you don't have a prepared statement that you are not prepared to speak to the media or to correct the problem.

If your communication procedure is to not take questions from the media, then your message is all they have, and you should provide the needed facts of what is the problem, what is the public threat, and how is it being corrected.

Most people, and reporters are no different, will quickly judge your approach to the emergency and the degree of organization in the response, plus an appreciation for the safety of the public. So start with a statement that shows how well your emergency response is organized.

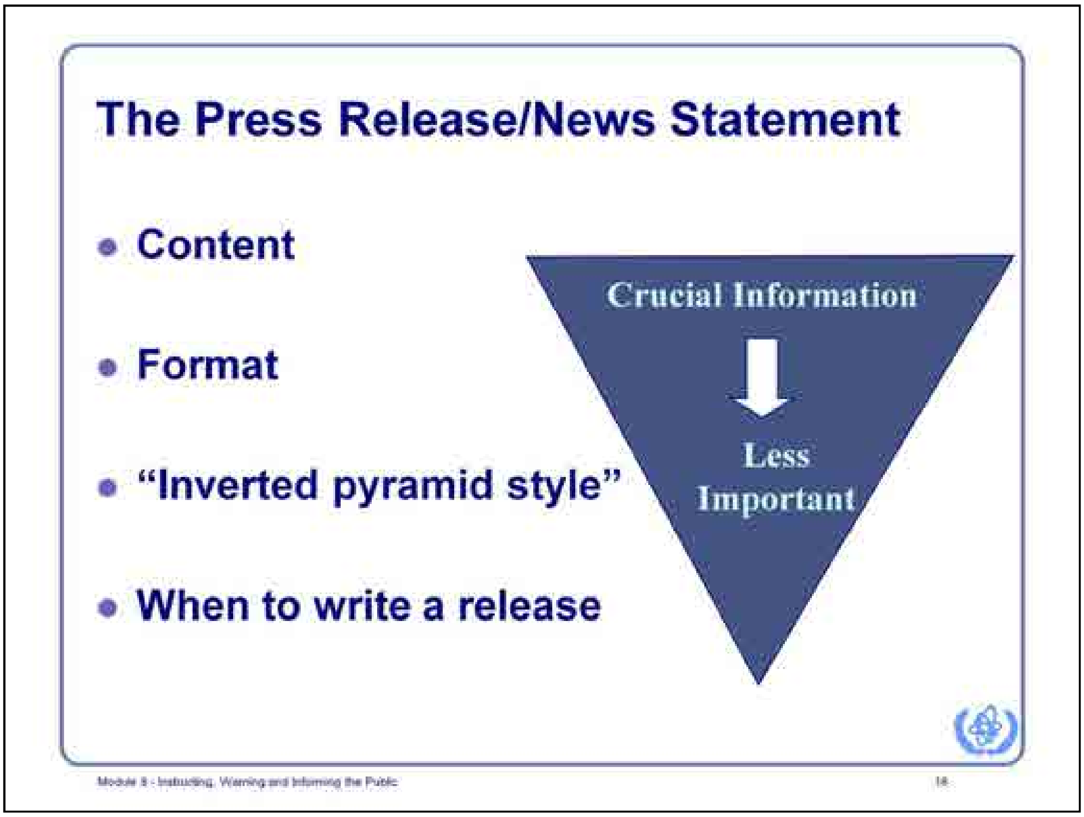
Lecture notes:

Hidden slide

Information cannot be provided to the media and the public in a haphazard manner. The Emergency Manager and/or On-Scene Controller(or designee) must approve all statements and press releases. Responders need to know the policies on speaking with members of the media – what they can speak to and what they cannot. "No comment" responses are looked upon favorably by the media. All responders should be aware of who their spokes person is so they can refer media inquiries to the appropriate person.

Does your emergency response plan and procedures provide for these considerations?

While the media will want to be as close as possible to the scene, it is usually not practical. If there are a large number of media and numerous response agencies, you may wish to establish a news center (there are several accepted terms for this facility – joint information center, emergency public information center, media center). Here all designated spokespersons will be available to the media. Each speaks only to their own jurisdiction/agency's role and operations. Example: police spokesperson speaks only to police operations, fire about fire, etc.



Lecture notes:

Hidden slide

In addition to media interviews, briefings, and meetings, another means of providing information to the public and media is through a press release, also called a news statement.

A press release should be on the letterhead of your organization, include a contact person, phone number, date/time or other identifier, and identify for immediate release. Try not to make it more than two pages double spaced, longer messages will not be read and your message may be lost.

The content should be written from the perspective of your organization. Do not speculate, use simple declarative sentences. Focus on facts, do not speculate or predict without well-grounded information from experts. Clearly identify quotes by name and organization.

Use what is called the inverted style. The lead sentence should include the most important information – the 5Ws+1 (who, what, when, where, why, and how). Prioritize each additional sentence and paragraph and write in declining order of importance.

Write press release/news statement when:

- You need to provide information or persuade a specific audience to take action
- You feel the media can help you reach your target
- You need to publicly establish a position on behalf of your jurisdiction or company
- You need to update old information or address false information

Let's turn out attention to the special considerations of media operations on-scene.

Lecture notes:

Hidden slide

There are numerous considerations when considering "boundaries" for the media.

Safety: Is it safe for the media to be in the area? Is the media's presence endangering themselves, response personnel, victims, public?

Interference: Is the media interfering with department operations or the ability of personnel to perform duties?

Legal: Can we legally prevent or allow the media from being in the area? Is the area a public place?

Is this a private business and do we need approval from owner to let media in?

Can airspace be closed above the incident scene to limit media helicopter coverage?

Fairness: Are we allowing all members of the media equal access to the incident? Are we treating print and broadcast media alike?

Range: Can the media hear conversations that we may not want overheard? Are they too close to the command post?

Convenience: Is there room for the media to bring in all their equipment, satellite trucks? Is there sufficient electrical, restrooms, and work area?

Monitor the media: This can be helpful in countering rumor, also occasionally it is helpful in that the media might have information you do not!

Lecture notes:

Hidden slide

If the decision is made that for safety reasons only a few media representatives should have access to the scene:

- Tell media you want to set up "pool coverage" for example – 2 from TV, 1 from radio and newspaper to act as pool members
- They will need to select their own representatives (normally different representatives are selected each time)
- Pool members are admitted to the scene
- Pool members, upon return, are interviewed by other media representatives; video/film is shared
- Peer pressure among media forces sharing
- If it is not working, issue warning, that pool coverage will be terminated completely
- Advances in information technology enable instant communication internationally. Use of satellites for transmission, cell phones, laptop computers, allow reporters to report live from the field.

These same technologies can work to your advantage – data can be gathered more quickly, the public can be alerted and warned more quickly also.

A special note – if there is a major incident, you can be assured there will be dignitaries and other top officials who will visit - so plan for it. They will want to have their appearance covered by the media. This can place special burdens on the response. You will have to work with the official's representatives to work out an acceptable arrangement.

We will now begin to focus on the methods to get information out to the media and public - a primary mechanism is the media briefing and interview.

Lecture notes:
Hidden slide

Media interviews can be done in numerous ways.

Remember if an interview is live your answers are instantly transmitted so choose your words carefully, stay calm, maintain eye contact and keep answers short.

Print journalists need more time in an interview, more background information, details, and analysis. Broadcast journalists need accommodation for radio, TV equipment and crew

Generally, all reporters want the basic facts – who, what , when, where, why, and how (5 Ws + 1). They need the facts as you know them at the moment. Investigative reporters usually enter the interview already knowing the background. They usually ask a combination of open-ended and challenging questions to build their story.

Sometimes the journalists will surprise you at a place unexpected - the ambush interview, if you cannot arrange for an interview at a more convenient time, be prepared to provide only the facts as you know them at the time. Do not speculate. Speak only to your operations/responsibilities. Use the interview to get your story out, if the reporter does not ask a question which allows you to get information out which you wanted to, work the information into another answer.

A pre-arranged or scheduled interview allows you time to research, prepare, and confer with others about what you can and cannot say.

Conducting interviews in your office requires you informing staff that a media interview will take place. This means all sensitive material and distractions should be cleared. There is a risk that the reporter might see or hear information that you wish not to be public.

If an interview is conducted at the incident scene – try to limit interference with the operation, it may be noisy, and distracting.

Lecture notes:

Hidden slide

There are certain rules that most journalist follow in interviews:

- Every thing you say is on the record – even if they say a comment will not be used. So speak only about those items which you are authorized and comfortable with.
- You are entitled to polite behavior. You do not have to tolerate rudeness, and inappropriate questions. You should be able to respond without being interrupted.
- Journalists must identify themselves, their employer, and the subject of the interview.
- You can control to a certain extent where the interview takes place. It is acceptable to ask them to set up an appointment, at a mutually convenient time and place.
- You should know if others will be present, who they are, and if there will be others interviewed, as well as the interview order.
- You are entitled to know if the interview will be taped, if it will be edited. If edited, you can ask to see it prior to broadcast, you may not be able to change the content, but you can prepare for reaction.
- If you need an interpreter, bring your own. It is more likely that your interpreter will understand your operations. An interpreter can act as a buffer, giving you a bit extra time to formulate your answer.

Source: 1999 IAEA Communications on Nuclear, Radiation, Transport, and Waste Safety: A Practical Handbook

Lecture notes:

Appendix VII of TECDOC-1162 (page 158), provides you with the "Ten Rules of Communication During an Interview"

- Be yourself
- Be comfortable and confident
- Be honest
- Be brief
- Be human
- Be personal
- Be prepared, positive, and consistent
- Be attentive
- Be energetic
- Be committed and sincere

Do everything you can to prepare. If you do not know something, say so, and commit to finding out the answer – follow through. Every effort should be made to minimize what could be called "message interference". Limit the use of jargon and technical terms – this is very difficult given the nature of the radiological hazard and general unfamiliarity with it among the public. Know if your audience includes a variety of different languages – plan for this by having translators, press releases in the different languages, if necessary.

Lecture notes:

Hidden slide

This worksheet will help a great deal in organizing your thoughts prior to a media interview or press briefing. You will be using it to practice your briefing skills in the next module.

We will now discuss how it is to be used.

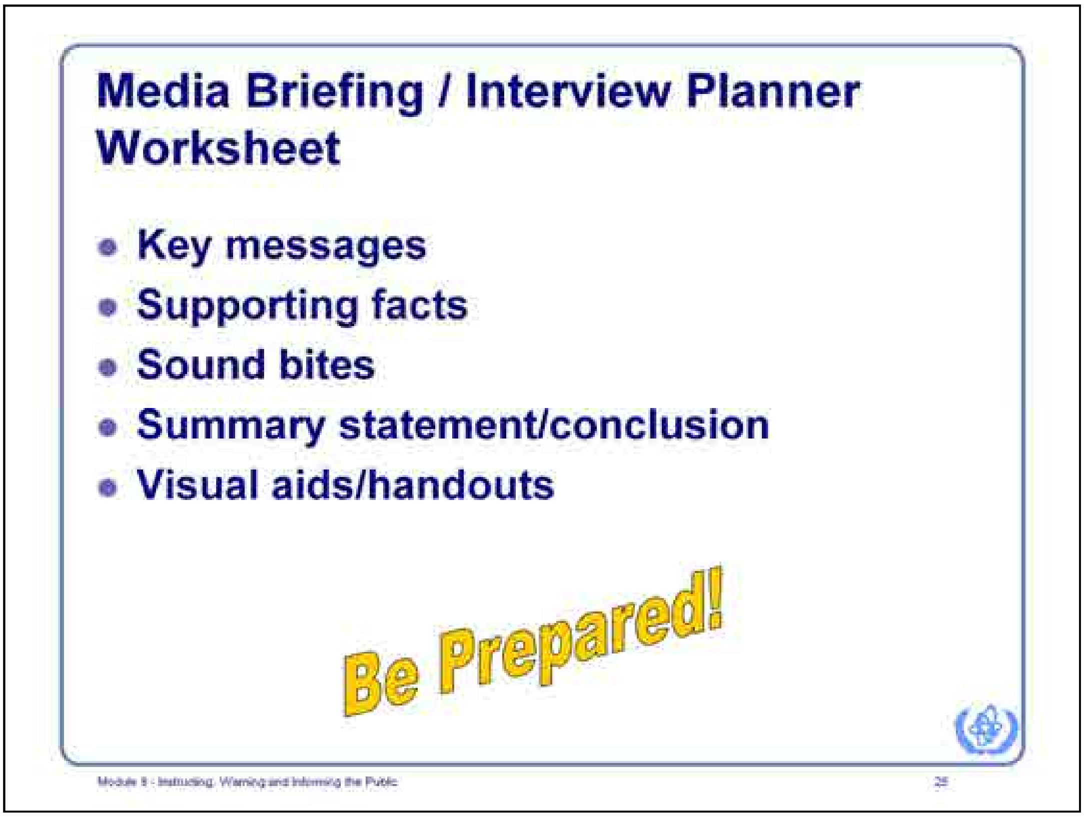
DATE/TIME/PLACE – Confirm all logistics for the interview or briefing

AUDIENCE – Tailor your comments to the audience you will be speaking to, anticipate, interests, concerns

ANTICIPATED QUESTIONS/RESPONSES – Crucial to a successful interview is the ability to have answers to most of the questions asked. You must analyze the situation and know the the interviewer's audience to anticipate the questions. Also practice giving responses before the interview.

OPENING STATEMENT/INTRODUCTION – Gives you an opportunity to get make a couple key points before any questions. Include a statement of personal concern, organizational commitment, and your purpose for the interview.

NOTE: Students need copy of Media Briefing/Interview Planner Worksheet.



Lecture notes:

KEY MESSAGES – These are messages you must include in the interview or briefing. Address central issues. Select just a few key messages/points (about three). Be concise.

SUPPORTING FACTS- Information which supports the key messages.

SOUNDBITES – Provide short statements and "quotable quotes" – for broadcast media 10-12 words, print media 1-3 lines. Examples: "We are actively responding to the emergency with all the resources we can muster" "We have trained personnel and emergency response plans in place to aid in protecting the public's health and safety

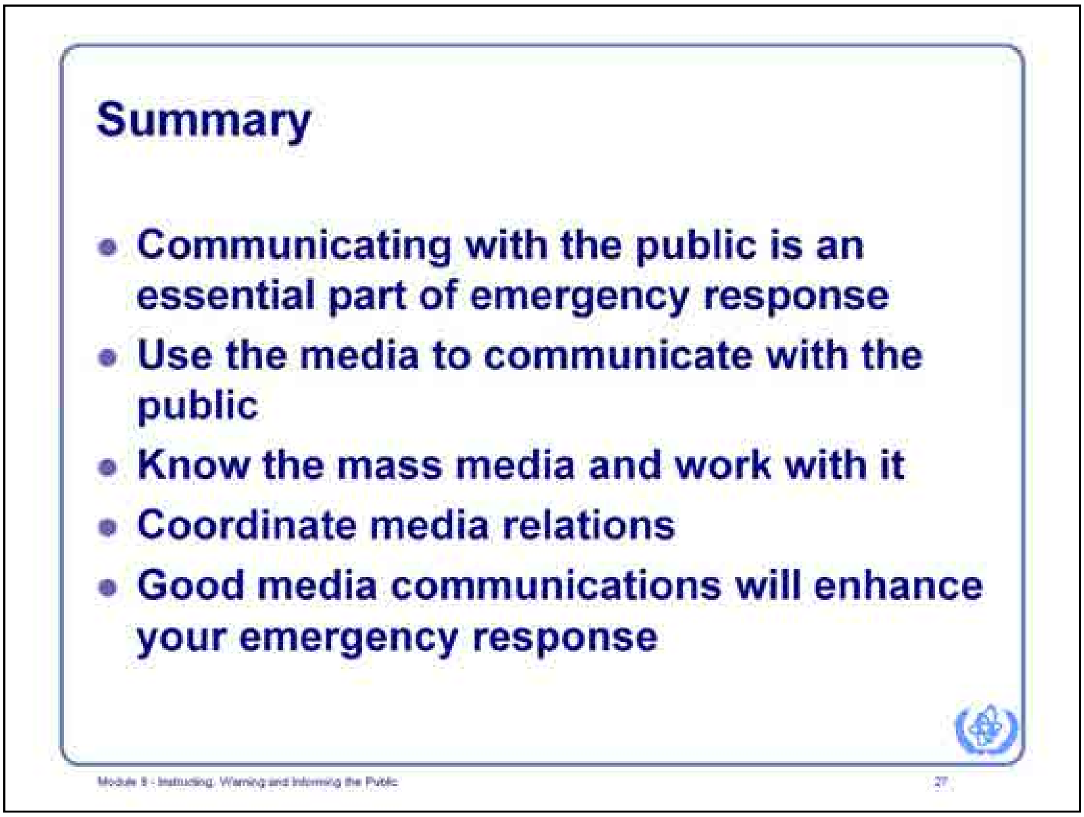
SUMMARY STATEMENT/CONCLUSION – Restate your key messages (or state them if you have not done so); If appropriate, this also is an opportunity to add what your organization will do in the short and long term future to show that you are thinking ahead and being proactive

VISUAL AIDS/HANDOUTS: Use pictures and graphics when possible; give reporters written material to reference when they write or report their story, include your key points, if appropriate.

Source: 1995, Emergency Public Information Pocket Guide, Emergency Management Laboratory, Oak Ridge Institute for Science and Education)

Lecture notes:

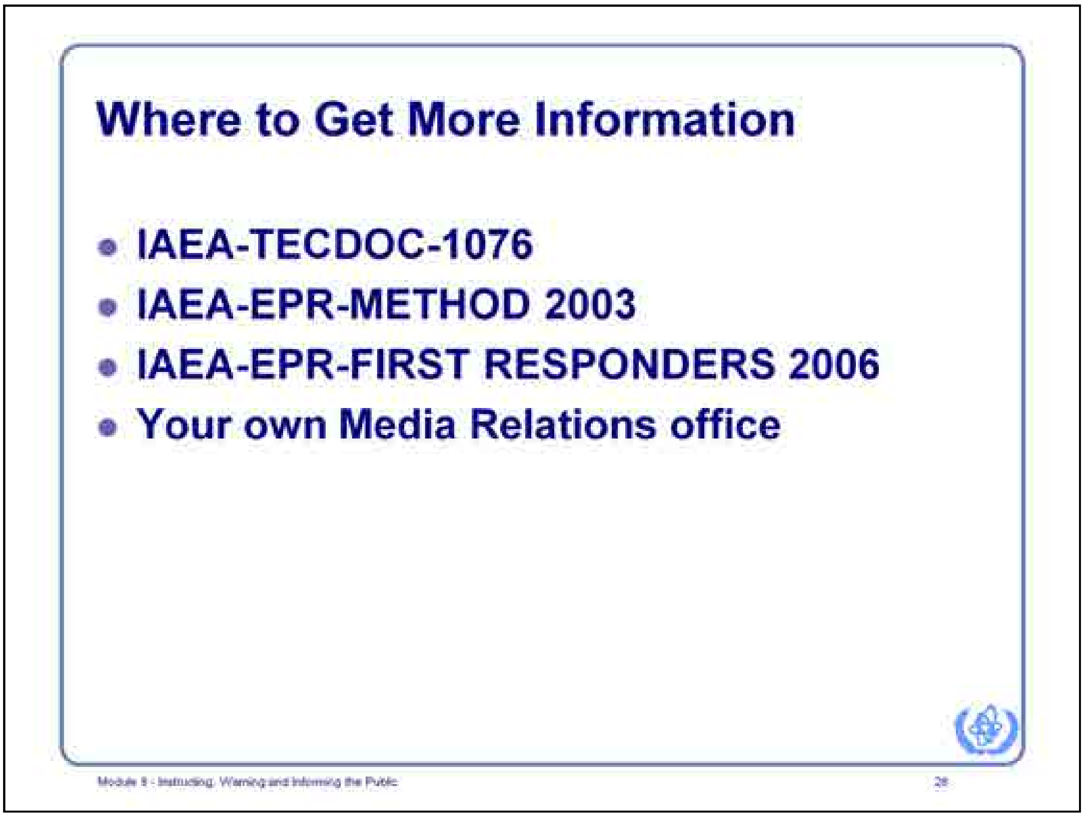
These are some of the benefits of good media communications. In the end, it all comes back to the original goals of media and public communications. The aim is NOT to manipulate them, but to make them part of you effort to respond to the emergency. Remember, the public and the media are your emergency partners. Work with them, not against them.



Lecture notes:

These were the major topics we covered in this module.

The next module will provide you with an opportunity to practice development of information for a media briefing and interview.



Questions:

1. What are two reasons it is important to effectively communicate with the media?
2. What are the different types of media outlets?
3. What skills are necessary for effective communications with the media?
4. What is the purpose of the Joint Information Center?
5. Name three considerations which must be addressed when establishing media boundaries on-scene.
6. True or False: Everything you say to a reporter is on the record.
7. Name 5 of the ten rules of communication during an interview.
8. How does the Media Briefing/Interview Planner Worksheet assist you in conducting briefings and interviews?

IAEA Training Course for Research Reactor Emergency Response

Emergency Preparedness and Response

Action Guides and Response Priorities

Seminar

Block 3: Emergency Preparedness and Response

Module 9: Action Guides and Response Priorities

Learning objectives: Upon completion of this module, the participants will:

- understand a suggested Emergency Response Team organization
- be able to list the responsibilities of each Team member
- be able to list the priority actions and expected timing
- understand how and when the organization may be modified

Activity: Seminar, questions and discussion

Duration: 2 hr

Materials and equipment needed: none

References:

1. INTERNATIONAL ATOMIC ENERGY AGENCY, Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency, EPR-METHOD 2003, IAEA, Vienna (2003)
2. INTERNATIONAL ATOMIC ENERGY AGENCY, Preparedness and Response for a Nuclear or Radiological Emergency, Safety Standards Series No. GS-R-2, IAEA, Vienna (2002)
3. INTERNATIONAL ATOMIC ENERGY AGENCY,, Generic Procedures for Response to a Nuclear or Radiological Emergency at Research Reactors, EPR-RESEARCH REACTOR, IAEA, Vienna (2011)

Introduction

- An Emergency Response Team is required to make decisions, to initiate and control response actions and to evaluate information for further actions
- The purpose of this lesson is to present a suitable organization for that Team and discuss the response priorities

Module 9 - Action Guides and Response Priorities 2

Lecture notes:

Organizing a response during the stress of recognizing that an emergency situation has occurred and is developing can result in confusion, missed information of importance and a loss of control of the response. It is important that an organization be created and exercised so there are trained individuals who have a clear set of priority actions to initiate when an emergency occurs. It is not possible to develop detailed instructions for use in an emergency since the variety of conditions would result in so many detailed procedures that finding the appropriate one, if such a procedure had been developed, would be too time consuming. Instead, an organization with a general set of actions to initiate, coupled with the collection of important information and experienced individuals will initiate the immediate actions and then the developing conditions can be addressed as they occur. In this regard, the experienced persons on the response team are expected to know their facility and site, have sources of the necessary information on the reactor conditions, and understand when and how to call on the off-site resources that have been preplanned for use, if needed.

While a specific set of positions is described in this seminar, it is not the only one that could be used. A specific organization is presented here because the action guides and responsibilities are constructed with that organization. A different organization could require modification to the action guides to accommodate a different set of responsibilities. That is part of the customization process developed by each reactor facility .

Content

- Emergency Response Team Organization
- Responsibilities of Team members
- Additional Team members
- Priority of response actions
- Suggested timing of response actions
- Summary

Module 9 - Action Guides and Response Priorities 3

Lecture notes:

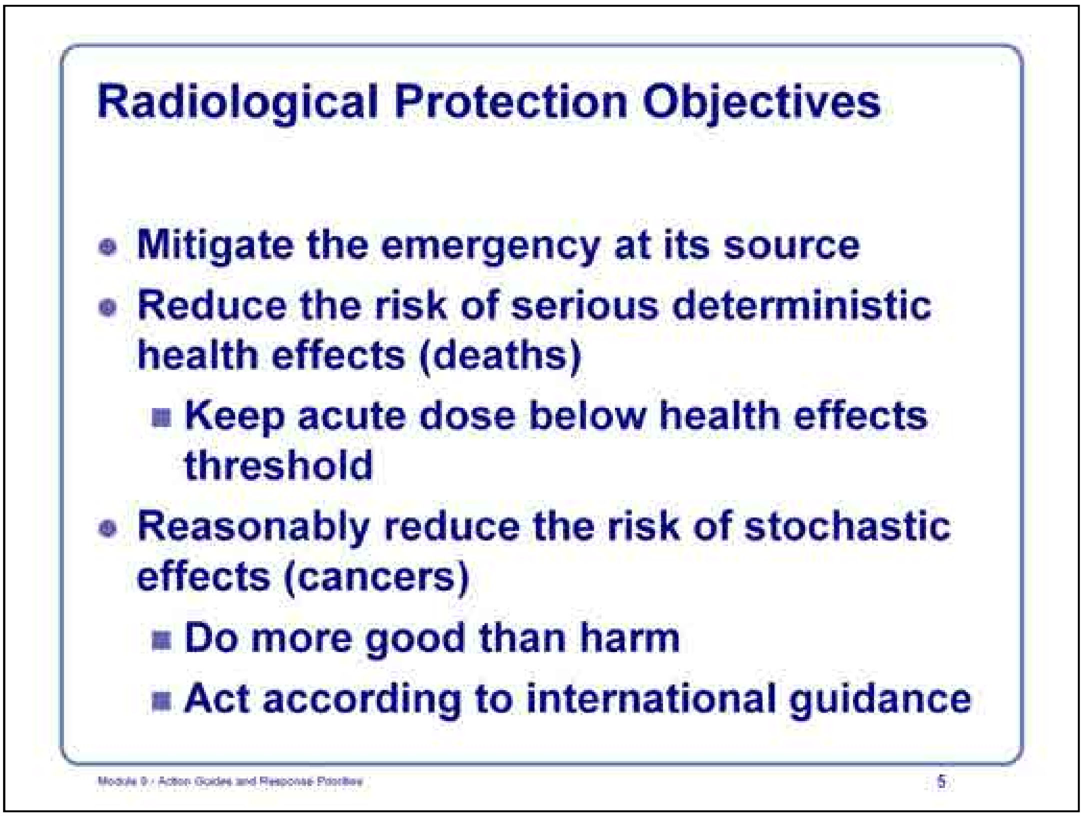
An Emergency Response Team is a group of individuals with well defined responsibilities and chain of command that assembles to respond to a research reactor emergency. Depending on the Threat Category of the reactor, some team members may not be required. Both Threat Category II and II organizations are discussed.

The expected sequence of response actions has a priority ranking and an expected time of initiation or completion suggested by IAEA GS-G-2.1, Appendix VI.

Additional members on the response team may be desired by specific reactor facilities to serve additional needs of the facility. Some of these positions are discussed briefly.

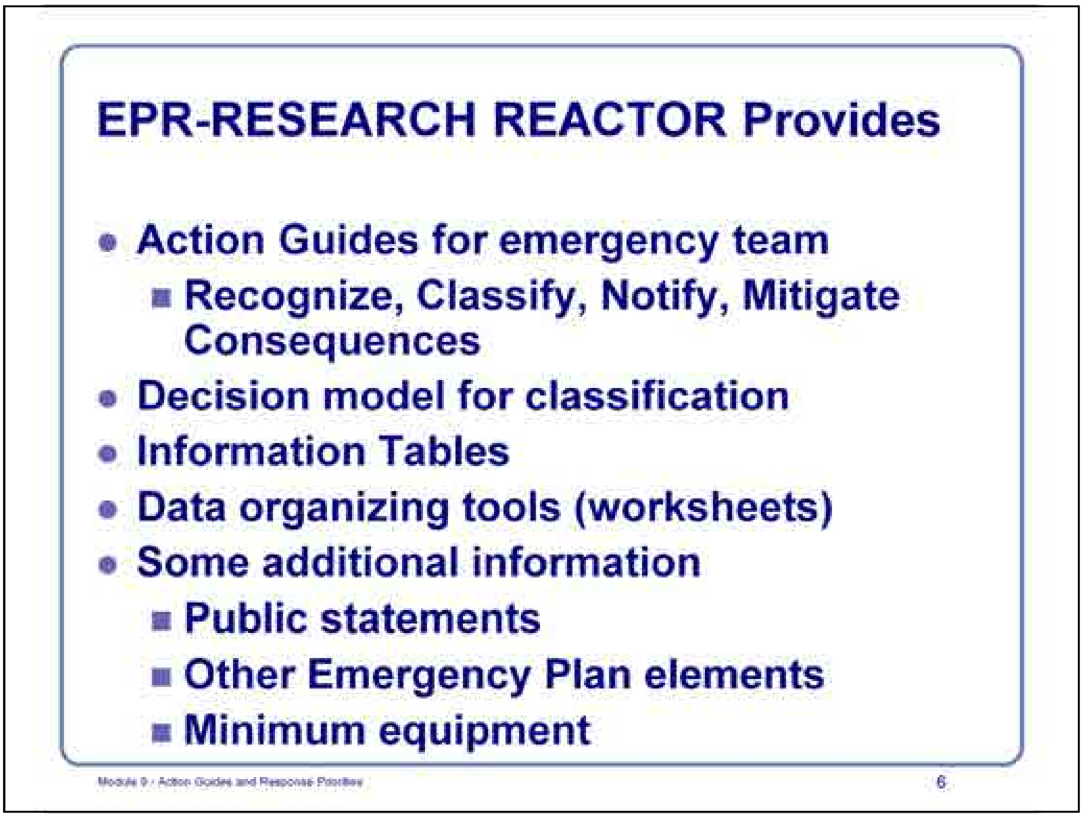
The response organization in this presentation is consistent with that recommended by IAEA EPR-RESEARCH REACTOR.

Lecture notes:



Lecture notes:

Emergency response programmes have three primary objectives. The first objective is to take actions at the source of the emergency to mitigate or reduce the potential risk. This objective is met by the reactor operators' actions to prevent or reduce a release of radioactive material. The second objective is to ensure that people will not receive doses high enough to result in sickness or death within weeks or months of the emergency. These are called deterministic, early, or acute health effects. Deterministic health effects result from very high doses received over a short time (hours to days). Each body organ has its own threshold dose below which deterministic health effects will not occur. In the case of a reactor emergency, keeping the early dose received by the red bone marrow below 1 Sv, for example, will prevent any early deaths. This is over 50,000 times the dose you normally receive in a few days. The third objective is to take reasonable actions to reduce the chance of people developing cancer years after the emergency. Cancers are called stochastic or late health effects. The normal risk of cancer is presumed to be increased by even very small doses. It is not practical or reasonable to reduce the additional risk of cancer from an emergency to zero. There is a point below which any further attempts to reduce the cancer risk resulting from the emergency is not justified. For example, it is unreasonable to relocate people from areas where the dose rate is less than that normally found in many areas not affected by the emergency.



Lecture notes:

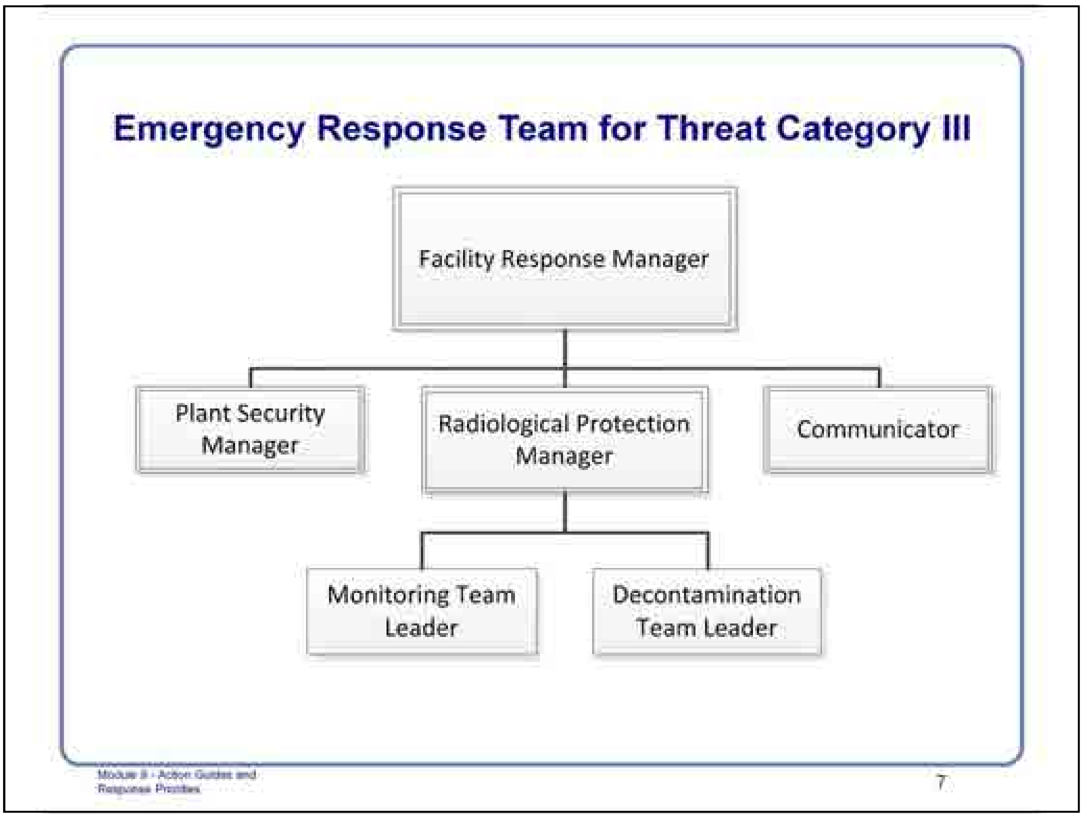
Here is a quick look at the content

The procedures are generic, that is no site specific information is provided, each site may do that as they customize the procedures to their needs. They are also written at a high level because they are for many emergencies with different details, but similar objectives (next slide).

The procedures may be viewed simply as Recognize, Classify, Notify, Mitigate Consequences, although there is some more detail than that. Mitigation is the action step with the most variability, including priority levels for that response. Expected time to execute steps are also provided, for example, consistent with timelines in GS-G-2.1 (Appendix VI, Table 12), identification of the emergency class is expected within 15 minutes of recognizing that an emergency exists.

The classification model is similar to TECDOC-955 adapted to an unpressurized research reactor.

The examples here of additional information is not an exhaustive list. Some references are given for additional information, such as the Monitoring Manual.

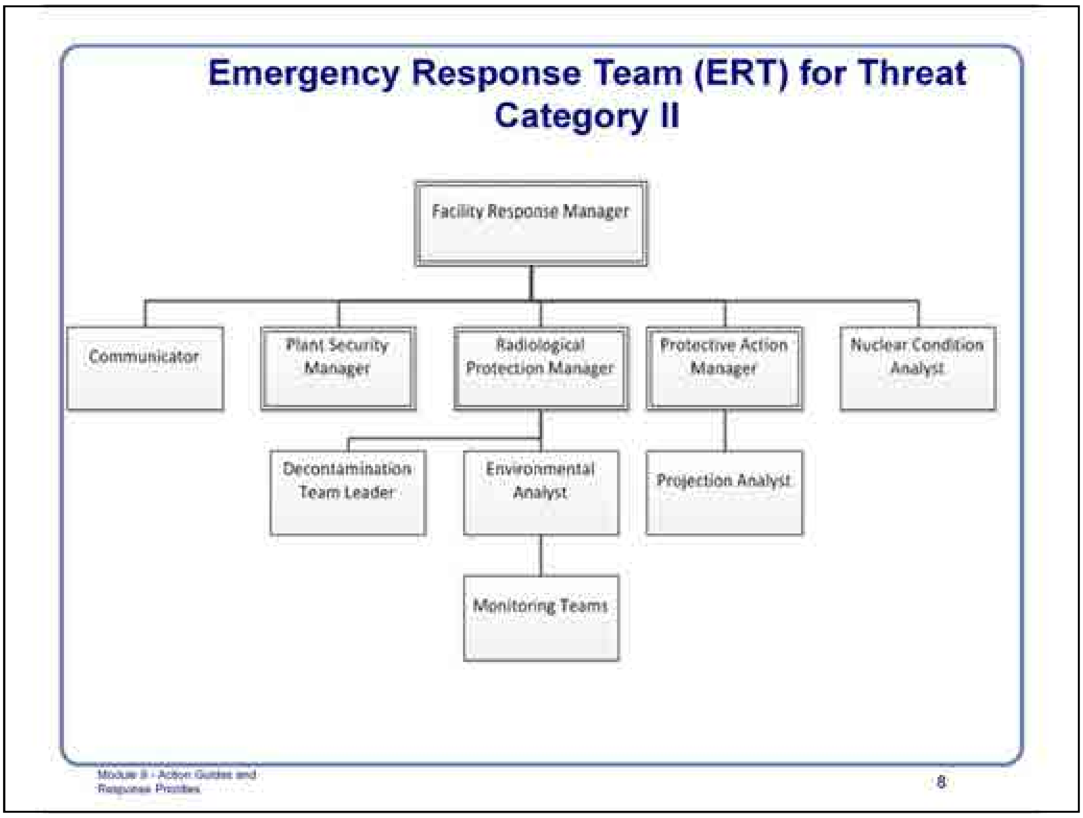


Lecture notes:

Threat Category III research reactors tend to be operated by small organizations, perhaps a department at a university, with few staff actually in the reactor at any one time. The consequences of emergencies at these research reactors does not include risk to the off-site population, although on-site personnel can be threatened by some of the more serious emergency events.

This core response team may be increased in the planning phase by adding positions the facility emergency plans judge are required, and then preparing action guides for the additional positions. For example, a Plant Security position may be determined to be required, with responsibilities to control access to the facility during an emergency and to coordinate the facility Security Plan with the emergency response actions.

We will next look at the Threat Category II organization which adds other positions. After that, the responsibilities of the positions will be discussed, including how those responsibilities are assigned to the smaller team shown here.



Lecture notes:

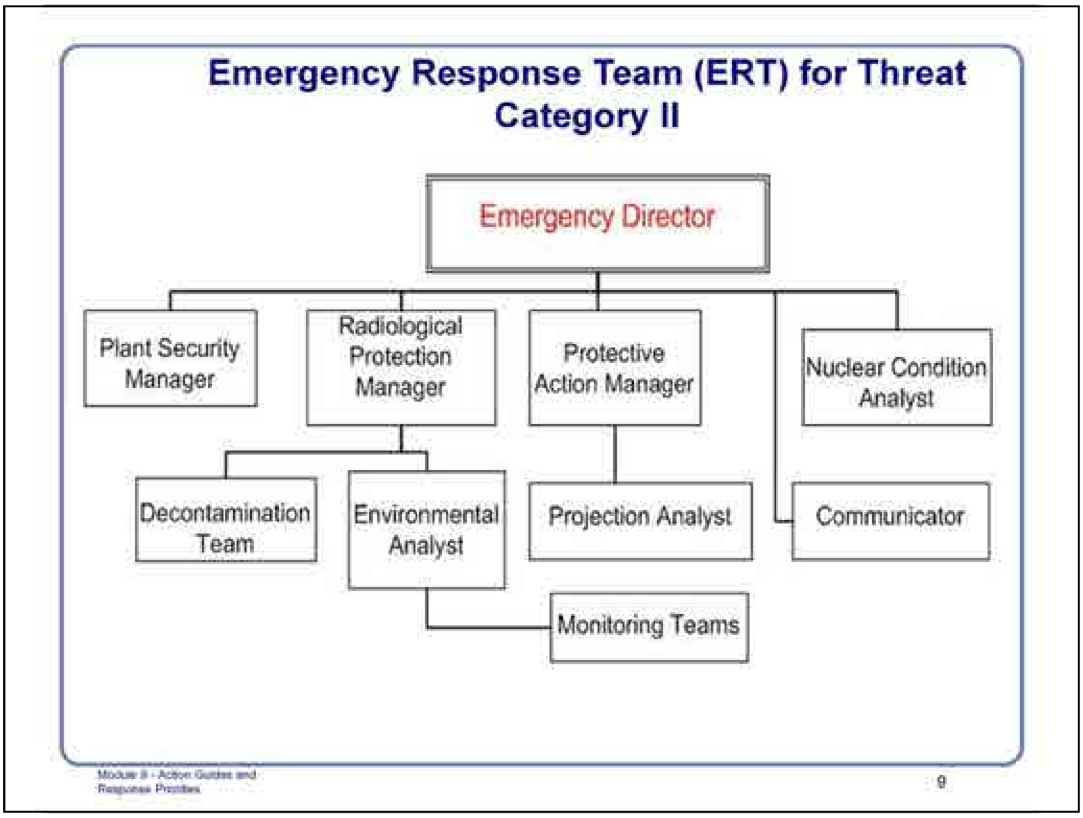
A larger team is required for the potential off-site actions.

Some of these blocks may be more than one person even when not shown as a team. For example, the Nuclear Condition Analyst may actually include a Technical Assistance Team at the site's option.

The response process will be similar, but, of course, quicker attention to off-site surveys is required and the off-site notification has to include the potential off-site protective actions. It is considerable more complicated!

Point out that these are roles. The Facility Response Manager, and all the positions, are filled with individuals who take on a role to assume the responsibilities assigned to the position. They may be one person at the start of the response who is replaced by a more senior person as additional individuals arrive. The individuals, by position in the site organization, who are available to perform a particular role should be identified in the facility Emergency Plan. For example, if the reactor staffing will always include a senior operator or other person with overall responsibility for the reactor, this would be the initial Facility Response Manager. A later arriving manager might be designated to replace the initial Facility Response Manager when that individual arrives, perhaps within the first hour or so. Certain of these response team positions must always have an individual at the reactor who is automatically assigned to fill the positions when the emergency is first recognized. These positions will be noted as we examine the responsibilities.

Now let's consider the individual duties and responsibilities.

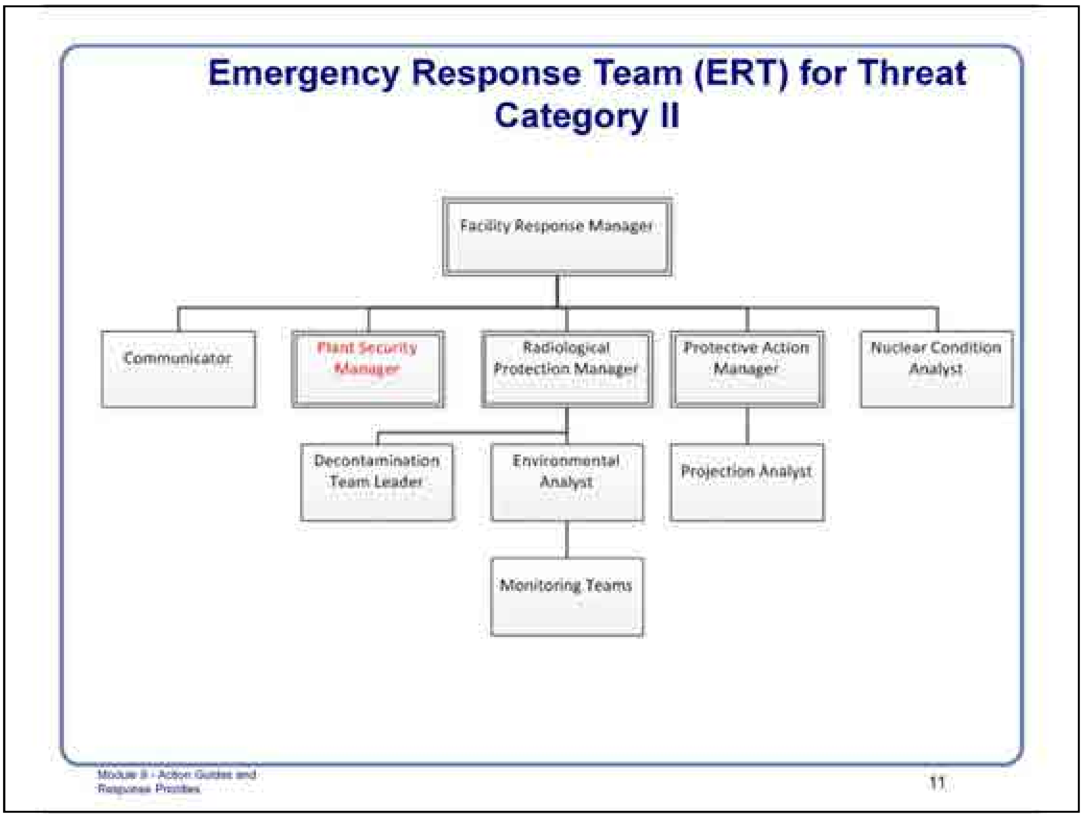


Lecture notes:

Lecture notes:

The leader of the response organization has a lot of responsibility, and expects to have a supporting team of technical experts who report directly to him/her.

In the first several minutes, or even the first couple of hours, the individual filling this role may be a senior operator who is at the reactor facility when the emergency begins, and who is later replaced by a more senior manager from the reactor or site organization.



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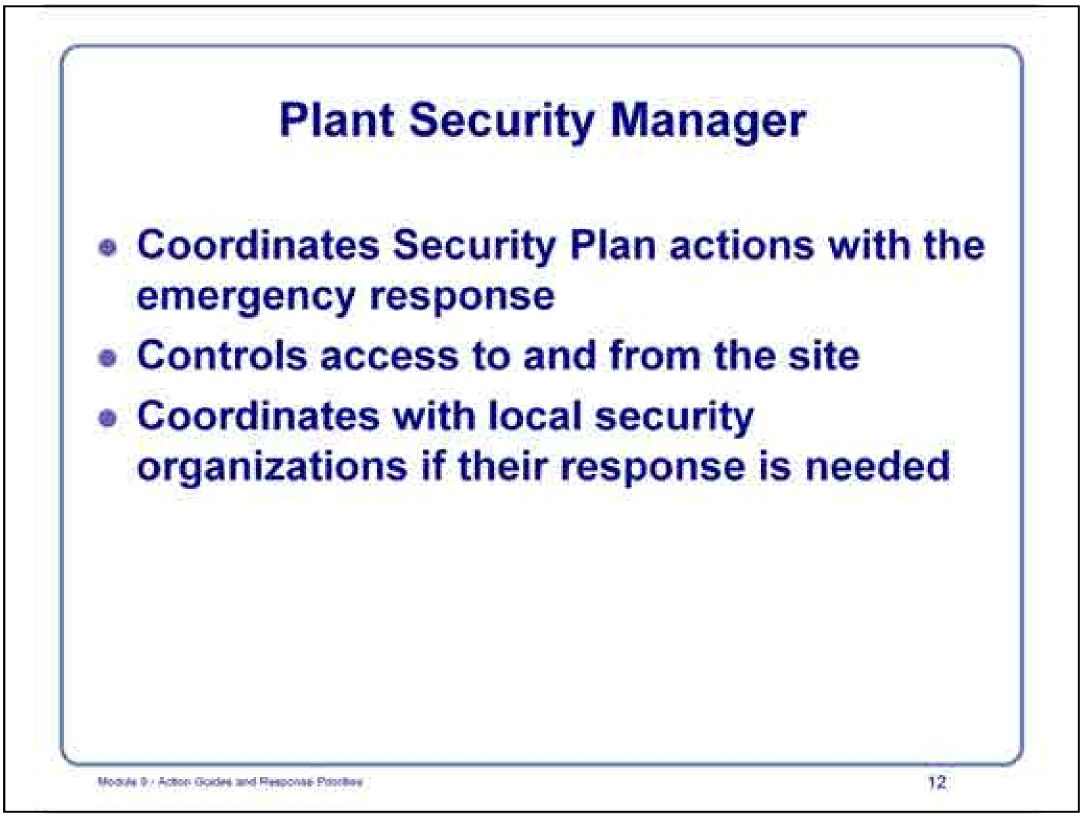


Lecture notes:

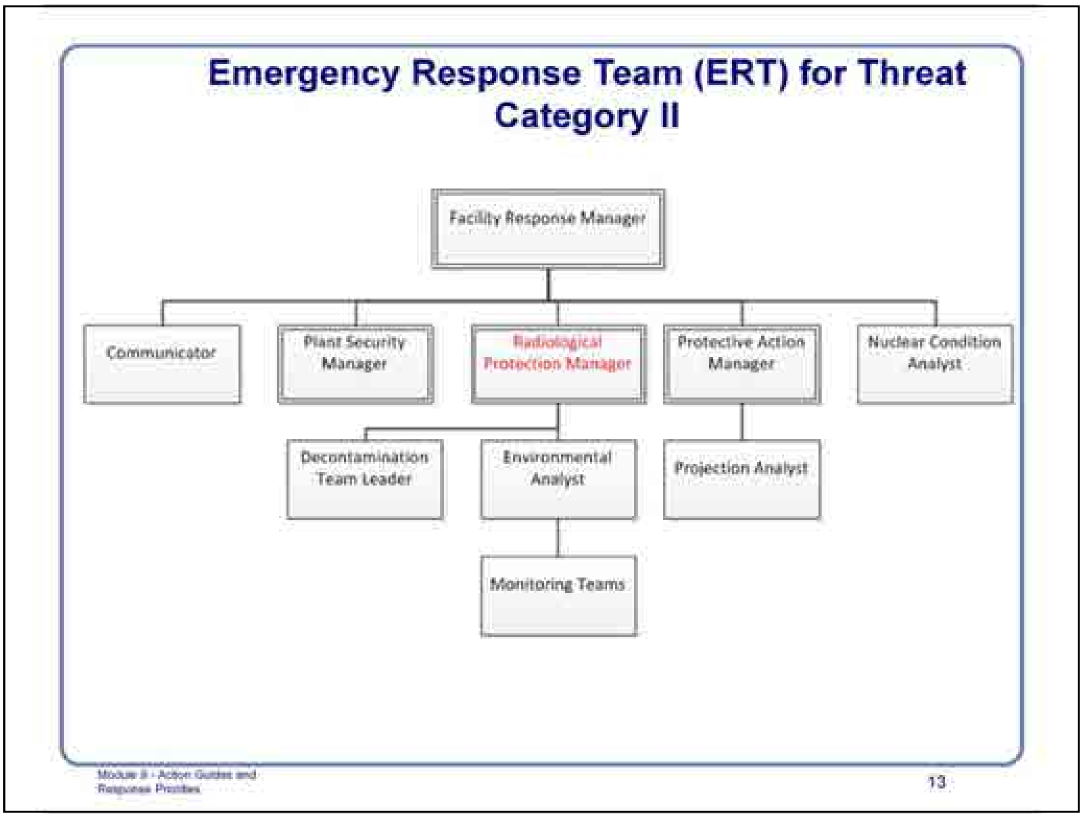
The Plant Security Manager takes charge of site security, usually with specific actions determined by the site security plan. This position on the Emergency Response Team is to make sure the actions in the site security plan are coordinated with the emergency response procedures. Specific functions of the Plant Security Manager are:

Establish control over the site entry and exit points such that only necessary emergency response support can enter the site and only individuals that the Radiological Protection Manager determines to be unnecessary to the response may leave,

Coordinate with local police officials if their response is necessary,

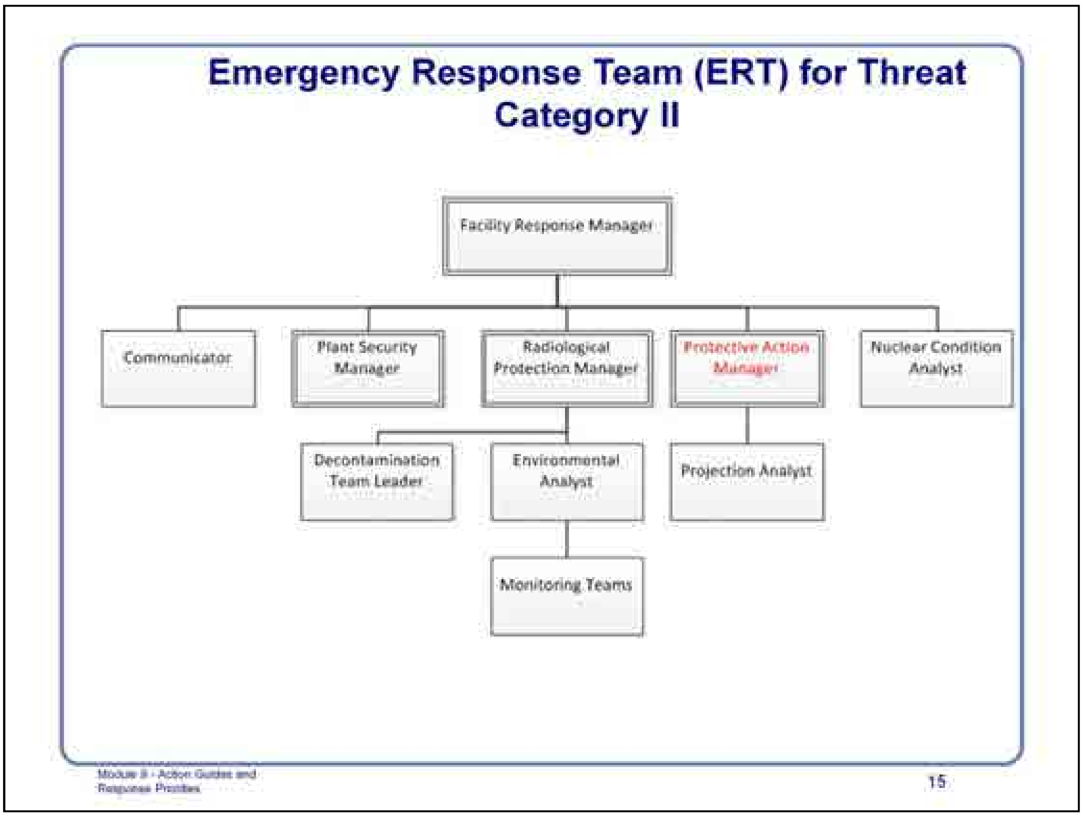
Respond to security threats to the facility as determined by the site security plan

This position may be necessary at Threat Category III facilities.



Lecture notes:


Radiological Protection Manager
Prepare a monitoring plan to determine the scope of the radiological threats
Assess environmental monitoring results and advise when OILs are exceeded
Determine need for medical assistance from off-site
Authorizes exceeding occupational exposure limits
Authorize departures from the facility
Module 9 - Action Guides and Response Priorities
14



Lecture notes:

Lecture notes:

The Protective Action Manager may be immediately required to initiate certain protective actions. The Emergency Plan should identify who is assigned to this position so a clear responsibility to perform the required duties assigned to a particular position. The responsibilities are :

Recommend appropriate protective actions to the Facility Response Manager for on-site personnel

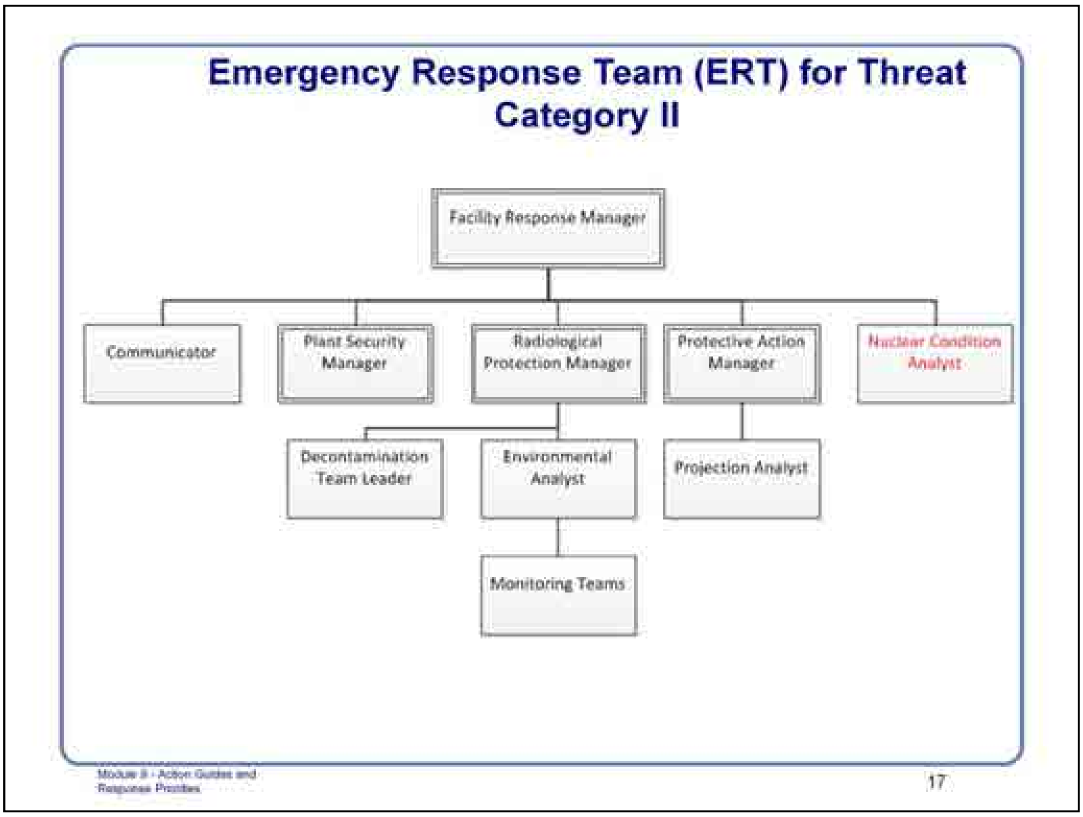
Recommend off-site protective actions, based on emergency class or environmental data

Evaluate collected environmental data and project where OILs may be exceeded in order to assist planning for environmental monitoring

Revise default OILs if detailed analysis permits such revision and inform the Facility Response Manager of the option to implement the revised OILs.

The Protective Action Manager is assisted by a Projection Analyst.

The scope of the protective actions are reduced for Threat Category III research reactors since there is not need for off-site protective actions. The on-site protective action responsibility is transferred to the Radiological Protection Manager.



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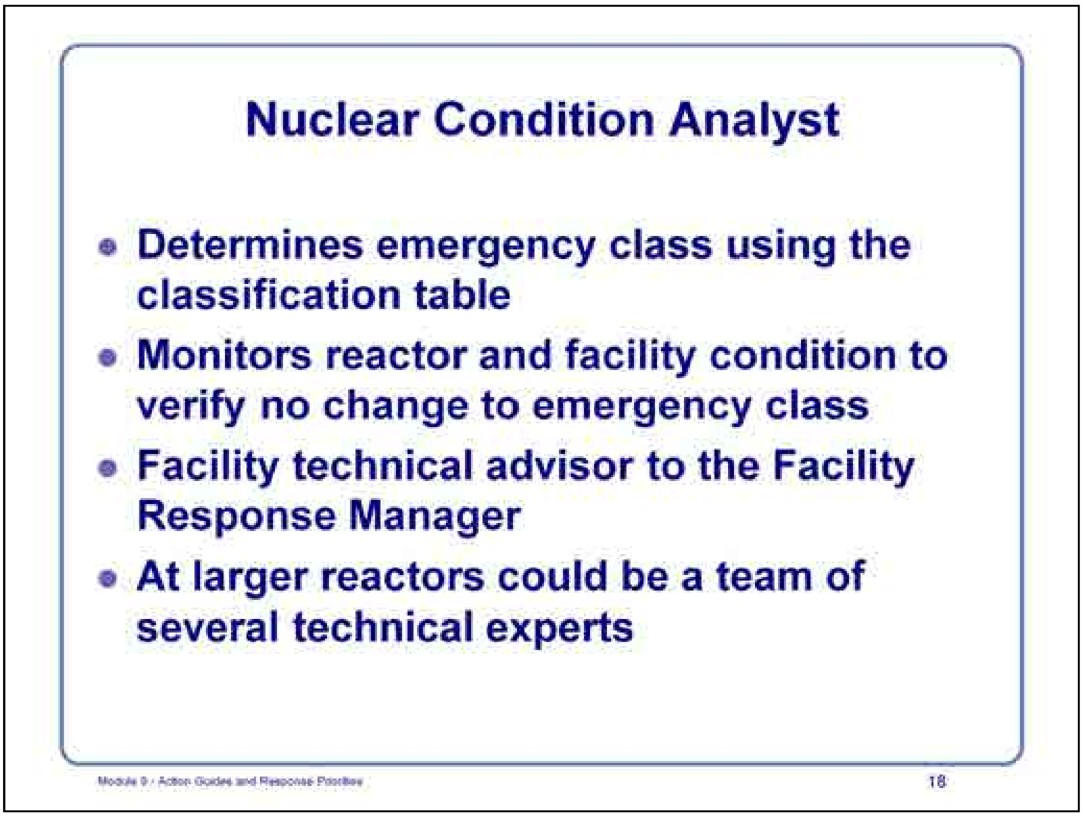
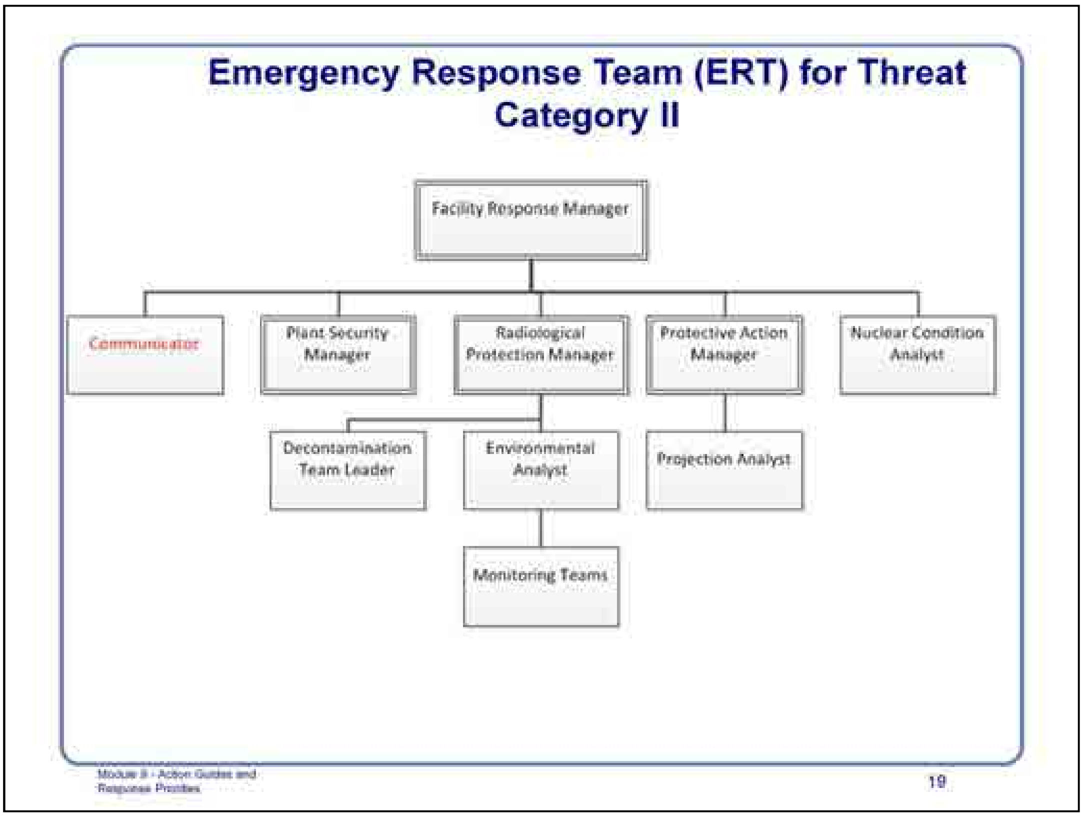


Lecture notes:

The reactor technical expert who uses the classification table and plant conditions to determine the emergency class for consideration by the Facility Response Manager. Some facilities may use a team of technical experts, operating staff, engineering staff and others to accomplish these duties. The decision to do that depends on the complexity of the facility.

For Threat Category III reactors, these duties could be accomplished by the Facility Response Manager alone.

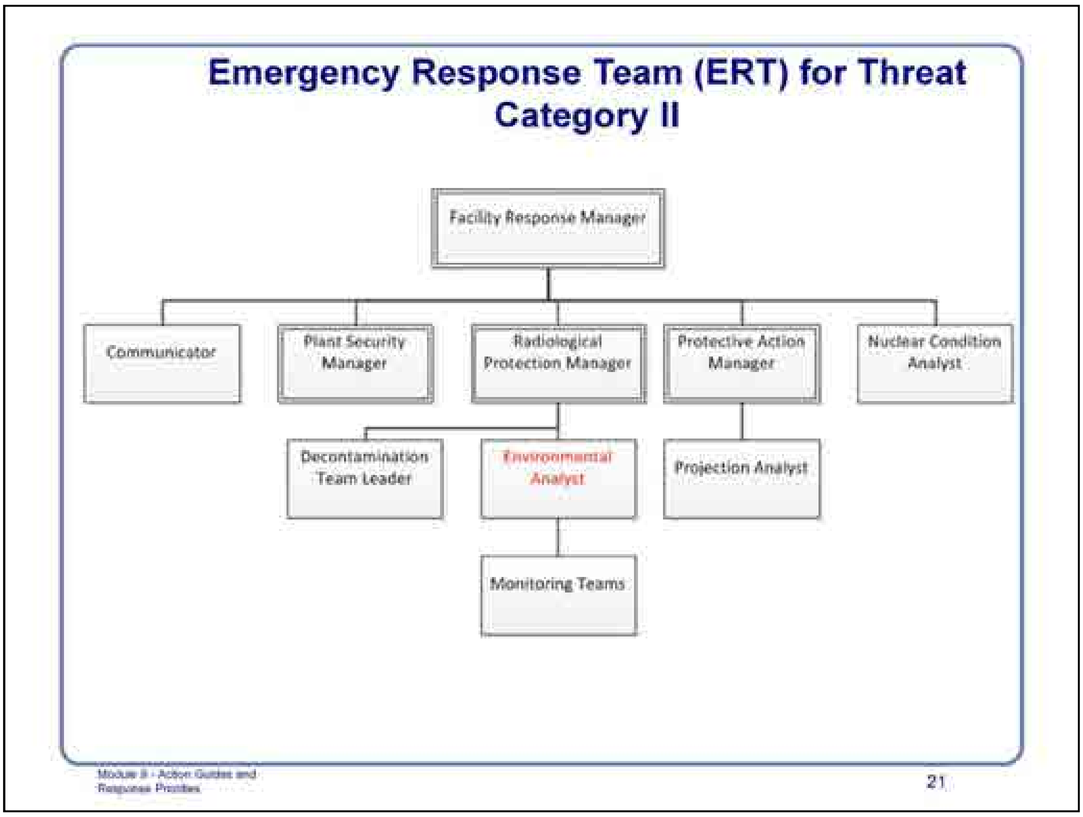


Lecture notes:

Lecture notes:

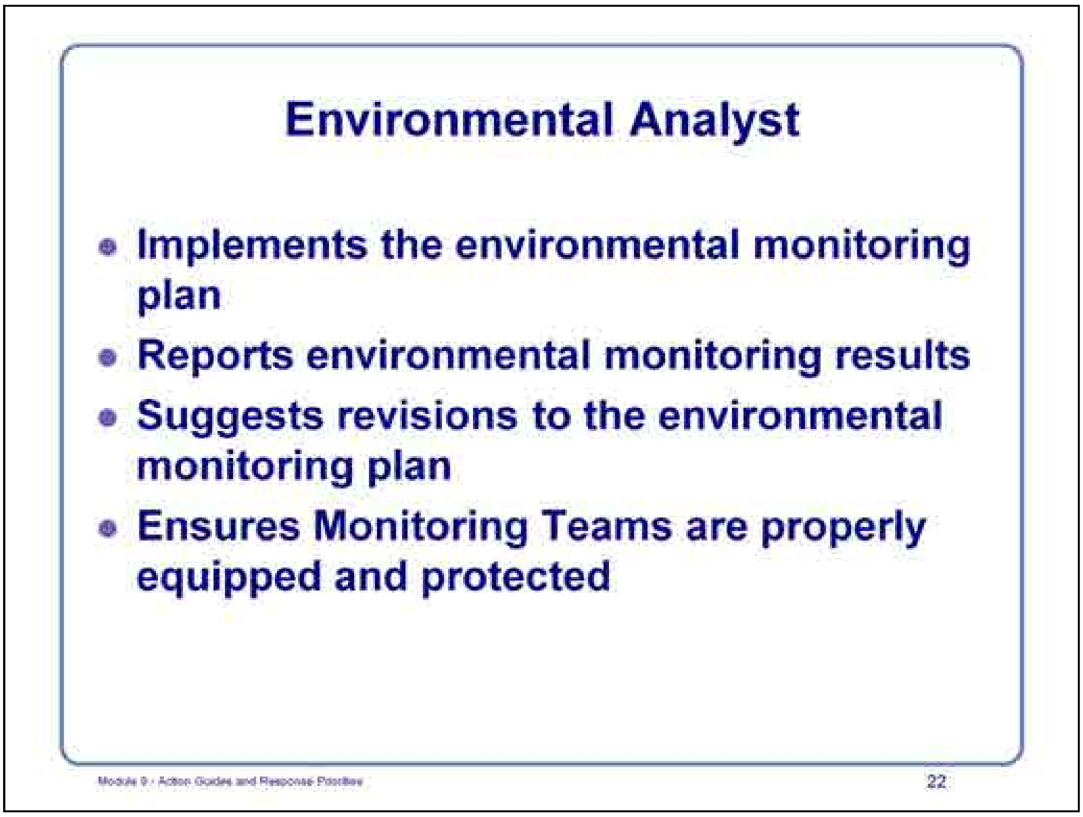
To allow the Facility Response Manager the ability to monitor and direct others, communication tasks are assigned to an individual. As with the Nuclear Condition Analyst, this position may be more than a single individual, however, only one of that group would be the Communicator and would coordinate the tasks assigned to the position.

With fewer notifications expected, these responsibilities would be performed by the Facility Response Manager at a Threat Category III facility. Of course, the facility could incorporate the position into their Emergency Plan if the need was there.



Lecture notes:

Reports to Radiological Protection Manager. Supervises the Monitoring Teams.



Lecture notes:

The environmental monitoring is done by Monitoring Teams using a monitoring plan approved by the Radiological Protection Manager. The Environmental Analyst is responsible to supervise these Monitoring Teams, including, but not limited to:

Conducting briefings,

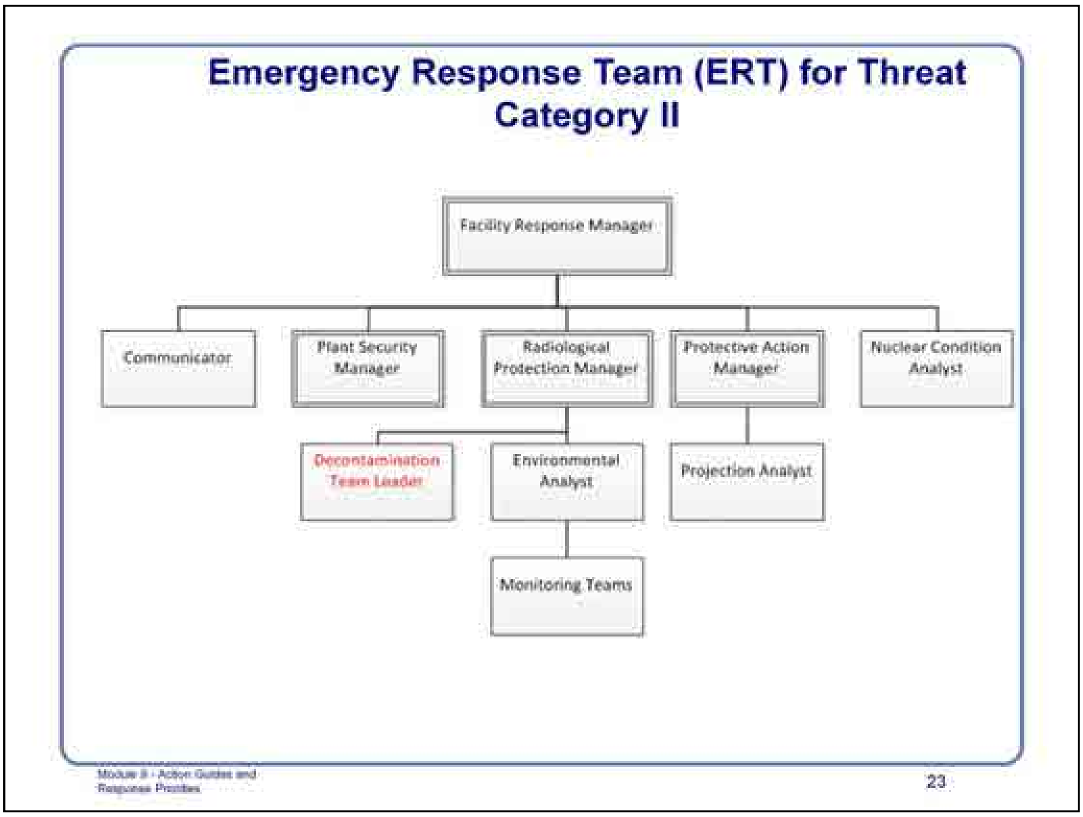
Verifying suitability of monitoring equipment for the assigned tasks,

Promptly reporting results to the Radiological Protection Manager and, if directed, to the Protective Action Manager,

Ensuring personal safety of the Monitoring Teams

Suggesting changes to the monitoring plan

Threat Category III facilities may have the Monitoring Teams directly supervised by the Radiological Protection Manager since monitoring will be more limited.



Lecture notes:

Reports to the Radiological Protection Manager

Lecture notes:

This may be a large or small team depending on the particular event. However, several key responsibilities are assigned. Specifically:

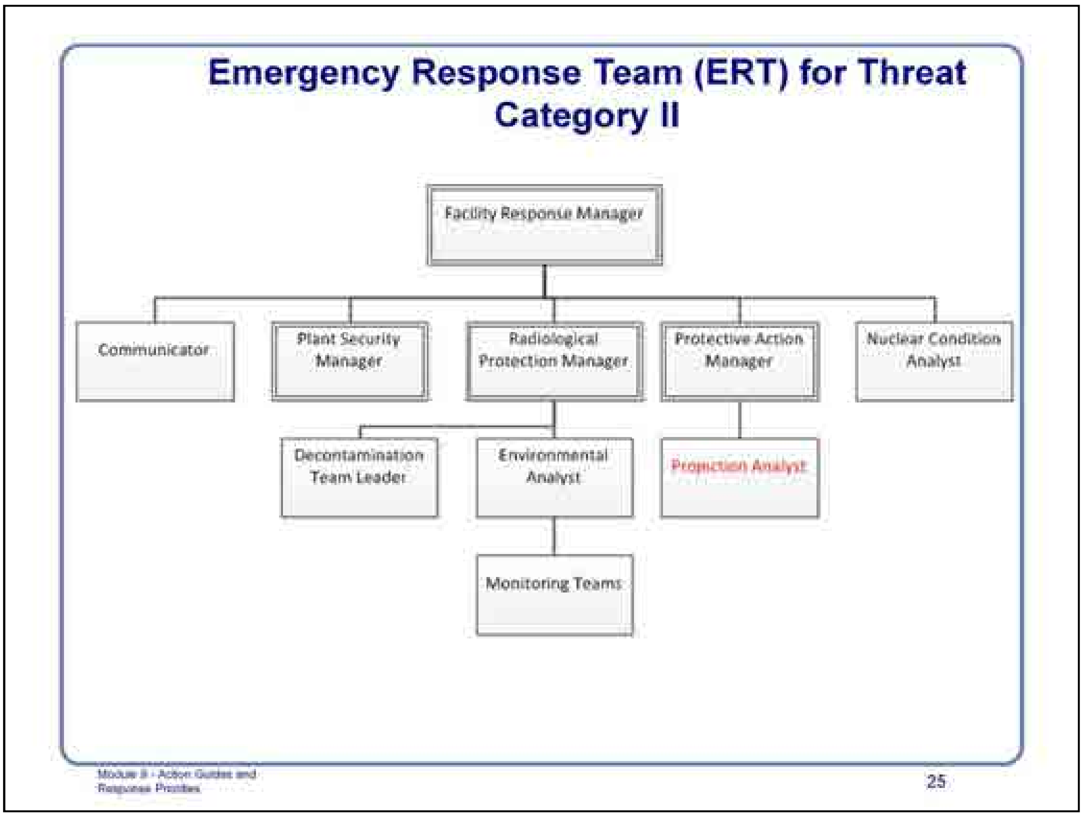
Evaluating medical and radiological condition of injured individuals

Recommending prompt off-site medical treatment when appropriate

Determining if on-site personnel are contaminated, decontaminating them when necessary, and then recommending their release to the Radiological Protection Manager

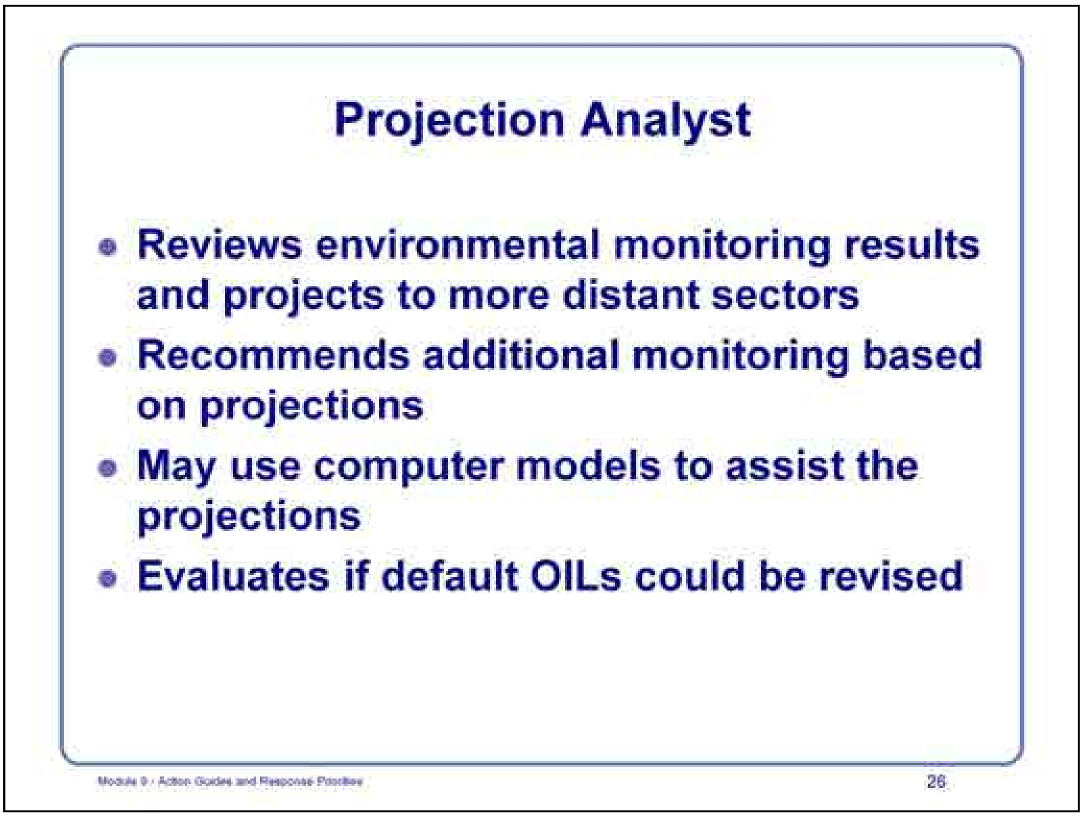
Assess contamination levels on the reactor site

The Threat Category III research reactor may also chose to have the Radiological Protection Manager directly supervise the Decontamination Team.



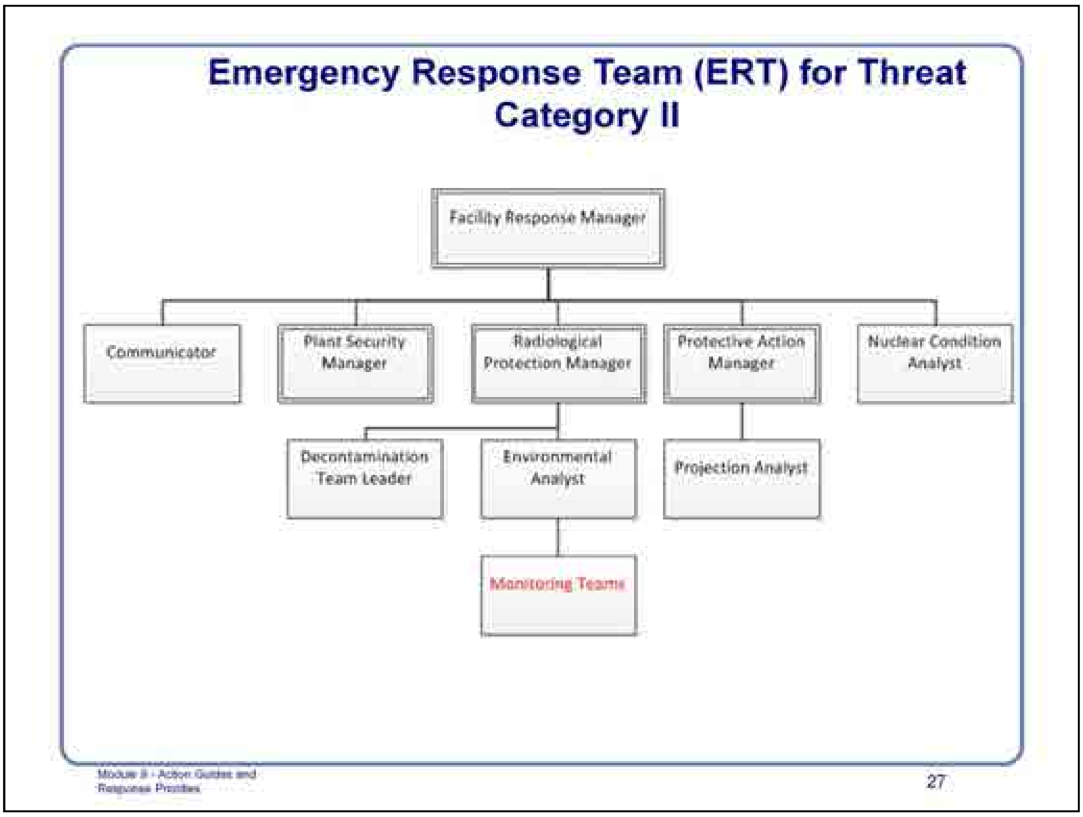
Lecture notes:

Reports to the Protective Action Manager



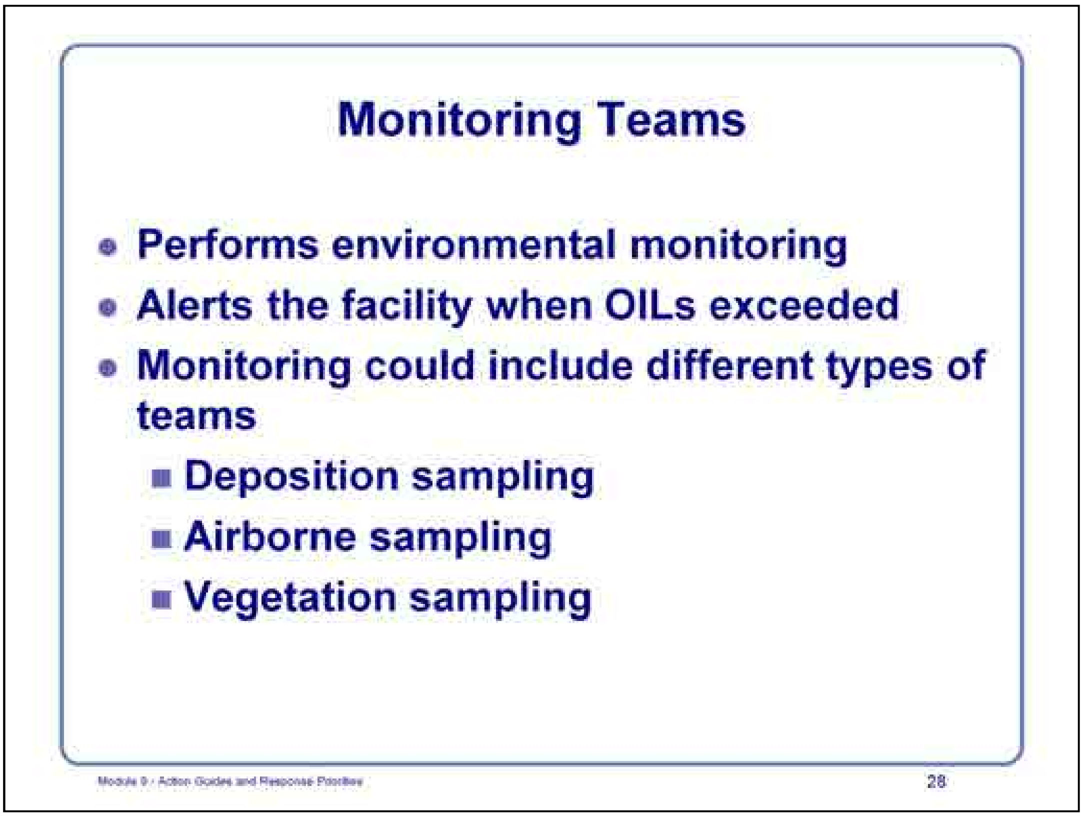
Lecture notes:

The Projection Analyst reports to the Protective Action Manager and performs the projections that can alter the environmental monitoring plan. This position is also responsible to consider revising OILs when more detailed analysis of the radioactive material is performed. The position may also perform hand or computer calculations of radiological consequences of a release from the facility as part of the projection analysis. There is no need for this position at Threat Category III facilities



Lecture notes:

Reports to the Environmental Analyst



Lecture notes:

The number and duties of the monitoring teams must be established in the preplanning stage based on the level of threat and the potential releases. Only a careful threats analysis can provide the information needed to determine what type and number of teams may be required. Even the emergency class will affect the number of teams. Another consideration for the facility is the environmental monitoring responsibilities that off-site authorities are able to accommodate. In some cases, no off-site monitoring is expected of the facility. In others, the local organizations have little capability to perform these duties.

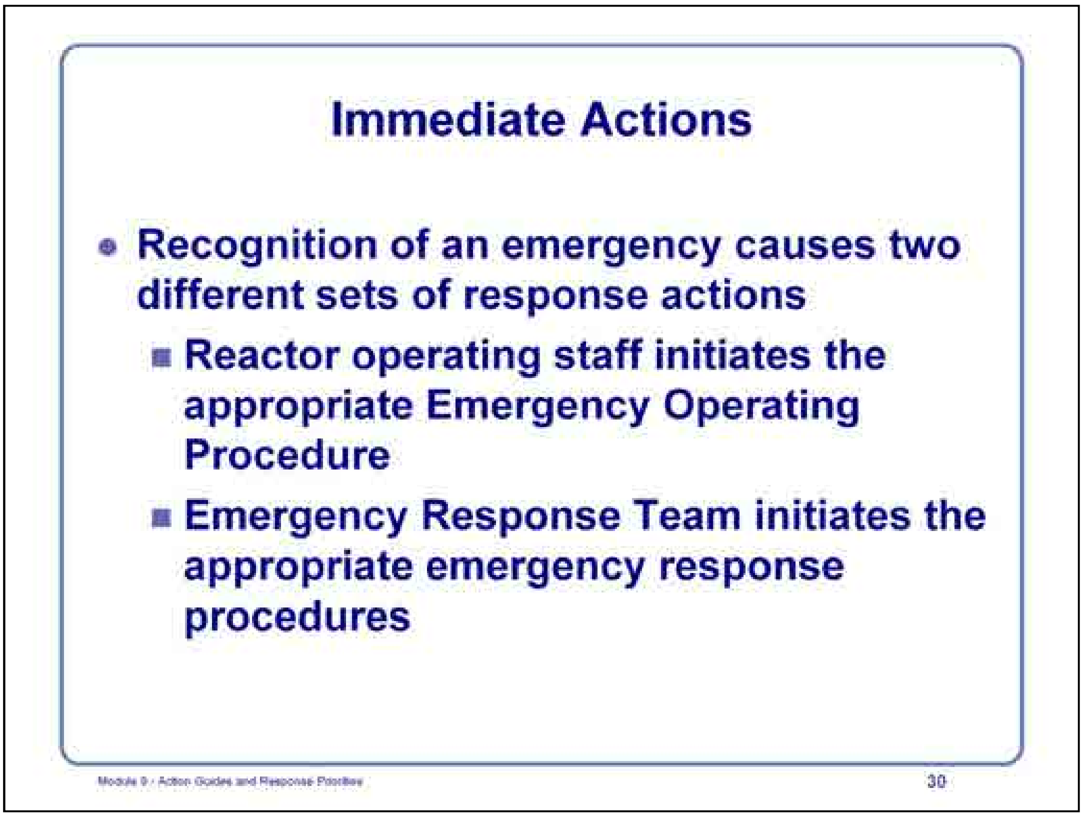
Lecture notes:

One can add positions to the response team based on the site capabilities and complexity.

An important coordination during the response is the need for someone who can manage the response tasks of the off-site support that may be needed. The local fire brigade is one of the most likely that could occur. The individual who controls these responders is an Incident Commander. Depending on training, the local fire brigade may already have encountered this arrangement from the IAEA First Responders Manual. Some sites have an internal fire brigade, and that may be sufficient for many emergencies. If an off-site fire brigade is needed, how they are assigned response tasks needs to be planned in advance. For example, will they work to the direction of the on-site fire brigade, or will they work under their own supervision and the on-site fire brigade becomes a technical adviser to them? Part of the process of arranging for a response from an off-site organization, such as the fire brigade, involves establishing the protocols for their involvement in the response.

Non-radiological safety can be a concern in certain emergencies and to some extent all the time. The specialized skills and training of an expert in industrial safety may be needed. Again, this is a position that the facility may assign to the emergency response.

These are just examples and not meant to be an exhaustive list. EPR-RESEARCH REACTOR was developed to focus on the radiological hazard of emergencies at research reactors and each site will have to determine when additional positions may be needed for their potential situations. For any added positions, careful thought is needed to define clearly the responsibility of the position, prepare an Action Guide to specify the duties that are expected to exercise those responsibilities, and the reporting relationship with the rest of the response team, especially the Facility Response Manager. If the Facility Response Manager is expected to be in overall control of the response, then every position must have a clear chain of command to the Facility Response Manager.

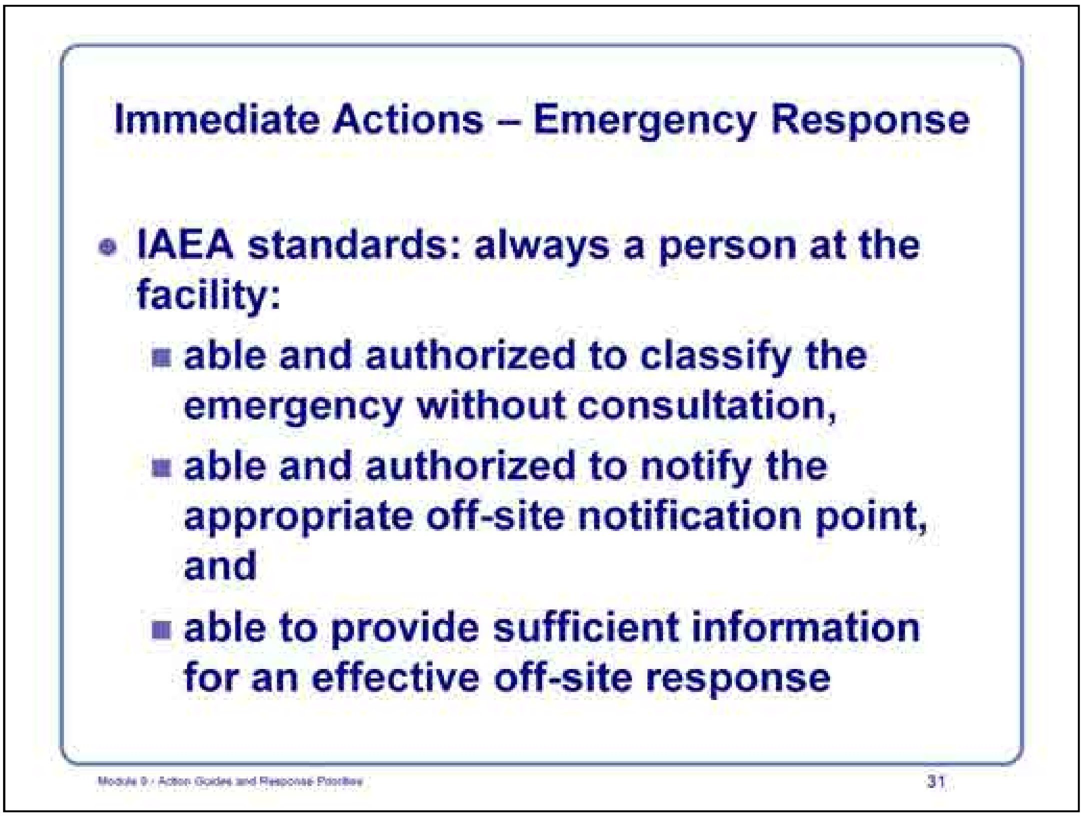


Lecture notes:

There are two levels of response when an emergency condition is recognized.

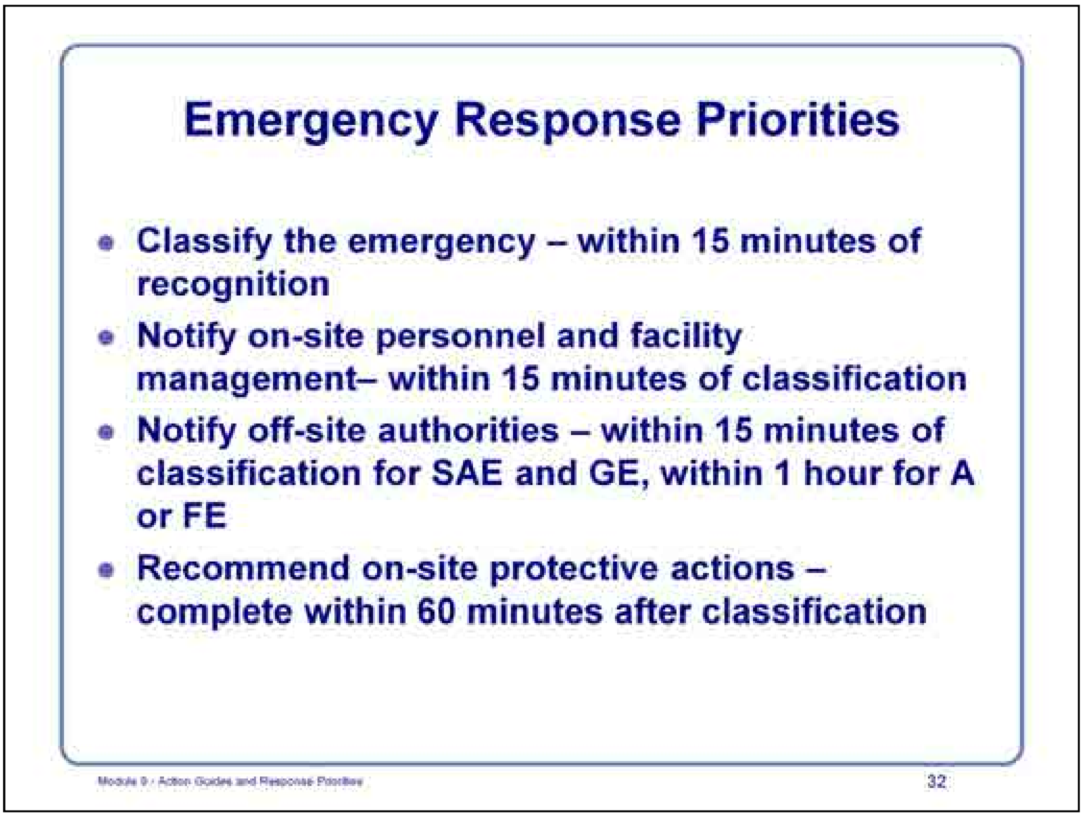
The reactor operator immediately initiates an EOP for the event, based on training and reactor condition in order to regain control of the reactor. It may be as simple as shutting down the reactor. Whatever is necessary, these actions have first priority and are not to be delayed by the emergency response procedures.

At the same time, an Emergency Response Team begins their duties. The Team did not exist, except as described in the Emergency Plan, until the emergency is recognized and the team members are notified. They may be, at least initially, also reactor operators or others at the reactor when the emergency occurs. Certain positions are so important that there needs to always be individuals who are prepared and authorized to initiate emergency response procedures, as long as doing so does not interfere with the first priority of regaining control of the reactor. As the emergency response proceeds these initial Emergency Response Team positions may be filled with other individuals from the facility, as described in the Emergency Plan. EPR-RESEARCH REACTOR provides the emergency response organization and procedures, but does not establish how the facility determines who should be able to assume the particular positions. That decision must be made by the facility as part of preparing its Emergency Plan.



Lecture notes:

This comes directly from GS-R-2. It doesn't allow for extensive phone conversation with managers who are not at the facility, nor does it allow for waiting for those managers to arrive, assess the situation and then react. Only pre-planned actions by trained individuals can allow this to occur. EPR-RESEARCH REACTOR provides the model set of information for a research reactor facility to build their own response plans to fulfill these expectations.

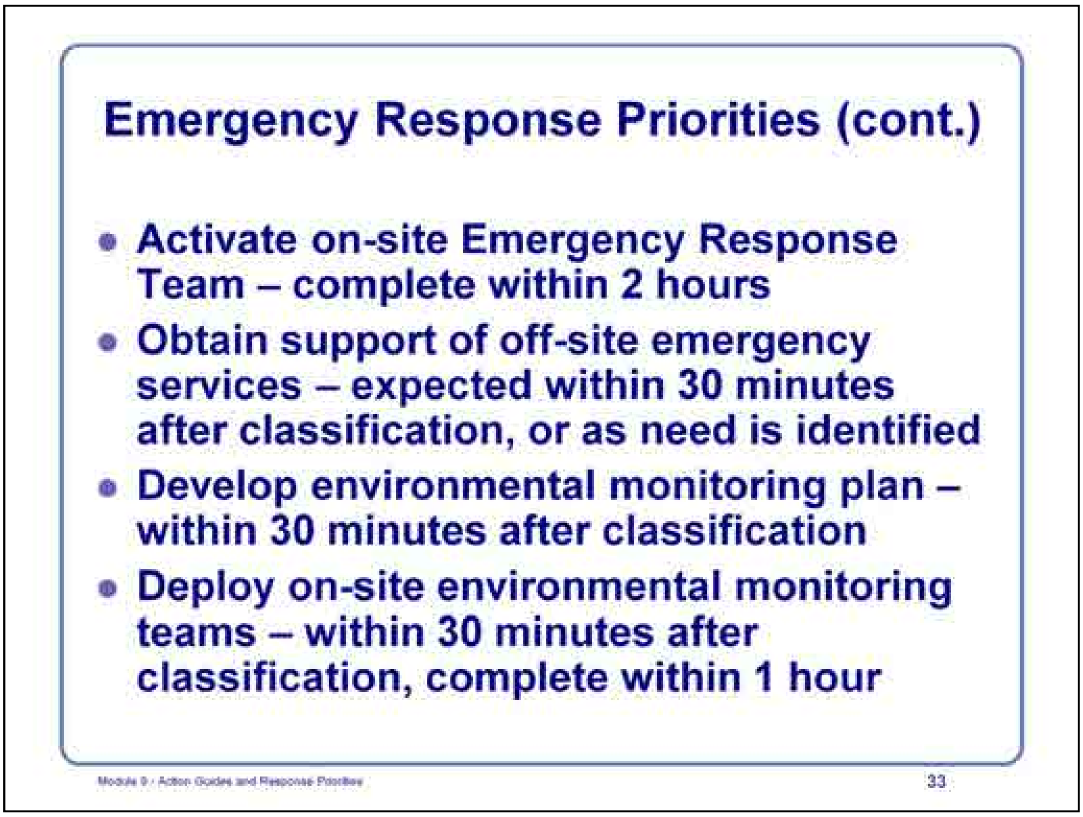


Lecture notes:

The prompt classification requires someone always able and authorized to perform this task.

Note the timing for off-site notifications depends on the emergency class. A continuously available off-site notification point is necessary for this response step. The notification may or may not, usually will not, include recommendations for off-site urgent protective actions. However, sheltering is an option that could be immediately recommended, and may be prudent for a General Emergency.

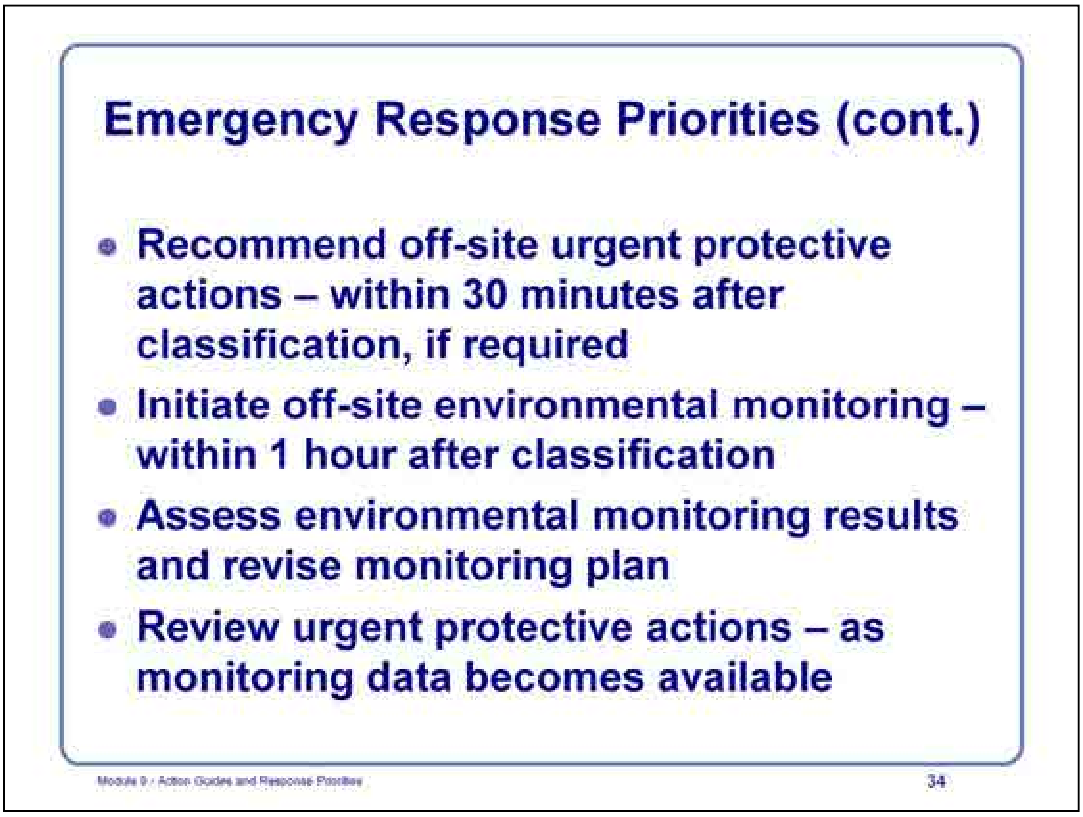
The on-site protective actions should not require and hour to complete. The time to evacuate or shelter on-site personnel could be automatically implemented by a site-wide alarm system such as a siren or PA system announcement. It is relatively simple to make arrangements for this action.



Lecture notes:

The full staffing for the Emergency Response Team may not be available on the site when an emergency occurs. Also, the Facility Response Manager should determine which positions are required. For example, for a Facility Emergency or an Alert, fewer monitoring teams and some of the team members for off-site actions may not be needed. It may be prudent to gather the full team until the situation is fully assessed, then release the unneeded personnel.

The environmental monitoring priorities will first conduct monitoring on the site, and the more comprehensive plan could be established after those teams have been assigned tasks. A proposed priority for the monitoring plan is provided in EPR-RESEARCH REACTOR. The site could also prepare a generic monitoring plan to initiate while the scope of the emergency is being assessed. An important part of the on-site monitoring is the identification of a release from the reactor that has the potential to move off-site. Thus, getting monitoring started near the reactor is an step that should not be delayed.

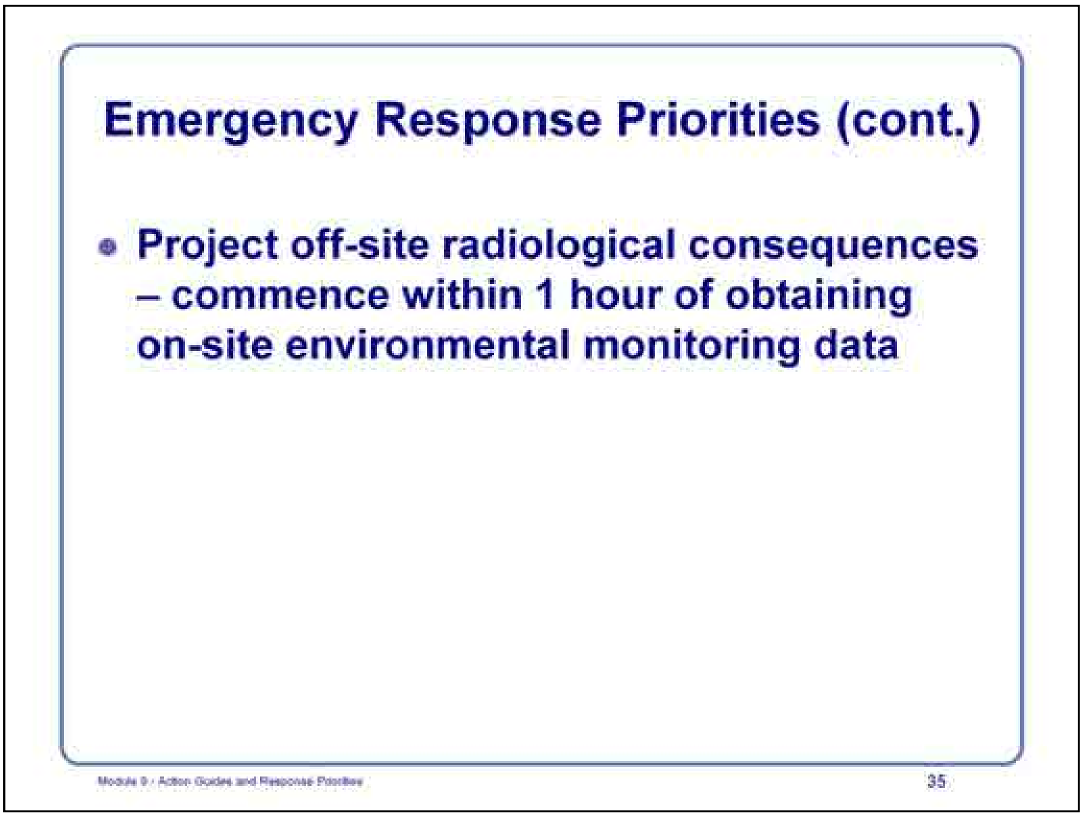


Lecture notes:

The prompt identification for off-site protective actions applies to General Emergencies, and perhaps also to Site Area Emergencies. For Threat Category II facilities, urgent protective actions would normally be based on environmental monitoring results. However, the facility threats analysis could show that population near the site, but within the UPZ are at immediate risk in certain extreme emergencies due to proximity of those individuals to the facility, and plans exist for action based on plant conditions.

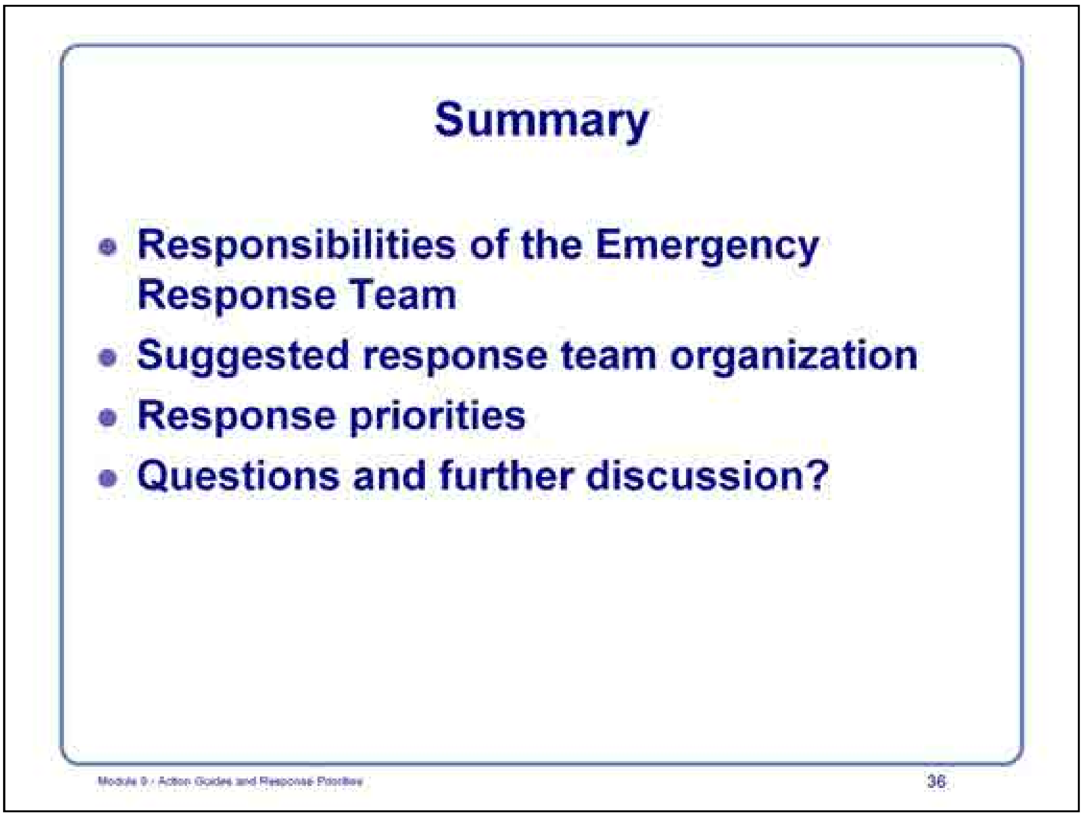
A part of advance arrangements with off-site authorities is the determination of the source of off-site monitoring teams.

As environmental monitoring data becomes available, it should be evaluated to determine if the urgent protective actions initiated on the basis of emergency class should be modified. The same data can cause changes in the monitoring plan.

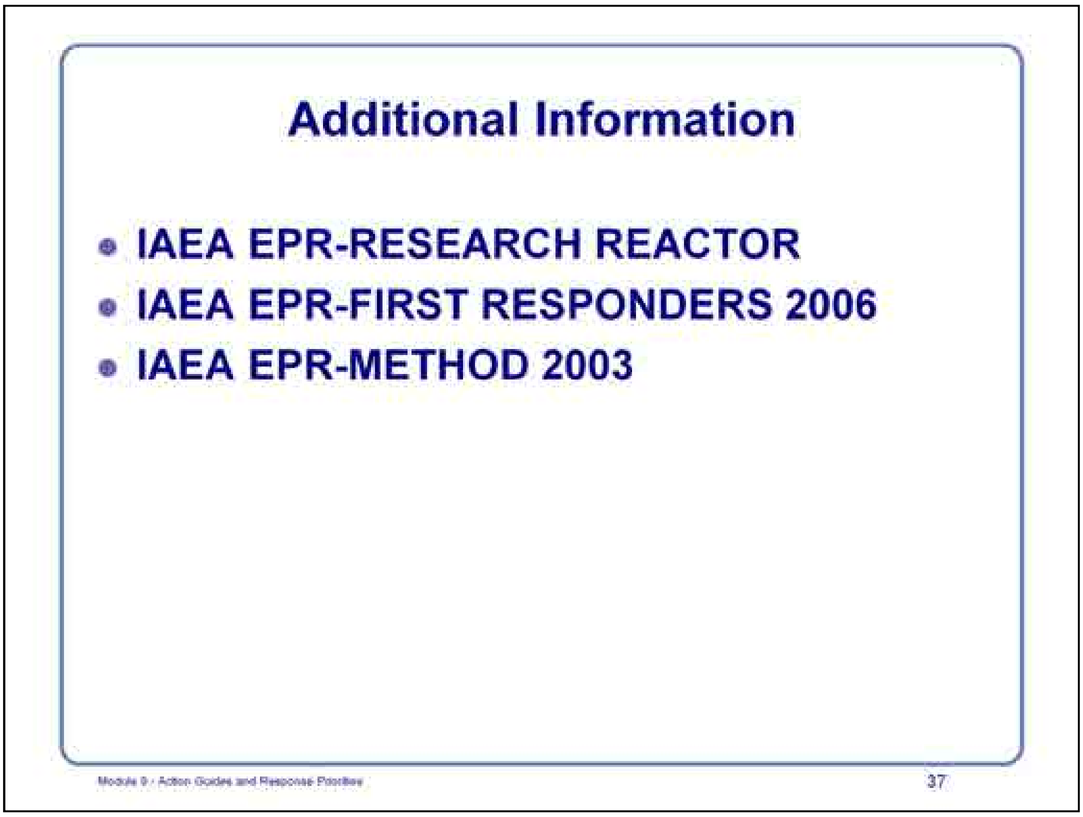


Lecture notes:

Projections are information that could be used to modify the environmental monitoring plan. Simple hand calculations are proposed in EPR-RESEARCH REACTOR. More complex projections using computer models may also be used. A site-specific model for the models that estimate radiological consequences will be better than the generic plume dispersion models, but the uncertainties are still high and weather conditions may vary enough in the nearby area that the weather conditions at the reactor do not represent reality.



Lecture notes:



Lecture notes:

IAEA Training Course for Research Reactor Emergency Response

Emergency Preparedness and Response

Medical Management Overview

Seminar

Block 3: Emergency preparedness and response overview

Module 10: Medical management overview

Learning objectives: Upon completion of this module, the participants will:

- be able to list health effects of radiation
- understand the difference between deterministic and stochastic health effects
- understand the role and place of medical preparedness and response in the overall organizational emergency response structure
- be able to list infrastructure and functional requirements for medical response preparedness
- be aware of the importance of psychological effects of radiological accidents

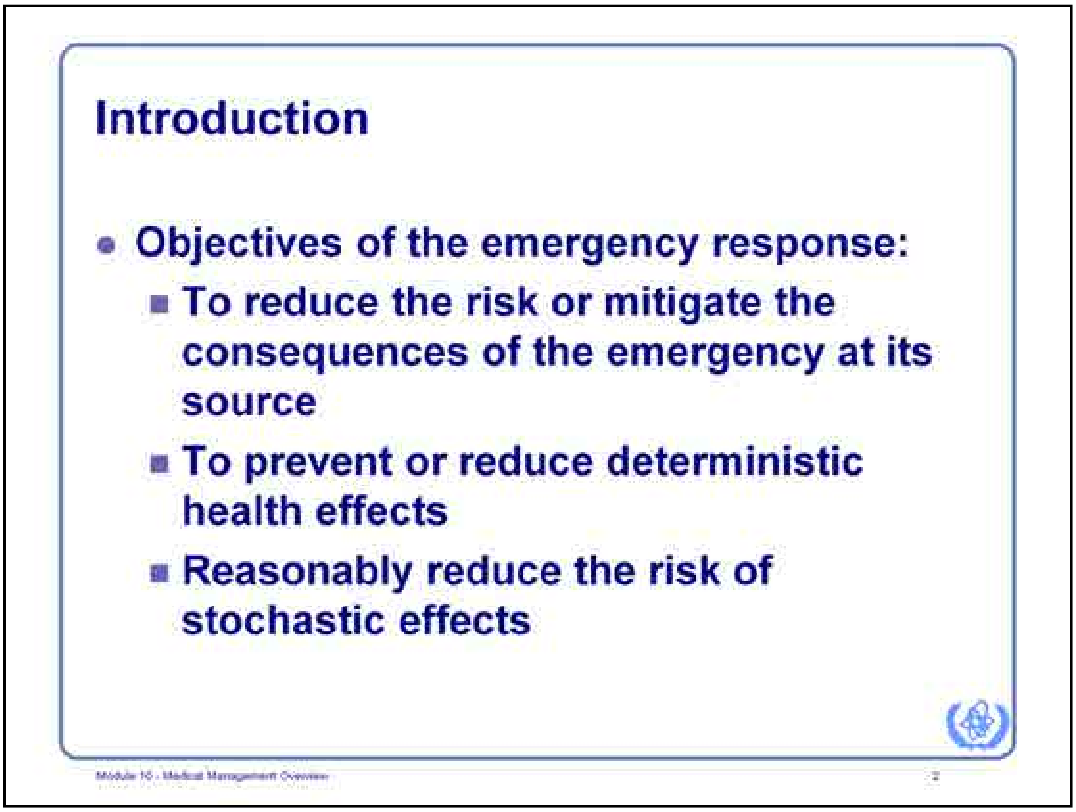
Activity: Seminar, questions and discussion

Duration: 1 hr

Materials and equipment needed: none

References:

1. UNSCEAR, Sources and Effects of Ionizing Radiation, 2000 Report to the General Assembly with Scientific Annexes, United Nations, New York (2000).
2. Ricks, R.C., Prehospital Management of Radiation Accidents, ORAU 223, Oak Ridge Associated Universities, Oak Ridge, TN (1984.)
3. Medical management of radiological casualties. Handbook. Ed. D. Jarrett., AFRRI, Bethesda, MD (1999.)
4. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic procedures for medical response during a nuclear or radiological emergency, EPR-MEDICAL, IAEA, Vienna (2005)



Lecture notes:

Emergency response activities have three primary objectives. The first objective is to take actions at the source of an emergency to mitigate or reduce the potential risk. The second objective is to ensure that people will not receive doses high enough to result in deterministic health effects induced by the emergency. The third objective is to take reasonable actions to reduce the chance of people getting stochastic health effects. It’s obvious that the second and the third objectives are directly related to the human health. Medical terminology is used even in the statements of the objectives. Therefore, every person participating in emergency response has to know and understand the meaning of the terms, and the relations between “pure” medicine, physics and radiation protection.

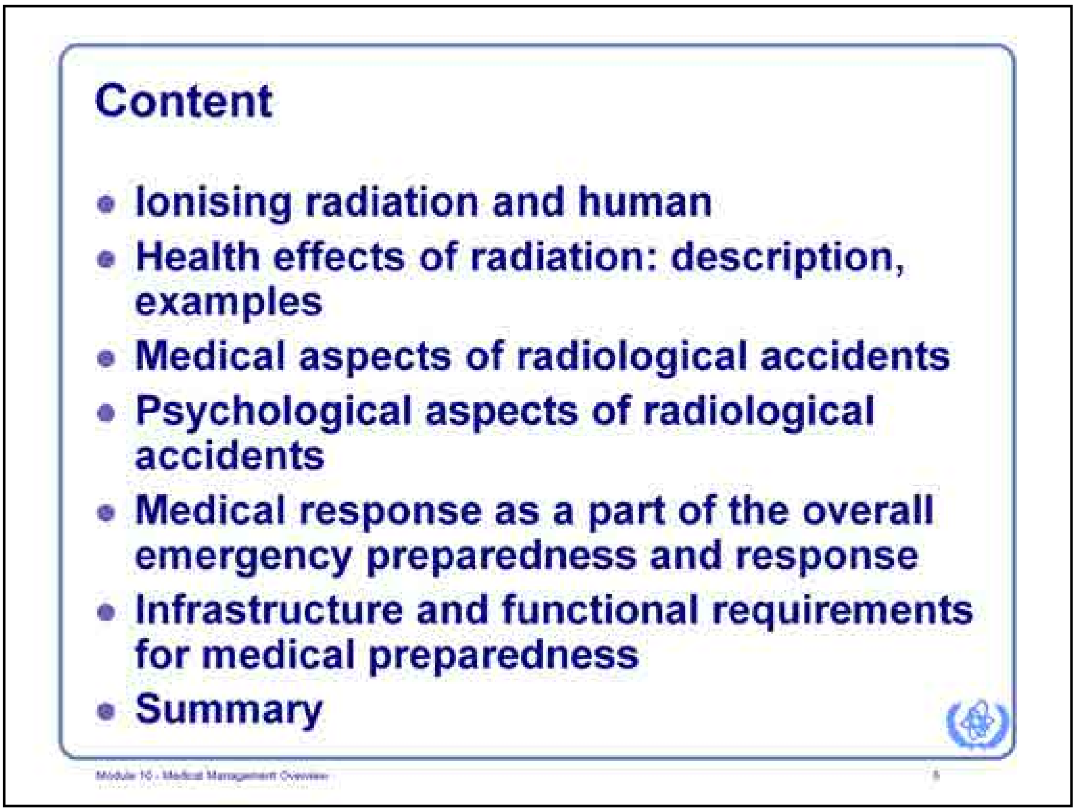
Lecture notes:

Effective medical response is a necessary component of an overall response to radiological emergencies. In general, the medical response to radiological accidents may represent a difficult challenge to the authorities due to the complexity of the situation, often requiring highly qualified specialists and organisational and material resources. Therefore an adequate planning is needed.The main objective of emergency medical response is to perform treatment of life threatening injuries. This is the first priority task which should be done not taking into account the presence of radiation factor. The general rule is: do not delay life saving actions due to the presence of radiation!

All actions within the responsibility of medical specialists (e.g., medical actions) should be consistent with the general objectives of emergency response. Therefore, the second objective of the emergency medical response is to implement actions needed to meet general objectives of emergency response.

Lecture notes:

In order to meet the objectives of emergency medical preparedness and response, medical organizations should participate in training, drills, and exercises to update and enhance basic knowledge and skills necessary to meet general objectives of emergency response. These later ones can also be considered as the objectives of the emergency medical preparedness. As the efficient performance of overall response organisation depends on all the organisations and teams involved in the activities, everybody should be aware of the roles and responsibilities of others. Therefore, specialists of different professions participating in the workshop, should be aware of the role and place of medical responders.

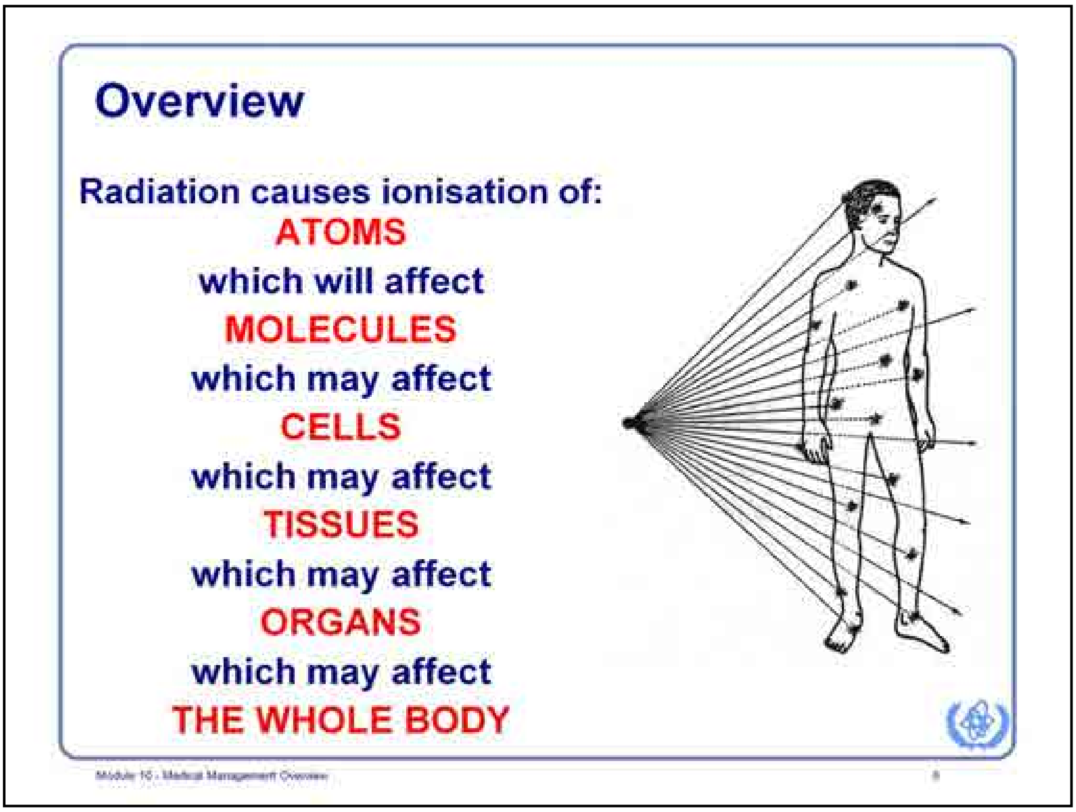


Lecture notes:

Many people of different professions are involved in emergency preparedness and response to radiation (nuclear or radiological) emergencies. Being joined in the overall response organization they need to understand on one hand the basic philosophy and objectives of radiological protection of the general public and emergency workers, and on the other hand, the aim of the response activities implemented in a radiation emergency. Therefore, specialists of different professions should understand basic facts about ionizing radiation and human behavior in an emergency situation.

Therefore specialists of different professions should know basic information about radiation and human. Such information will help for better understanding of purposes for emergency response and on the long run will help to organize the activities of emergency response organization in the most efficient way.

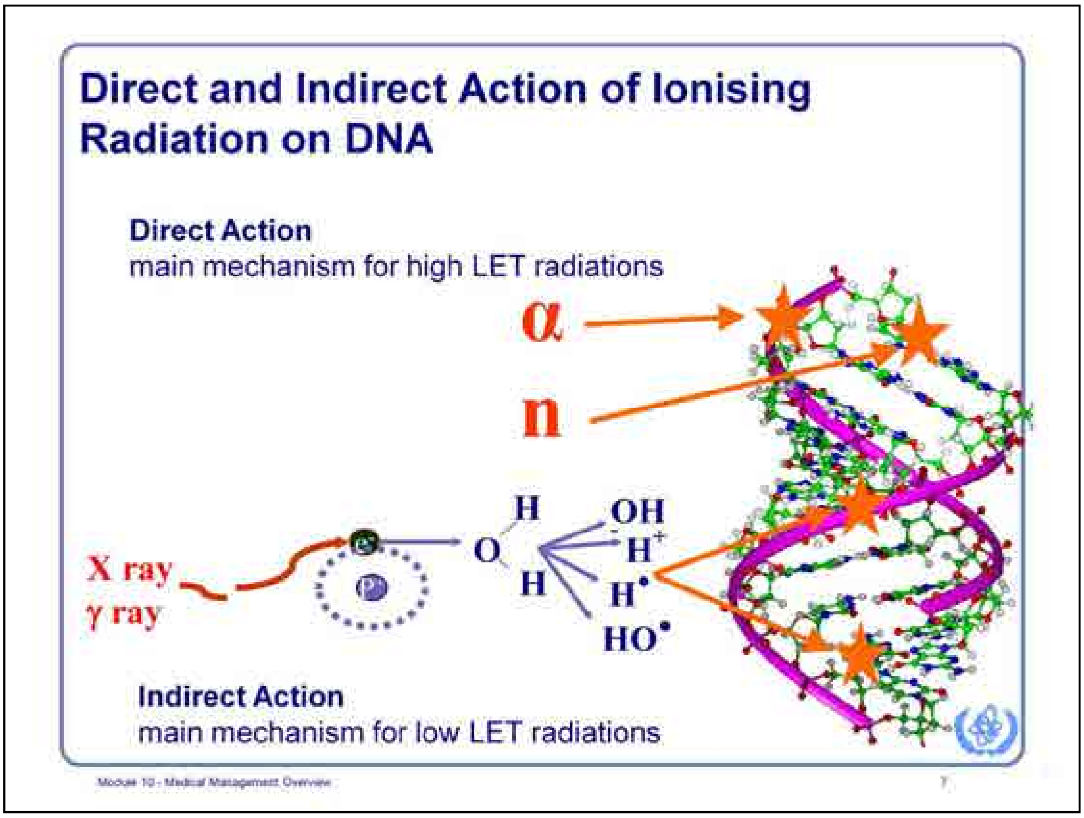
The aim of this lecture is to explain possible health effects of ionizing radiation, to give an overview of preparedness elements for an efficient medical response and to present medical and psychological aspects of radiation accidents.



Lecture notes:

Whether the source of radiation is natural or man made, whether it is small dose of radiation or large, there will be some biological effects.

Although we tend to think of biological effects in terms of the effect of radiation on living cells, in actuality, ionising radiation, by definition, interacts only with atoms by a process called ionisation. Thus, all biological damage effects begin with the consequence of radiation interactions with the atoms forming the cells. As a result, radiation effects on human proceed from the lowest to the highest level as noted in this slide.



Radiation interactions that produce biological changes are classified as either ***direct*** or ***indirect***. The change takes place by direct action if a biological macromolecule such as DNA,

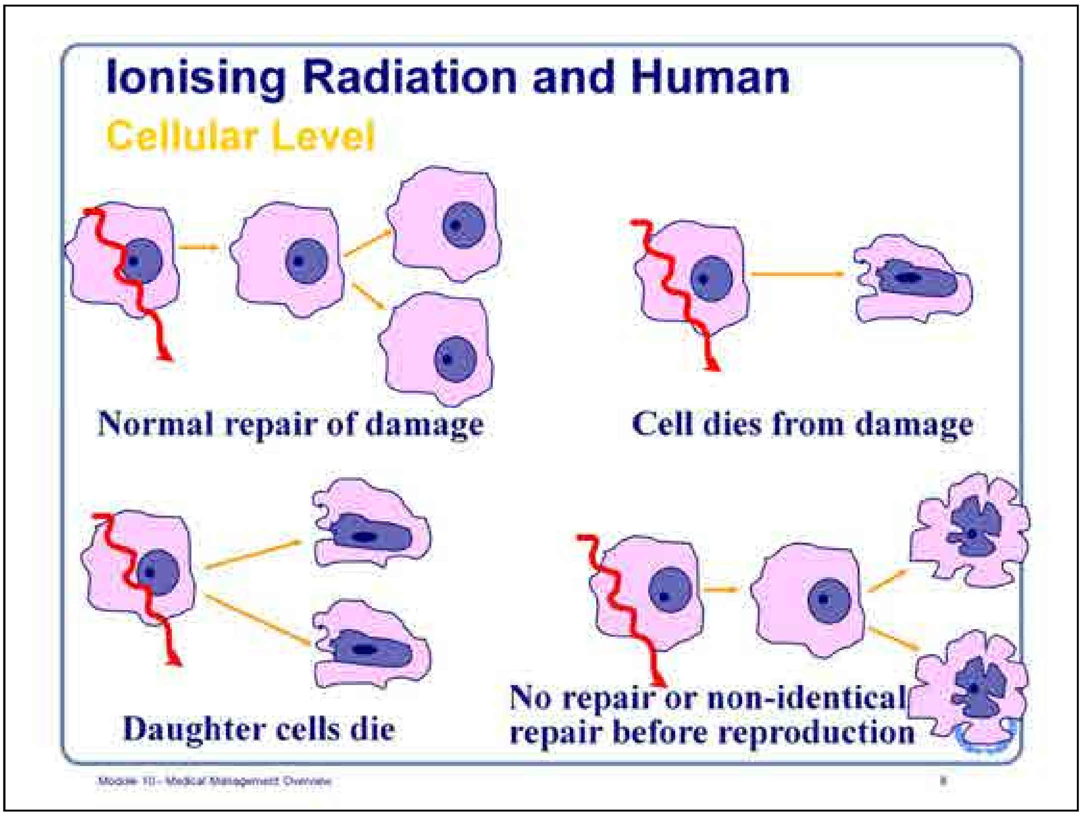
RNA, or protein becomes directly ionized or excited by an ionising particle or photon passing through or near it. Indirect effects are the result of radiation interaction within the medium

(e.g., cytoplasm) creating reactive chemical species called ***free radicals*** that in turn interact with the target molecule. Because 70-85% of the mass of living systems is composed of water, the vast majority of low LET radiation-induced damage is mediated through indirect action on water molecules. The water molecule absorbs energy and disassociates into two radicals with unpaired electrons in the valance shell. These are denoted by the symbols H• and OH• below

H2O → H+ + OH- (ionization)

H2O → H•+OH• (free radicals)

Free radicals are extremely reactive chemical species that can undergo a variety of chemical reactions. Free radicals can combine with other free radicals to form non-reactive chemical species such as water in which case no biological damage occurs, or with each other to form other molecules, such as hydrogen peroxide, which are highly toxic to the cell. Although their lifetimes are limited (<10-5 sec), free radicals can diffuse in the cell producing damage at locations remote from their origin. Free radicals may inactivate cellular mechanisms directly or via damage to genetic material (DNA and RNA) and are believed to be the primary cause of biological damage from low LET radiation.



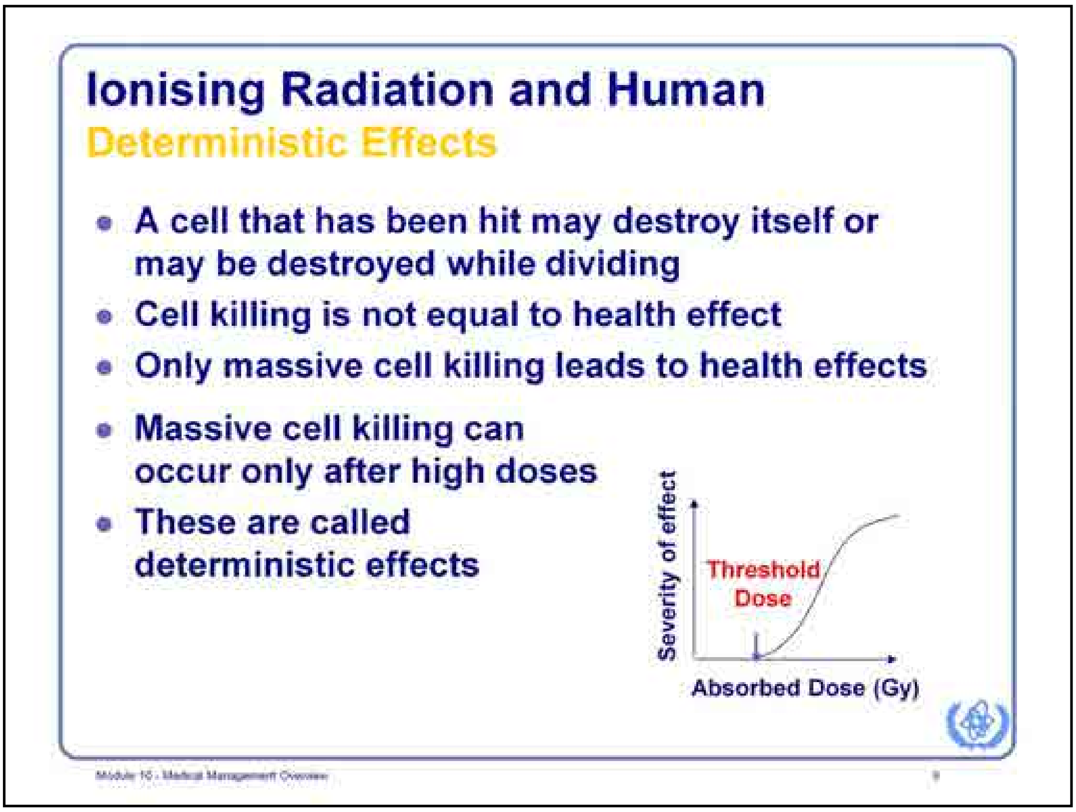
Lecture notes:

The target for all health effects of ionising radiation is the genome of the cell, the DNA (deoxyribonucleic) molecule. Even a single hit by a particle or a photon can cause a break in the DNA molecule. If it is a break in one strand of the DNA only (a single strand break) it will most probably be perfectly repaired with no consequences for health. If, however, both DNA strands are broken close to each other, which is also possible after a single hit, repair mechanisms are likely to fail and the genome may be changed.

Cells, like a human body, have tremendous ability to repair damage. As a result not all radiation effects are irreversible. In many instances, the cells are able to completely repair any damage and function normally.

In some case, however, the damage is severe enough that the cell dies. In other instances, the cell is damaged but it still able to reproduce. The daughter cell, however, may be lacking some critical life sustaining components, and they die. Finally, the cell may be affected in such a way that it does not die but is simply mutated. The mutated cell reproduces and thus perpetuates the mutation. This could be the beginning of the malignant tumour.

Generally, cells are most sensitive to radiation when they are dividing, so that the most radiosensitive tissues are the blood, the intestinal wall, the skin, and the fetus. Conversely, the most radioresistant tissues are muscle, nerves, and the adult brain, where cell reproduction is minimal.



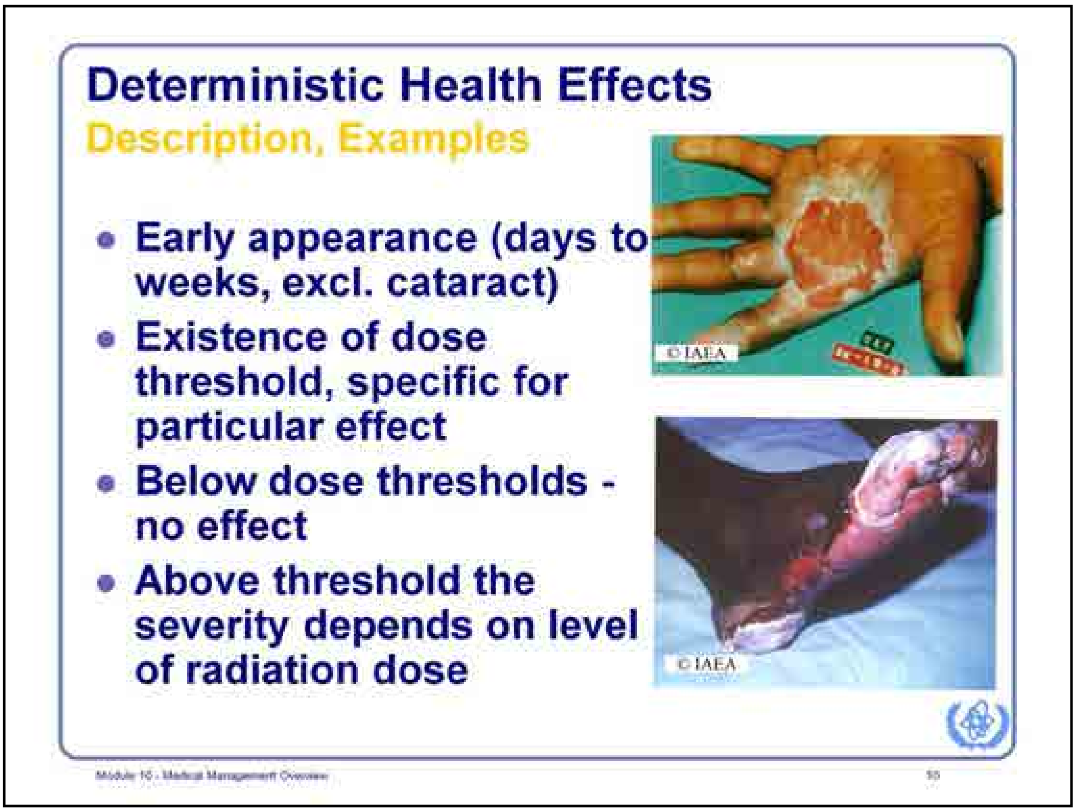
Lecture notes:

The function of most organs and tissues of the body is unaffected by the loss of small numbers of cells, or sometimes even of substantial number. However, if the number of cells lost in a tissue is large enough and the cells are important enough, there will be observable harm, reflected in a loss of tissue function. The probability of causing such harm is zero at small doses of radiation, but above some level of dose (the threshold) it increases to unity (100%). Above the threshold, the severity of the harm also increases with dose. This type of effect is called deterministic, because it is sure to occur if the dose is large enough and is higher than threshold. If the loss of cells can be compensated by the repopulation, the effect will be relatively short-lived.

Examples of deterministic effects are local radiation injuries (radiation burns); induction of temporary or permanent sterility in the testes and ovaries; depression of the effectiveness of the blood forming system, leading to a decrease in the number of a blood cells; cataract. A special case of the deterministic effect is the acute radiation syndrome resulting from acute whole body irradiation.

Photo

Two views of the right hand of a pioneer medical radiologist. The first injury to this radiologist was seen in 1899, namely 3 years after the discovery of X-rays was announced. The hand was amputated in 1932 and death from cancer occurred in 1933.

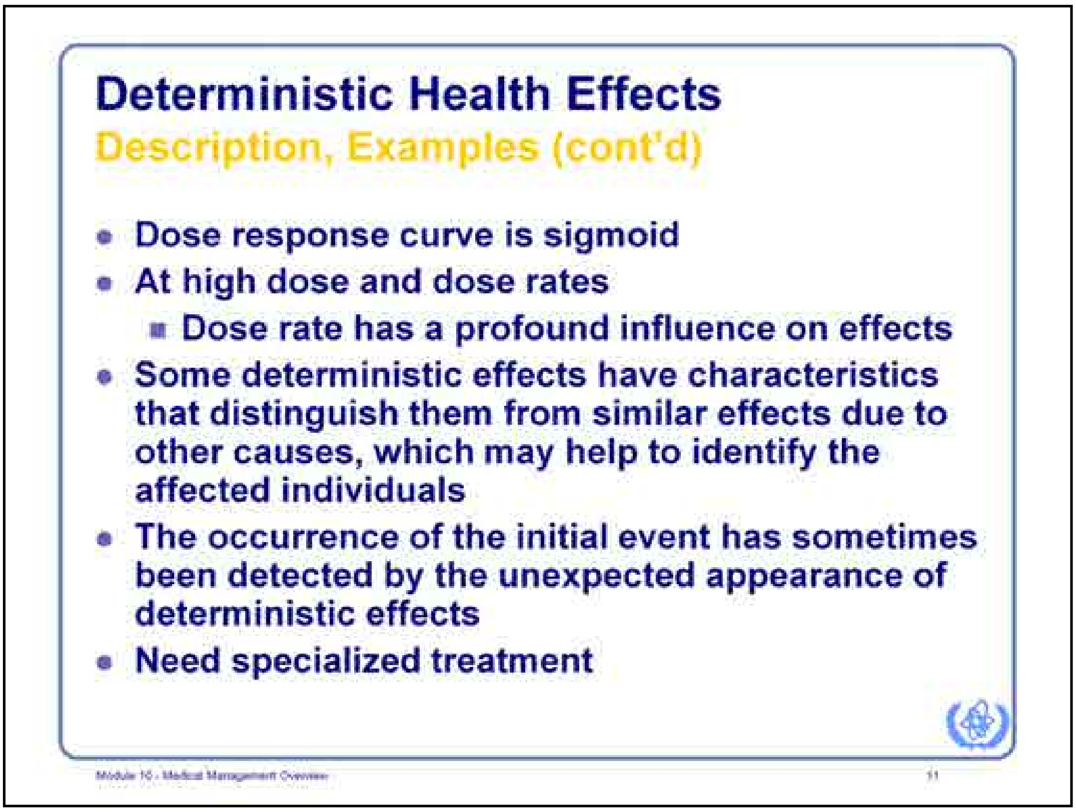


Lecture notes:

A deterministic effect generally shows up within a short time after exposure (”early effects”), but this is not always true. Cataract, for example, is a typical deterministic effect appearing only after several years. That is why the term ”early effects” can not be used as a synonym .

For each deterministic effect there is a **threshold dose**, below which the effect does not appear. This threshold shows only limited variation between individuals. If people of varying susceptibility are exposed to radiation, the threshold in a given tissue for deterministic effects of sufficient severity to be observable will be reached with the lower doses in the more sensitive individuals.

Once the threshold has been exceeded, however, the effect is certain (”deterministic”) and is rapidly getting worse with increased radiation dose. Threshold dose depends on the organ, dose rate, and other factors.

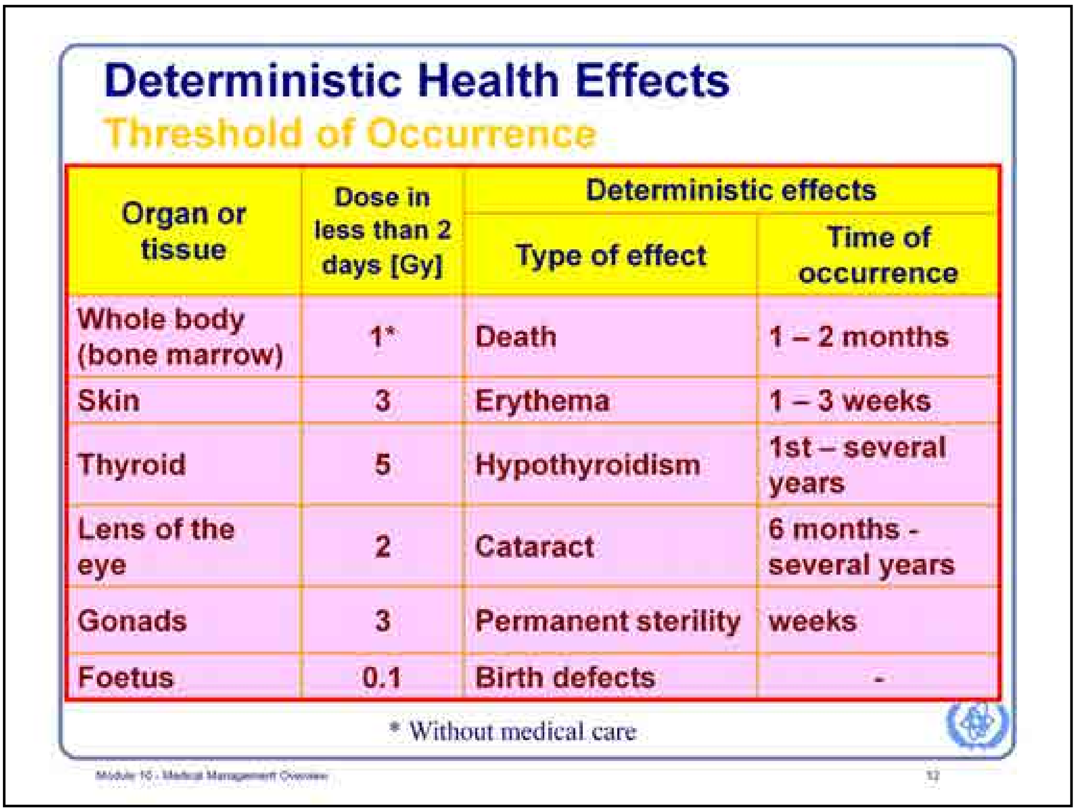


Lecture notes:

Graphically, the **dose response** curve can be represented by a sigmoid form, starting after a threshold and then rising steeply, soon reaching 100% response.

Dose rate has a profound influence on both the threshold dose itself and the severity of the effect. Quite high doses can be tolerated, if received during a long time, allowing cell division to compensate for radiation induced cell loss.

If the exposure is caused by a certain identified event, it will usually be possible to identify the affected individuals. Some deterministic effects have characteristics that distinguish them from similar effects due to other causes, which may help to identify the affected individuals. The occurrence of the exposure has indeed sometimes been detected by the unexpected appearance of deterministic effects.



Organ or tissue	Dose in less than 2 days [Gy]	Deterministic effects	
		Type of effect	Time of occurrence
Whole body (bone marrow)	1*	Death	1 – 2 months
Skin	3	Erythema	1 – 3 weeks
Thyroid	5	Hypothyroidism	1st – several years
Lens of the eye	2	Cataract	6 months - several years
Gonads	3	Permanent sterility	weeks
Foetus	0.1	Birth defects	-

Lecture notes:

The organs of the body have different sensitivities to radiation, therefore, dose thresholds for deterministic health effects are also different.

A typical deterministic effect of radiation exposure is Acute Radiation Syndrome (ARS). It occurs after acute whole body doses of penetrating radiation of not less than one sievert. The first signs of exposure appear after a latency time of one or two hours and consist of malaise, nausea and possibly vomiting. The prognosis can be greatly improved by high standard hospital care, but if the dose to the bone marrow has been more than 6-8 Gy, death usually follows after a few weeks.

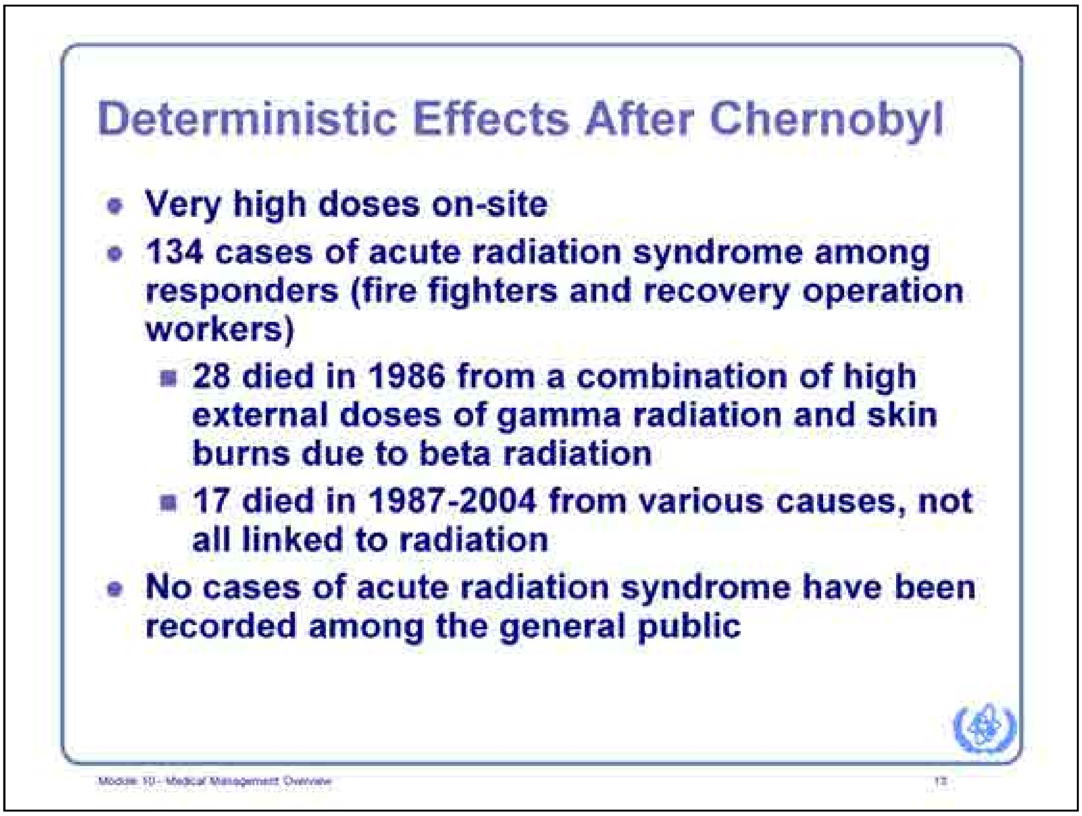
Doses of this magnitude are seen only in serious accidents, often in connection with strong radiation sources in wrong hands. It is extremely unlikely that a population exposed to fallout from a nuclear emergency would get such high doses except possibly in the close vicinity of the reactor. No member of the public got acute radiation syndrome after the Chernobyl accident. It appeared only in emergency workers working at the emergency site. 28 of them died of the disease.

The acute radiation syndrome may be further complicated by high doses to certain organs. In an emergency, exposure is often highly inhomogeneous, in which case severe organ damage is possible in spite of a moderate bone marrow dose. In the Chernobyl accident response, the situation for exposed emergency workers was worsened by severe radiation damage to the skin.

In case of a prolonged dose of several Gy, a chronic form of bone marrow depression may develop. However, **doses of less than half a gray, whether acute or prolonged, do not lead to immunodeficiency or any other chronic disease**. This fact should be clearly understood by health personnel dealing with people exposed to radiation. Otherwise, radiation exposure may be blamed for any complaint, from rheumatism to toothache or flu.

The skin is especially sensitive to *beta* rays. Beta particles are moderately penetrating, a few cm in tissue, this causes damage to the stem cells of the skin.

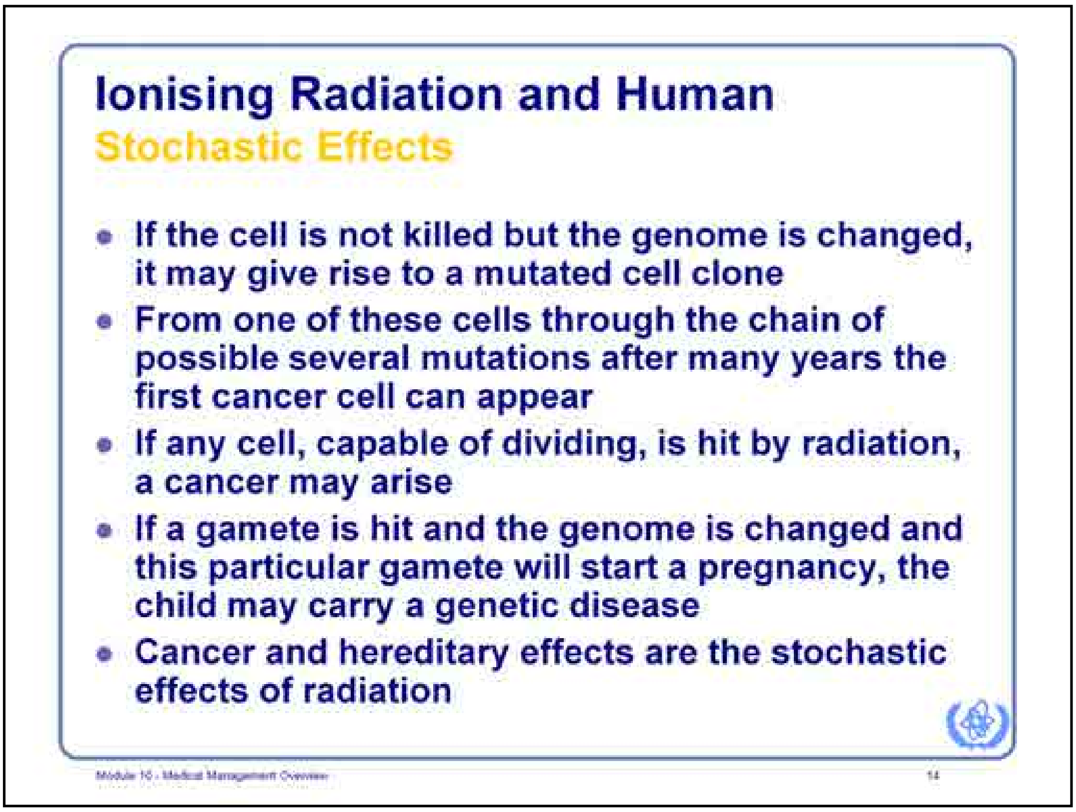
A high local dose causes reddening of the skin after a few hours. Two weeks later hair of the skin falls off. Epilation of all hair is usually observed after a life threatening whole body dose of a few Gy. High local doses to the skin may damage and occlude the blood vessels of the skin, and ulcers and necrosis may develop. Such type of a damage can be very painful and invalidising, and amputation may be the solution.



Lecture notes:

It is extremely unlikely that a population exposed to fallout from a nuclear emergency would get such high doses except possibly in the close vicinity of the reactor. No member of the public got acute radiation syndrome after the Chernobyl accident. It appeared only in emergency workers working at the emergency site. Twenty-eight emergency workers died of the disease.

The acute radiation syndrome may be further complicated by high doses to certain organs. In an emergency, exposure is often highly inhomogeneous, in which case severe organ damage is possible in spite of a moderate bone marrow dose. In the Chernobyl accident response, the situation for exposed emergency workers was worsened by severe radiation damage to the skin.

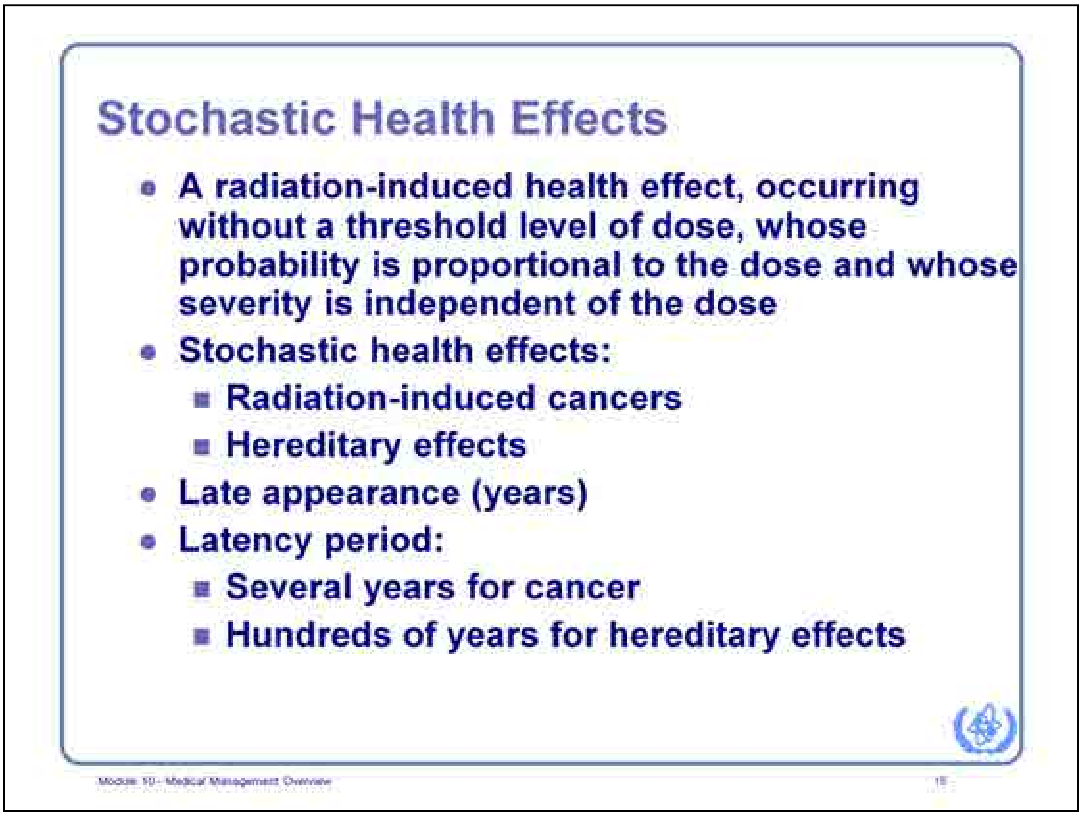


Lecture notes:

Of the various forms of damage that exposure can cause in living cells some do not cause the death of the affected cells. A viable but modified somatic cell may still retain its reproductive capacity and may give rise to a clone. If the clone is not eliminated by the body's defence mechanisms, it may result, after a prolonged and variable period of delay termed the **latent period**, in the development of a malignant conditions, usually termed cancer, which is the principal late somatic effect of exposure to radiation.

If the damage occurs in a cell whose function is to transmit genetic information to later generations, the effects, which may be of different kinds and severity, will be expressed in the progeny of the exposed person. This type of stochastic effect is called a **hereditary effect**.

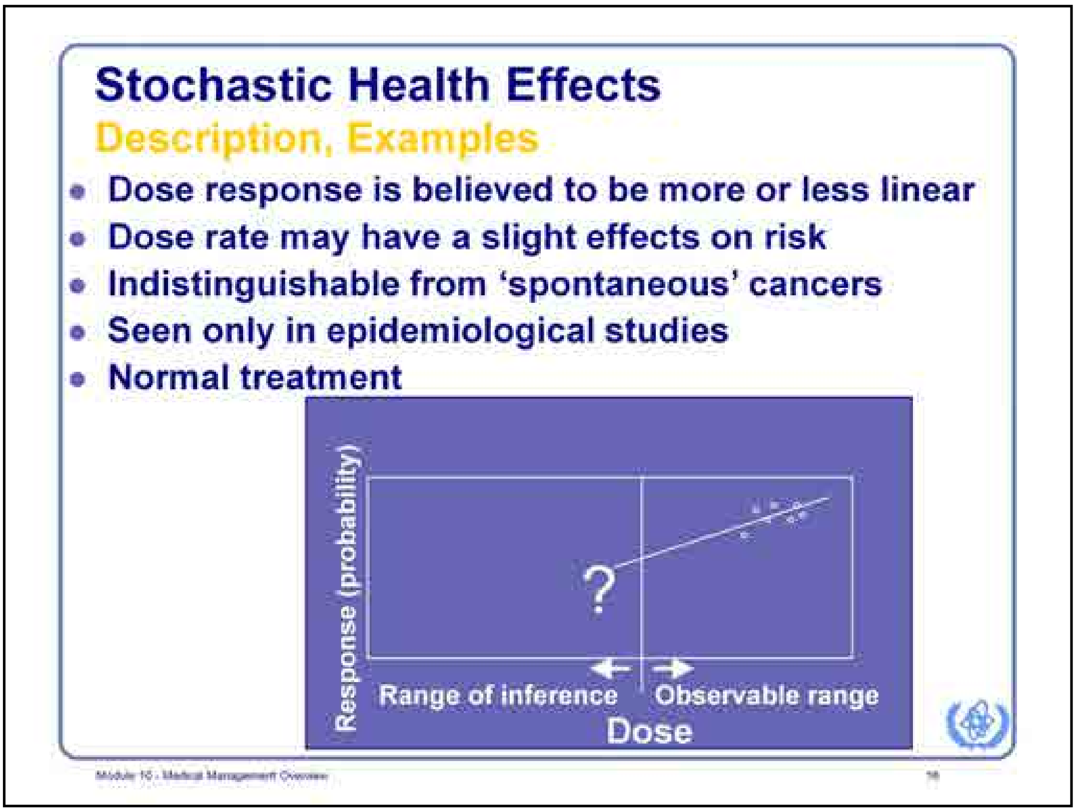
In general, it is impossible to know whether an individual cancer case was caused by exposure in the past or not. If a person is accidentally or occupationally exposed to radiation and then gets cancer later in life, he may be convinced that his cancer was caused by the radiation. In reality, however, this is probably not the case.



Lecture notes:

As was already said, the effects of ionization can lead to biological effects, including cell death and abnormal cell development. If the dose is low or delivered over a longer period of time, there is a greater opportunity for the body's damaged cells to repair themselves; however, harmful effects may still occur. Effects of this type, called stochastic, are not certain to occur, but their likelihood increases for higher doses, whereas the timing and severity of an effect do not depend on the dose. Examples are cancers of various types and hereditary effects.

Are the cancers induced by radiation different from those induced by other hazards (e.g.. chemicals, biological agents, naturally from one's genetic make-up etc..) ? The answer appears to be no - they are indistinguishable, unlike a deterministic effect, which can readily be attributed specifically to radiation. This means that the only way these effects can be detected is by studying cancer statistics for a population, using careful cancer and dose registration. This also means that the radiation-induced cancers are treated in exactly the same way as non-radiation-induced similar cancers, needing no specialized treatment, but additional screening programs may be warranted.

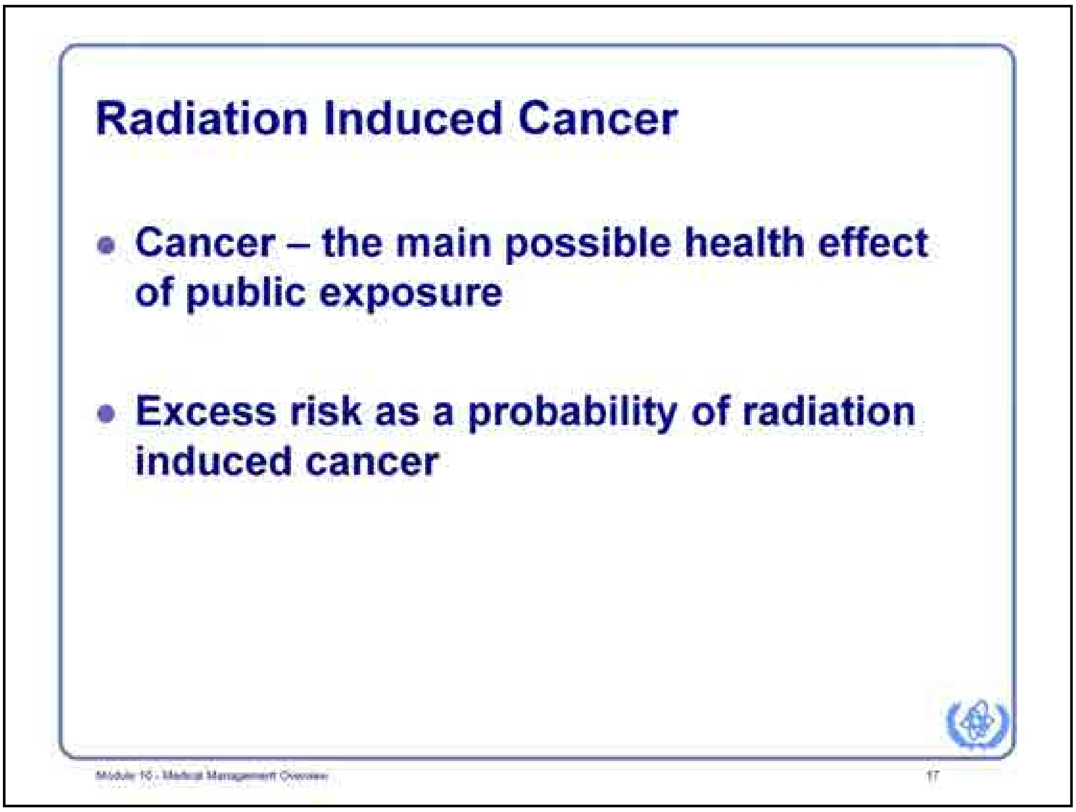


Lecture notes:

The cancers introduced by radiation, with or without the contributions of other agents, are not distinguishable from those that occur owing to other causes, or "spontaneously". Since the probability of cancer resulting from radiation is related to dose, this type of radiation effect can only be detected by statistical means in epidemiological studies carried out on exposed population groups.

Based on general theories of how ionizing radiation acts to produce cancer it is assumed that there is no threshold below which the risk of cancer is zero. In other words, all finite exposure levels will increase the risk that cancer will occur. This does not mean that all finite exposures actually will cause cancer. This also implies that living in areas of high background radiation can be dangerous to your health!

Except as a result of serious accidents or inevitable irradiation of healthy tissues in radiotherapy, the doses incurred by man are not so large as to produce deterministic effects. Therefore, the main practical interest in the risks of radiation lies in the region of lower doses and dose rates that are experienced in radiation work or in other situations of everyday life.



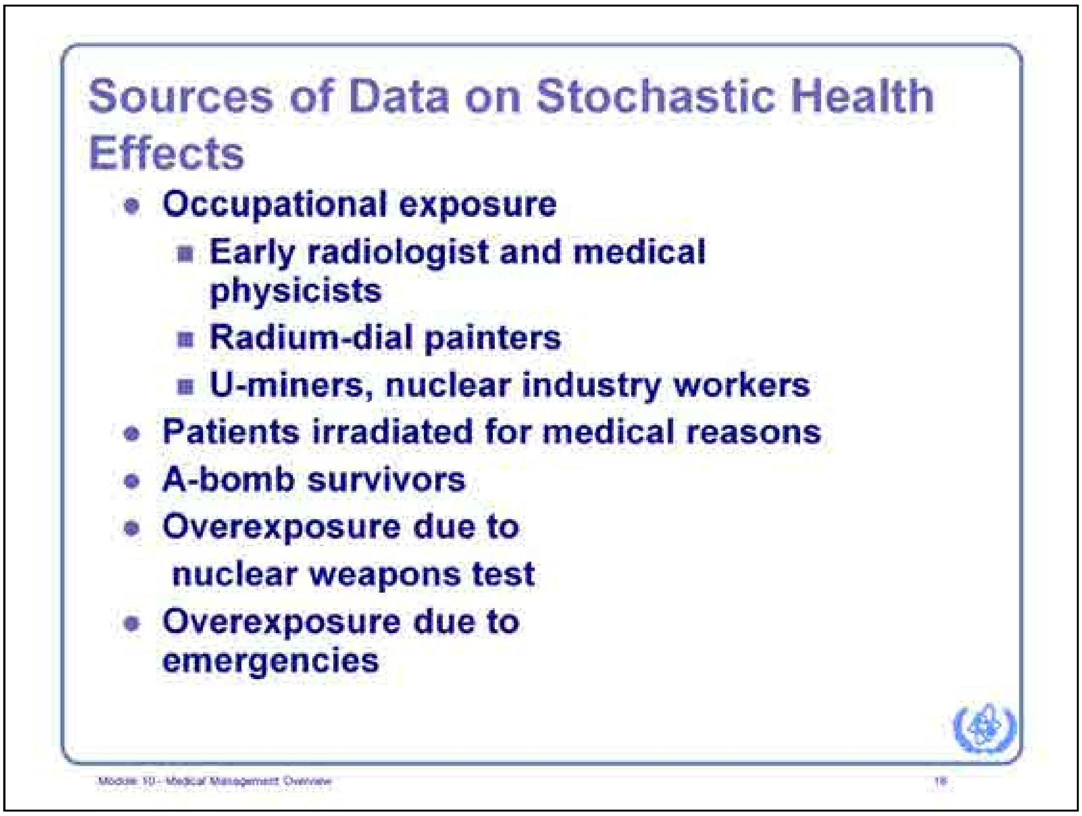
Lecture notes:

From a public health perspective, cancer is the most important health effect of ionising radiation.

Unlike genetic effects of radiation, radiation induced cancers are well investigated. Many studies have been accomplished which directly link the induction of cancer and radiation exposure. The following are examples of epidemiological studies:

- Lung cancer – Uranium miners;
- Bone cancer – Radium dial painters;
- Thyroid cancer – Therapy patients, population exposed due to Chernobyl accident;
- Breast cancer – Therapy patients;
- Skin cancer – Radiologists;
- Leukaemia – Bomb survivors, in-utero exposures, therapy patients.

The most important groups that were studied are those exposed to the atomic bombs in Japan in 1945.



Lecture notes:

Data on human effects were studied based on the observation of the following groups of exposed people, presented at this slide.

Unlike genetic effects of radiation, radiation induced cancer is well documented. Many studies have been accomplished which directly link the induction of cancer and exposure to radiation. Some of the populations studied and their associated cancers are: Lung cancer – Uranium miners; Bone cancer – Radium dial painters; Thyroid cancer – Therapy patients, population exposed due to Chernobyl accident; Breast cancer – Therapy patients; Skin cancer – Radiologists; Leukaemia – Bomb survivors, in-utero exposures, therapy patients.

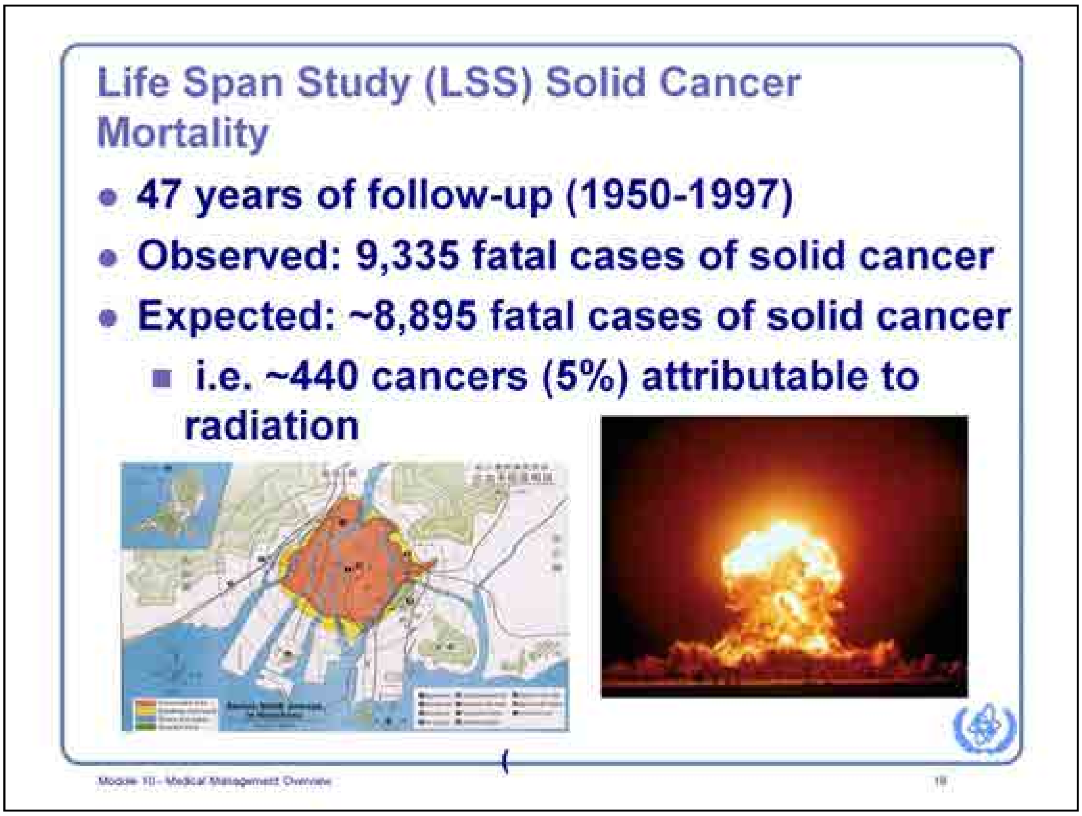
The most important of these groups are those exposed to the atomic bombs in Japan in 1945. A-bomb survivors were exposed to a range of whole body doses and comprised a wide range of ages:

Average dose – 0.27 Sv

~ 6,000 individuals exposed in dose > 0.1 Sv

~ 700 individuals exposed in dose > 1 Sv

Total number of exposed people included in the Life Span Study (LSS) is about 90.000 people.



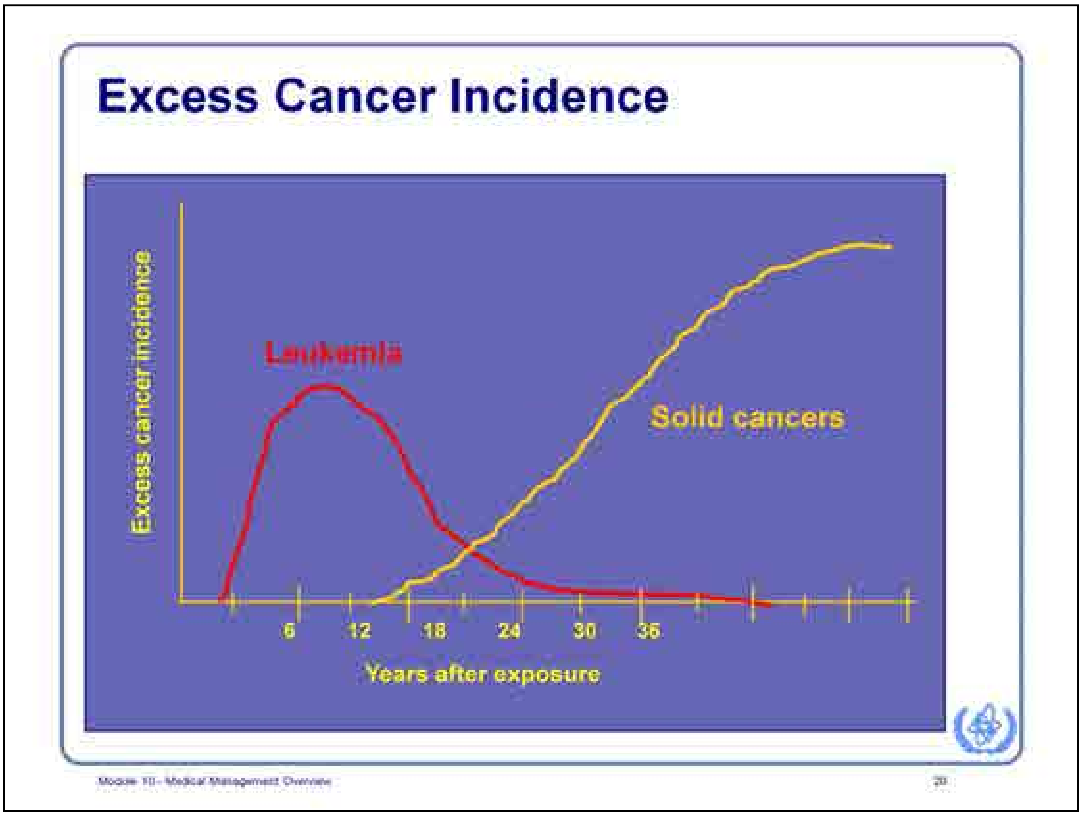
Lecture notes:

This slide presents data of 47 years follow-up of the atomic bomb survivors (Ref. to **Preston et al, *Radiat Res* 160:381-407, 2003**).

Among these people, the leukaemia incidence started to increase two years after exposure and then gradually faded. The maximum increase occurred less than ten years after exposure. In contrary, the incidence for solid tumours started to increase later, about 5 years after exposure, but the increase is still going on and seems to continue to the end of life. It is actually accentuated when the exposed population gets older and natural cancer incidence increases.

Note for instructor: While discussing these numbers, compare with ~20-25% probability of fatal spontaneous cancer in a life time.

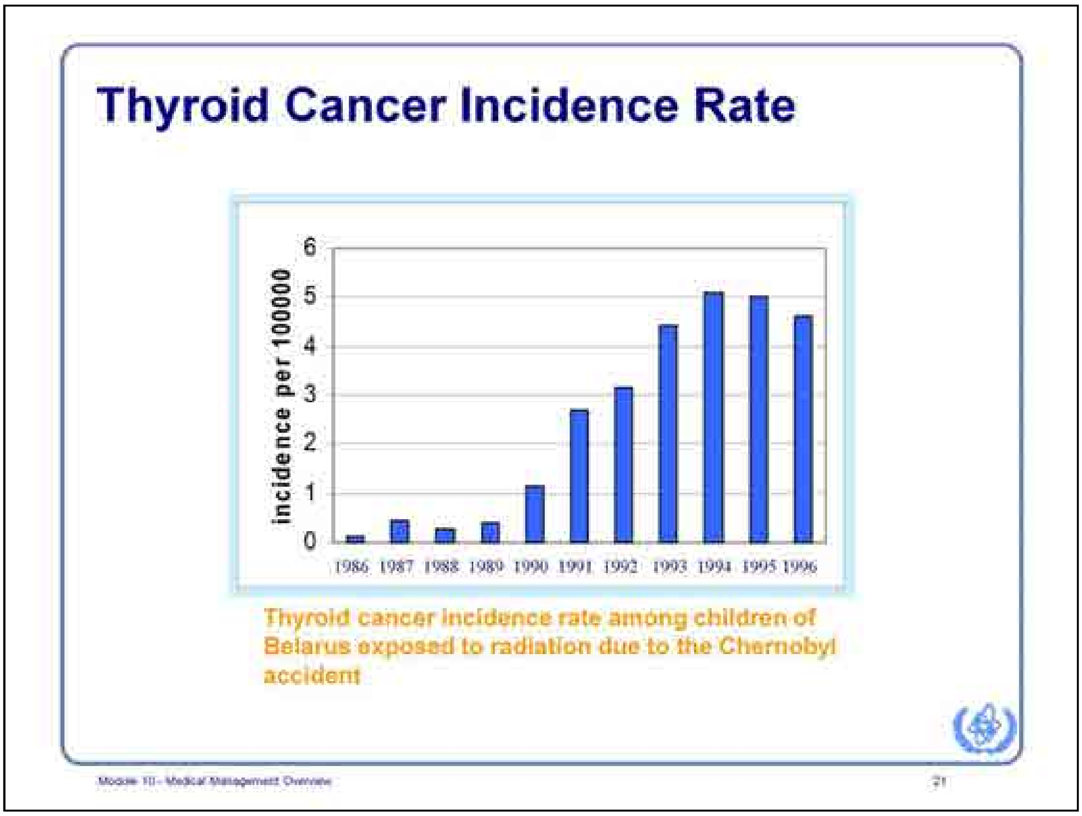
To help put this in perspective think about the following statistics today regarding cancer. Approximately 1 in 5 people will get some form of cancer in their lifetime. This is approximately 20% of the population. Look around the room count the total number of people in the room and divide by 5. How many people in the room statistically will get cancer?



Lecture notes:

For most cancers in adults, the latent period is at least ten years, or even longer. The shortest latent period is for the leukaemia and thyroid cancer (3-5 years).

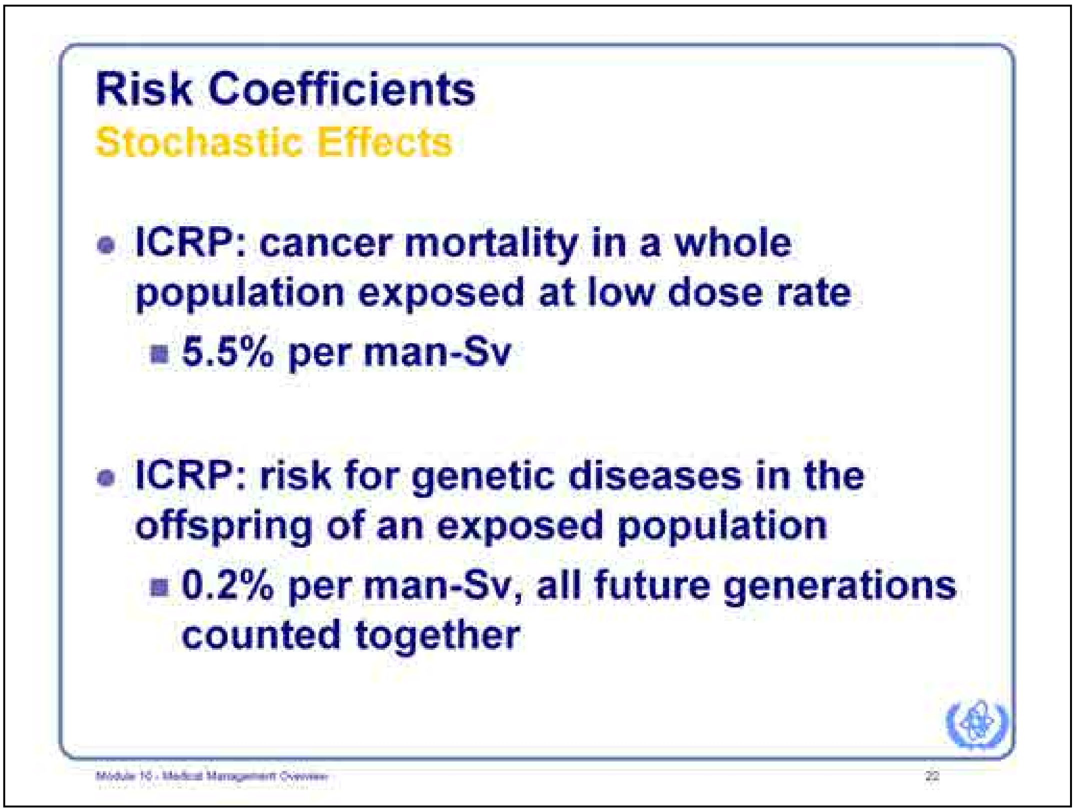
Among the atomic bomb survivors in Japan, the leukaemia incidence started to increase two years after exposure and then gradually faded. The maximum increase occurred less than ten years after exposure. In contrary, the incidence for solid tumours started to increase later, about 5 years after exposure, but the increase is still going on and seems to continue to the end of life. It is actually accentuated when the exposed population gets older and natural cancer incidence increases.



Lecture notes:

One of the well investigated health consequence of radiation exposure is radiation-induced thyroid cancer in childhood. A radioactive release containing radioiodine can cause high doses to the thyroid gland. Children are sensitive to the carcinogenic effect of radioiodine. The estimation of risk for thyroid cancer in children exposed to radioiodine which was done before Chernobyl accident showed the value 2.5 per 10^4 person-gray per year. This means that if 1 million children get a mean thyroid dose of 10 mGy, 2-3 extra cases of thyroid cancer per year will occur in this group. As the background frequency of thyroid cancer in children is about 1 per million children per year, this very low dose may in fact cause a noticeable increase in children's' thyroid cancer rate.

The population exposed due to the Chernobyl accident therefore appears to be one of the most important group for studying the radiation induced thyroid cancer. Indeed, significant increase of thyroid cancers was observed in Belarusian population, specially among exposed in childhood.



Lecture notes:

The overall lifelong risk for cancer mortality in the Japanese group is calculated to be about 10% per sievert. This does not include the non-lethal cases of cancer. The dose response curve for solid tumours is remarkably linear. For leukaemia, however, the *risk per dose* is higher for high doses than for low doses.

The atomic bomb survivors, whether getting a low or a high dose, were all exposed at a high dose rate. Based on experimental evidence, it is believed that exposure at a low dose rate implies a smaller risk. Exposure to the population after radioactive fallout would typically extend for years. The ICRP has adopted a dose and dose reduction factor of 2 for low doses and low dose rates, thus estimating a total increase in risk for lethal cancer of 5% per Sv. This means that a collective dose of 10000 Sv is estimated to cause 500 extra cancer deaths in the population, regardless of the size of the population. Naturally, the exact number is not known, but the magnitude is probably not much in error. These cases are expected to appear, beginning after a latency time and continuing as long as exposed persons are alive, perhaps for more than 80 years. During the same time period, roughly 20% of the exposed people are expected to die of cancer from other causes. If the population has been exposed to radiation from a fallout, the extra cancer cases caused by radiation will therefore possibly never be recognised as an increase compared to the high background cancer rate. Still, the numerical amount of extra cases may be considerable. Actions to protect the public are aimed to reduce this number, regardless of whether it would ever show up as a recognisable increase against the background.

The ICRP has estimated the risk for genetic disease in the offspring of an exposed population to be 0.2% per man-Sv, all future generations counted together. In a population of working age, excluding children, the calculated risk is 0.1% per man-Sv.

Lecture notes:

It is difficult to estimate risks from radiation, for most of the radiation exposures that humans receive are very close to background levels. In most cases, the effects from radiation are not distinguishable from normal levels of those same effects. With the beginning of radiation use in the early part of the century, the early researchers and users of radiation were not as careful as we are today. The information from medical uses and from the survivors of the atomic bombs in Japan, have given us most of what we know about radiation and its effects on humans. Risk estimates have their limitations:

•The doses from which risk estimates are derived were much higher than the regulated dose levels of today;

•The dose rates were much higher than normally received;

•The actual doses received by the ABS group and some of the medical treatment cases have had to be estimated and are not known precisely;

•Many other factors like ethnic origin, natural levels of cancers, diet, smoking, stress and bias effect the estimates.

Medical Aspects

Accident	Critical organ	Major source of dose
Reactors (power, research, ship)	Whole body (bone marrow) Skin Thyroid	Gamma Beta Radioiodine
Spent reactor fuel storage or reprocessing	Whole body (bone marrow)	Gamma
Industrial and medical gamma sources (sealed)	Whole body (bone marrow) Skin	Gamma Gamma
Industrial and medical gamma sources (damaged, unsealed)	Whole body (bone marrow) Skin	Gamma Beta
Pu - weapons damage or manufacture	Lung	Alpha

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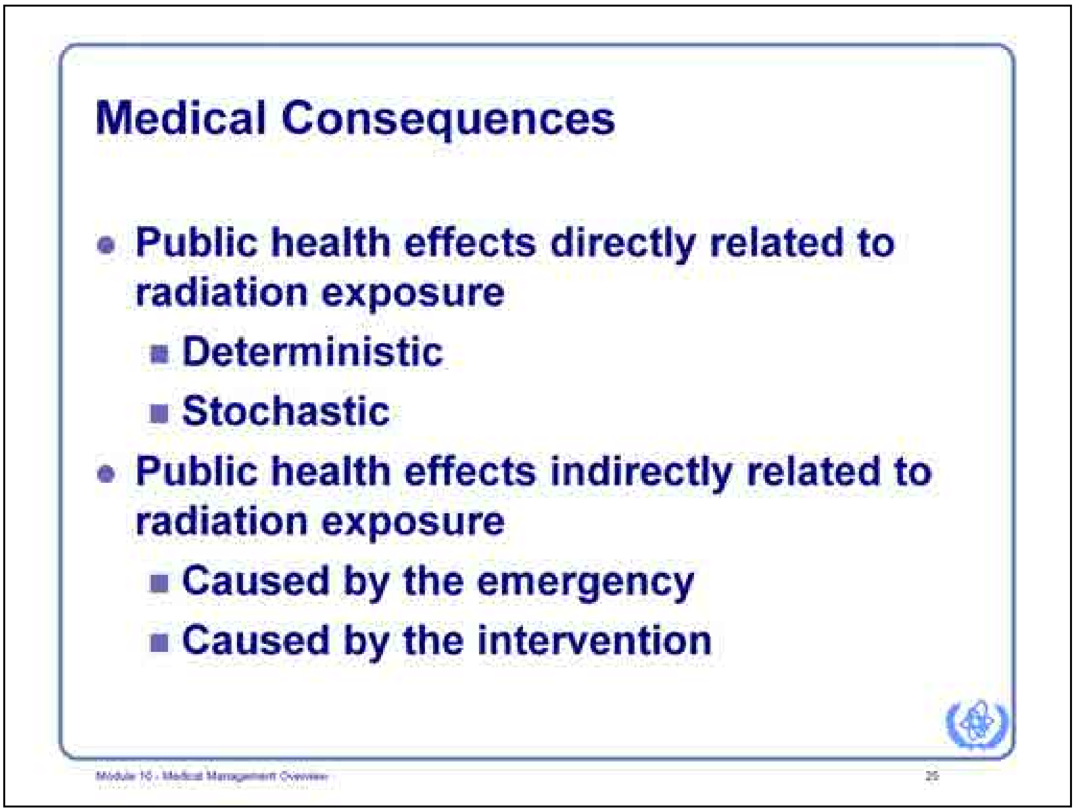
Lecture notes:

Every possible effort should be made to prevent anyone receiving doses above the thresholds for deterministic effects. Critical organs can be identified for many accidents. If the dose is kept below the threshold for deterministic health effects in this critical organ than deterministic health effects will be prevented in all the organs. Studies and experience have shown that the types of emergency that can result in severe deterministic effects (e.g., deaths) are rare. They include individuals unknowingly handing highly radioactive sealed sources, industrial accidents where workers are accidentally exposed and releases from large power reactors or reprocessing facilities.

Medical consequences of the radiation accidents could be seen among the public or/and workers. In general, severe radiation accidents are related to acute overexposure and affect more often professionals than the general public. In most of them only one or very few individuals are involved – those who were using the source for professional reasons. From the other side, more and more accidents are related to lost or stolen industrial radiation sources which are found by the members of the public. Nuclear accidents, the dramatic example of which is Chernobyl accident, may be the cause of general public overexposure while professionals and emergency workers could receive the doses above threshold for deterministic health effects.

In major radiation accidents which happened during the period 1944-2009 in nuclear industry, non-nuclear industry, research medicine there were about 3000 overexposed people and about 130 fatalities. This number includes 28 firemen who got acute radiation sickness due to the Chernobyl accident in 1986.



Lecture notes:

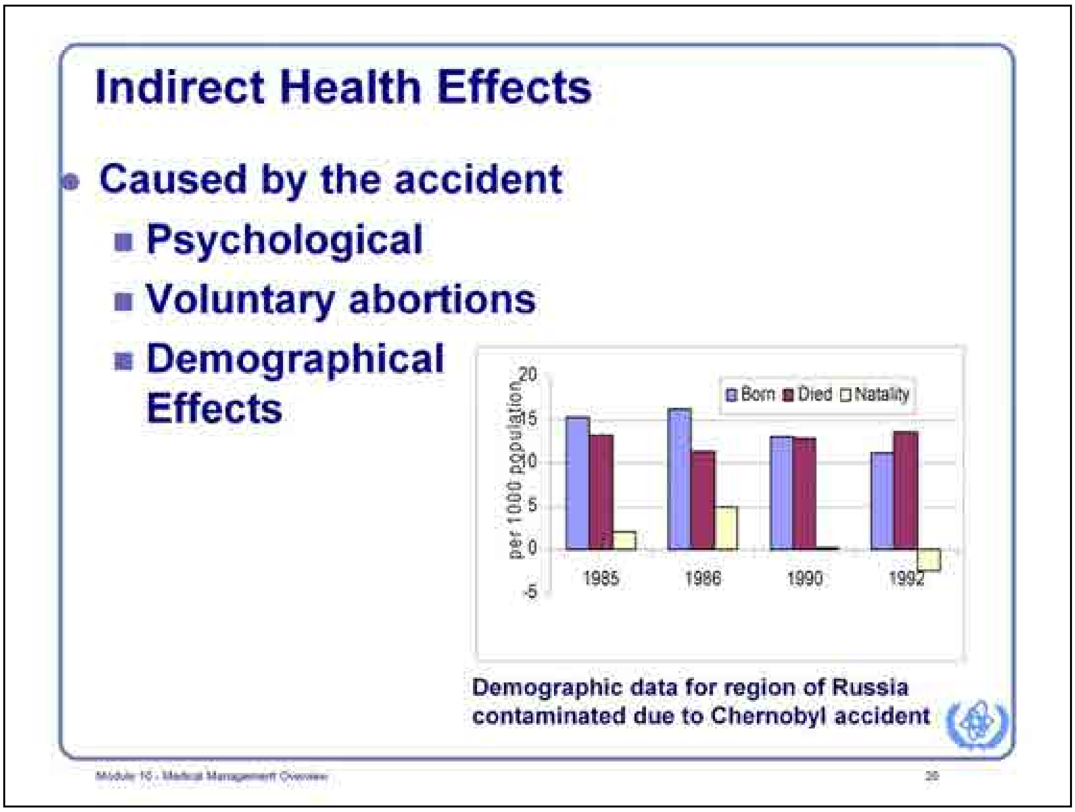
Radiation emergencies may induce health effects in affected population. These are very often due not only to the radiation exposure but also to the societal disruption, economic disorganization and environment impact, which are usually accompanying any radiation accident.

Therefore, medical consequences of the radiation accidents could be classified into two categories: those directly related to the accidental exposure and those, which are indirectly caused by the accident.

Deterministic and stochastic effects fall into the first category. Medical consequences, which could be caused indirectly by exposure, or by the intervention aimed to reduce/minimize exposure fall into the second category.

Direct effects of exposure are not dependent on awareness or subjective perception of risk. They can be prevented or reduced by protective actions only.

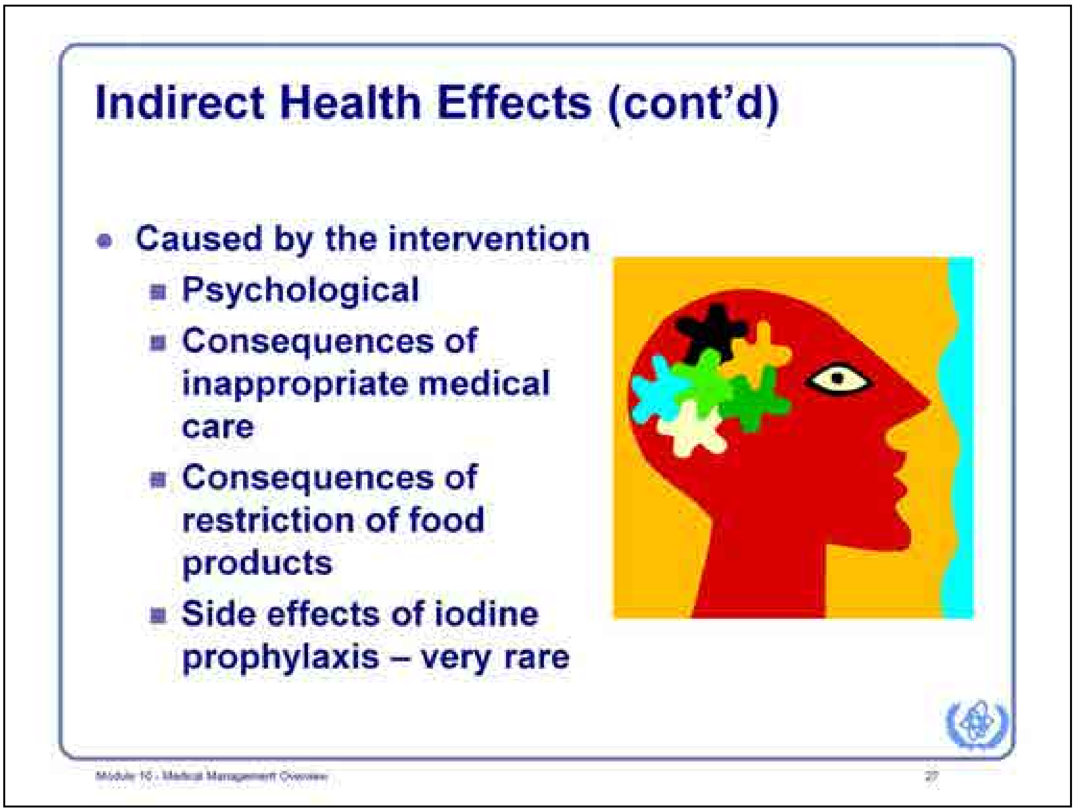
On the contrary, health effects related secondarily to the release may be widespread both geographically and temporally and may affect a very large number of people, thus far outnumbering the direct radiation effects.



Lecture notes:

Psychological effects in affected population are among the most important health consequences indirectly caused by the emergency. Another possible consequence of the emergency is a number of voluntary abortions, which were reported after Chernobyl accident in Switzerland, Northern Italy, Greece and other countries. Choice of voluntary abortions may be considered as a consequence of the stress to pregnant women. They also reflect the inadequacy of the medical profession's knowledge of the risks linked to ionising radiation.

There may be also changes in demographic situation which could be indirectly caused by accidental conditions.



Lecture notes:

Other types of indirect effects are strictly related to intervention. Intervention itself may also cause psychological effects. Protective actions aimed to reduce exposure may even be counterproductive with respect to psychological effects.

In addition to that intervention could indirectly lead to different diseases. It may be possible, for example that urgent protective actions as evacuation or sheltering could prevent performance of normal emergency health care, home care of helpless elderly people and other urgent tasks. These are the issues to be planned in advance. It is also possible to expect side effects from taking stable iodine (among people allergic to iodine). But this effect is observed very rarely.

Another possible consequence may be the influence of the restrictions of food products in affected areas to the human health. Such restriction, specially long-term, could lead to the micronutrient deficiencies or sub-deficiencies.

Lecture notes:

It is now generally agreed that radiation accidents have serious negative consequences to the mental health of affected population. Psychological effects cover psychic suffering, changes in risk perception and modifications in individual and social behaviours. Psychic suffering can be simply the perception that one's psychic welfare has deteriorated, or it also can be more intensive change with medical symptoms and pathological conditions. All these different aspects damage health as defined by WHO: a state of well-being – mental, physical and social.

A psychological impact has many features, generally related to the notion of the stress. Stress corresponds to a permanent situation of biological, psychic and social maladjustment, which requires alertness, tension and energy on the part of the subject. This physiological reaction depends on how the person experiences the situation. If a person's well-being is harmed over a long period, then pathologies, including generalized anxiety, panic attacks and depression may appear.

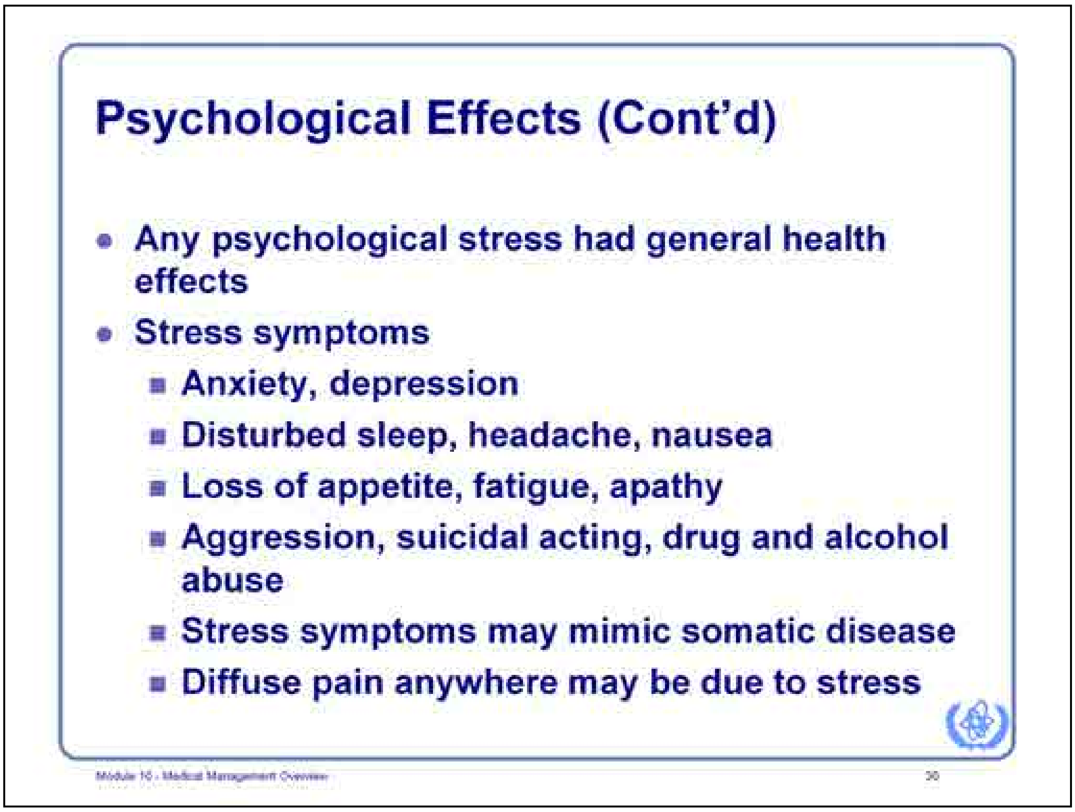
Several factors can modify the seriousness or the nature of the effects. Most of these are demographic (sex, age). Others are perceptual: perception of the emergency, of it's health consequences, of the authorities' competence. Influencing factors may also include beliefs about everyday life and coping abilities. There are also sociological factors like the management of the situation from the side of the person, by the community, affective support from family and relatives, the financial compensation for victims, etc.

Lecture notes:

From the studies performed after three major radiological accidents, i.e. TMI, Goiânia and Chernobyl accident, common reactions and psychological consequences can be summarised as follows:

- individuals relate all their present health problems to radiation, although they either don't know the doses they were exposed or don't believe in the reported doses;
- they live under the threat of possible delayed effects;
- life style has been modified by changes in food consumption, substance abuse, the elimination of some activities and new habits induced;
- somatic complains are reported;
- individual coping mechanism include apathy, avoidance, depression, denial, information seeking, search for the culprit, etc.

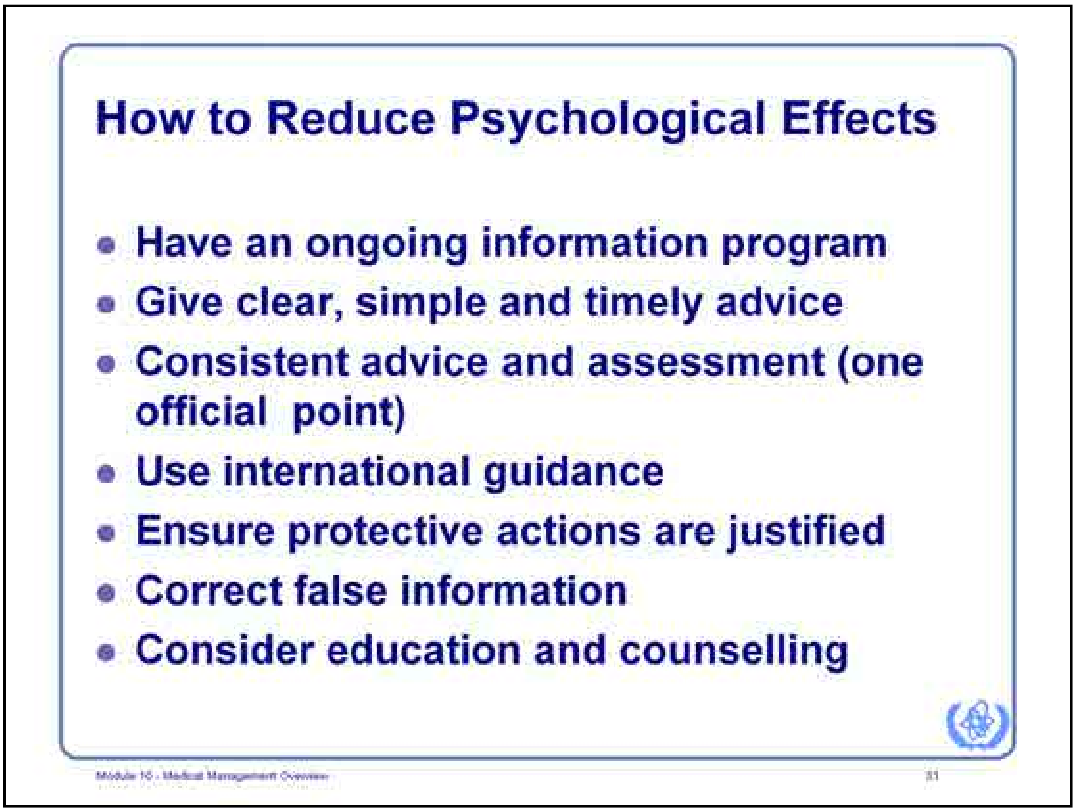
All these individual reactions were gradually pronounced and intense, depending on factors related to the emergency as well as to affected individual.



Lecture notes:

The typical symptoms of stress are anxiety, depression, a disturbed sleep pattern, headache and nausea, loss of appetite, fatigue and apathy, aggression, suicidal acting, drug and alcohol abuse. Symptoms of stress may also mimic somatic disease. Diffuse pain anywhere without any underlying organic disease may be due to stress.

Stress can induce functional gastrointestinal disturbances but also overt organic disease like gastritis and peptic ulcer. Also, stress is believed to be a relevant factor in the aetiology of diseases like ulcerative colitis, hypertonia and ischemic heart disease.



Lecture notes:

It is believed that having clear, simple advice available at the time of an emergency based on internationally endorsed or recommended guidance will do much to maintain confidence in the national authority, and thereby help to alleviate mental distress and anxiety.

The only way to cope with the problem of mistrust is to give rapid, correct and open general information about contamination and exposure. Still, some mistrust probably cannot be avoided. Part of this problem is that the news media have their own interest in propagating exaggerated exposure and risk data. Thus conflicting information and views of risk reach the public, decreasing trust in information given by authorities. The public reacts to dramatic media reporting with increased anxiety, which in turn stimulates further media promotion.

Efforts should be made to provide consistent advice and assessment to the public and media (press), and to correct false information. This is best accomplished by having one source of official information within the country and having co-ordinated protective actions with nearby countries in advance. This should increase the public confidence and compliance with recommended actions. Every effort must be made to maintain public trust.

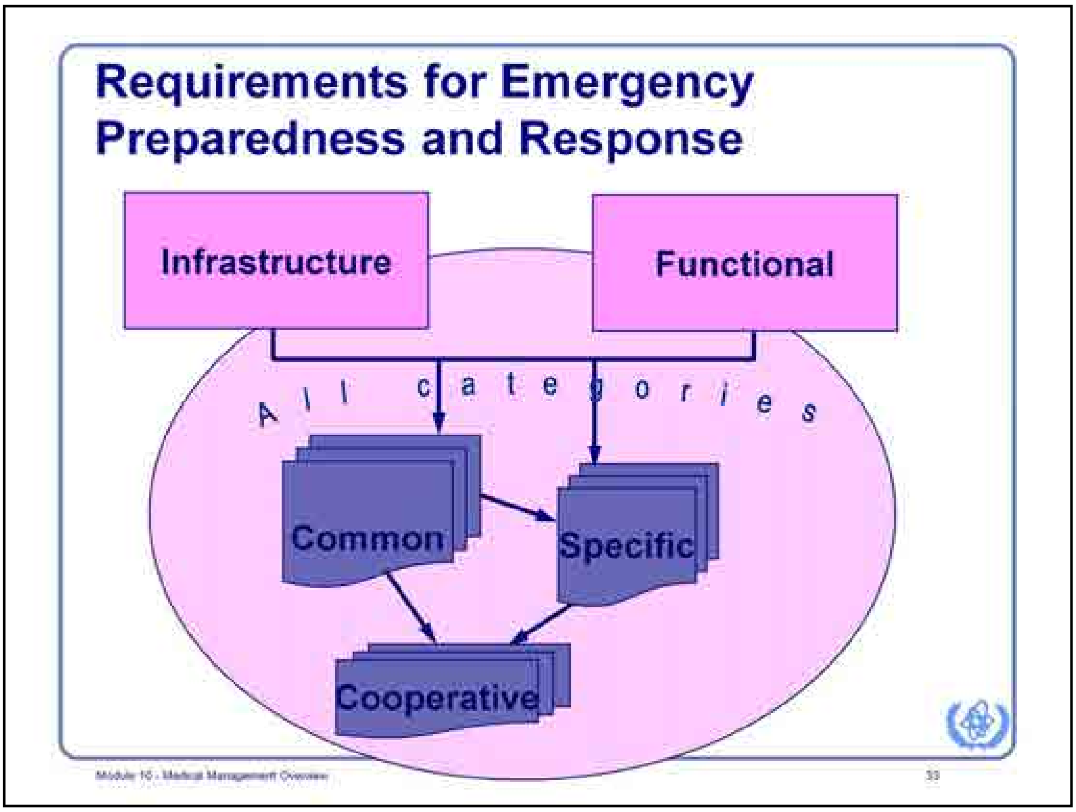
Social support and education, including individual and group counseling, is an important part of coping with the situation. It is necessary and urgent to convince the population in contaminated areas that their symptoms cannot be attributed to radiation but may be due to the psychological consequences of stress. This educational task requires the active involvement of individuals, organisations and authorities who enjoy or can establish credibility. Locally trusted people can include medical personnel, teachers or youth leaders.

Lecture notes:

In order to be effectively implemented, emergency medical response should be planned and organized in accordance with particular infrastructure and functional requirements.

Being the part of overall emergency preparedness and response, medical response should meet the same approach to requirements as it's given in the IAEA EPR-METHOD 2003, *"Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency* for all response organizations.

The infrastructure requirements must be in place to ensure that the functional requirements of a response can be performed when needed. Planning objectives are provided for each infrastructure requirement along with items to be considered when developing the capability to meet these objectives and response objectives are given for each functional requirement along with items to be considered in developing the capability. See IAEA EPR-METHOD 2003 for details.



Lecture notes:

Infrastructure and functional requirements for effective response can be divided into:

- common, applied to all organizations involved in emergency response,
- specific, applied only to medical response, and
- cooperative, applied when joint efforts are needed.

Common requirements should be discussed at the early stages of emergency planning by emergency planners and managers from all involved organizations including medical.

Specific requirements are the responsibility of medical organizations. In development their own specific tasks medical organizations are more independent from others. However, there are no completely independent tasks in the emergency. Therefore medical organizations should check the existence of common interest in implementation of the tasks and inform others about their activities.

Cooperative requirements are related usually to the tasks and responsibilities where joint efforts are necessary at all stages. Cooperative requirements call for maximum joint efforts at all stages of preparedness and response. They should be taken into account by all response organizations.

Common features of all requirements of medical response are as follows. Requirements are:

- connected with the other elements of the overall response organization,
- applicable for all treat categories.

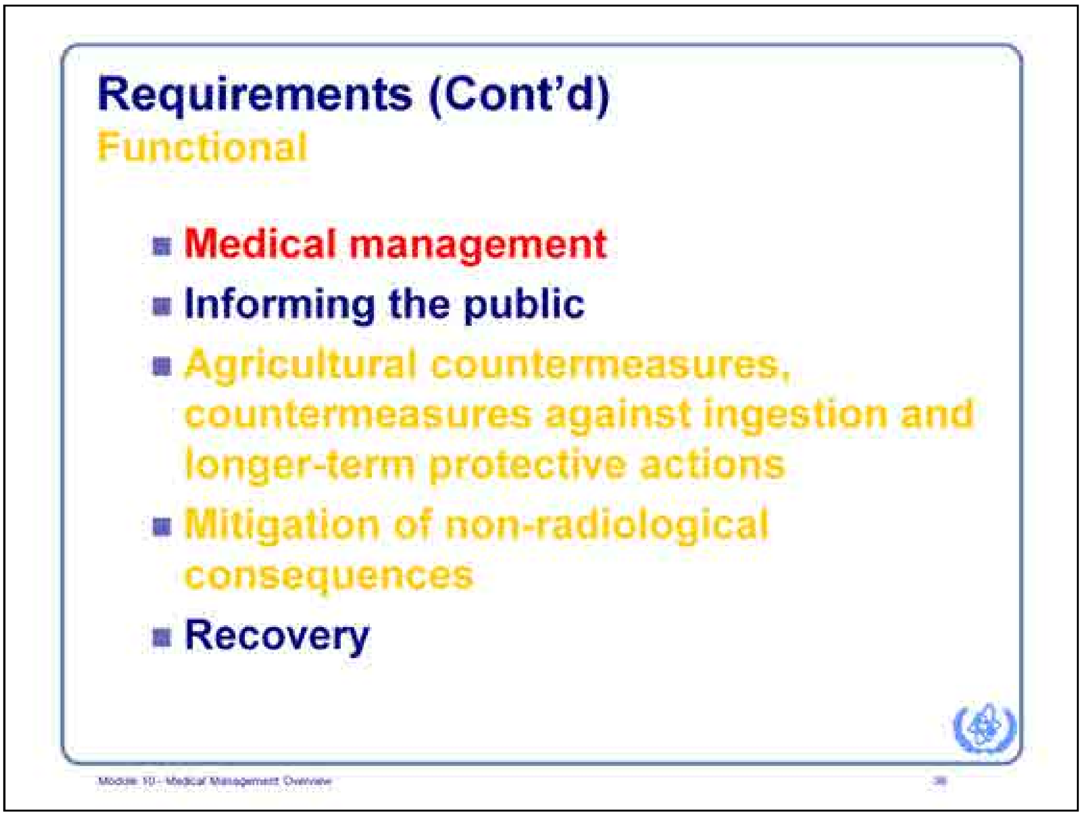
Lecture notes:

The majority of requirements which are considered to be common with other organizations involved in emergency response, are attributed to infrastructure requirements. This is logical consequence of the statement that infrastructure requirements must be in place to ensure that the functional elements of a response can be performed when needed. Therefore, emergency preparedness will start from development of infrastructure requirements. It's necessary to stress that after discussions and agreements between all involved organizations, the same infrastructure requirements have to be developed in medical organizations taking into account their own specific goals and responsibilities. For example, all involved medical organizations will be represented by one medical authority at the national level during the planning process. This authority will be involved in response coordination, writing plans and procedures at the national level. However, one step lower, within medical organizations a response coordination and writing plans and procedures is needed as well. These activities will be secondary or derived from the activity at the national level, and will have more specific features attributable for medical facilities. Another example could be participation in training, drills and exercises. These activities will be organized between all response organizations and within medical community as well.

We can conclude that at the national level all listed infrastructure requirements are common, as they are applied to all organizations involved in emergency response, including medical. Such requirements as "Plans and Procedures", "Logistical support and Facilities" and "Training, Drills and Exercises" have some specific features reflecting the peculiarities of medical response as at the national, as at the local levels. Therefore, these requirements are also specific for medical response to the extend of specificity of medical responsibilities. To the fulfillment of the requirements "Plans and Procedures" and "Training, Drills and Exercises" joint efforts are needed, as it was described in the examples above. Therefore, these requirements should be considered as cooperative.

Lecture notes:

All functional requirements are listed on this and the following slide.



Lecture notes:

Specific requirement for medical response is “medical management”. However, medical organizations have to participate adequately in the implementation of other functional requirements as well. Especially regarding

- Urgent protective actions
- Issuing instructions and warnings to the public
- Agricultural countermeasures, countermeasures against ingestion and longer-term protective actions
- Mitigation of non-radiological consequences.

These four mentioned above requirements are cooperative in the nature of their fulfillment.

Lecture notes:

There are several planning items to be fulfilled by facility, local or national level within medical assistance. These items, applicable for the planning category I facilities (Facilities for which events, including very low probability events, that could give rise to severe deterministic health effects off-site are postulated or have occurred in similar facilities) are listed at the slide.

Immediate on-site first aid requires some planned capabilities, not a substitute for a hospital

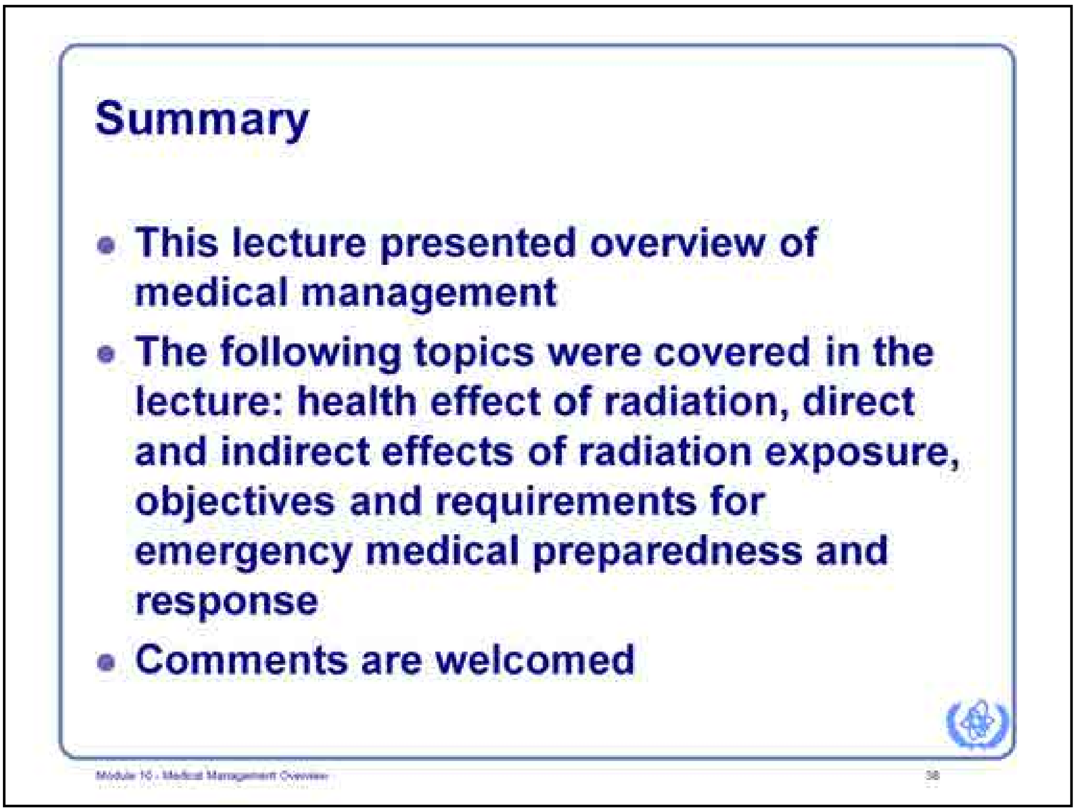
Injured persons may require decontamination, it may be done on-site if minor and the injury does not interfere or require prompt off-site medical attention.

Some injuries may require treatment at an off-site location. Make arrangements for this assuming injuries severe enough to need prompt attention, and the individuals may be highly contaminated. The chosen off-site facility needs to be able to accommodate this situation.

Highly exposed individuals, life threatening exposures, may require specialized treatment. Plan how this will be obtained, especially if the capability is not readily available.

How would the public be treated, or even only registered for follow-up so occurrence of medical problems could be treated or recognized at a later date.

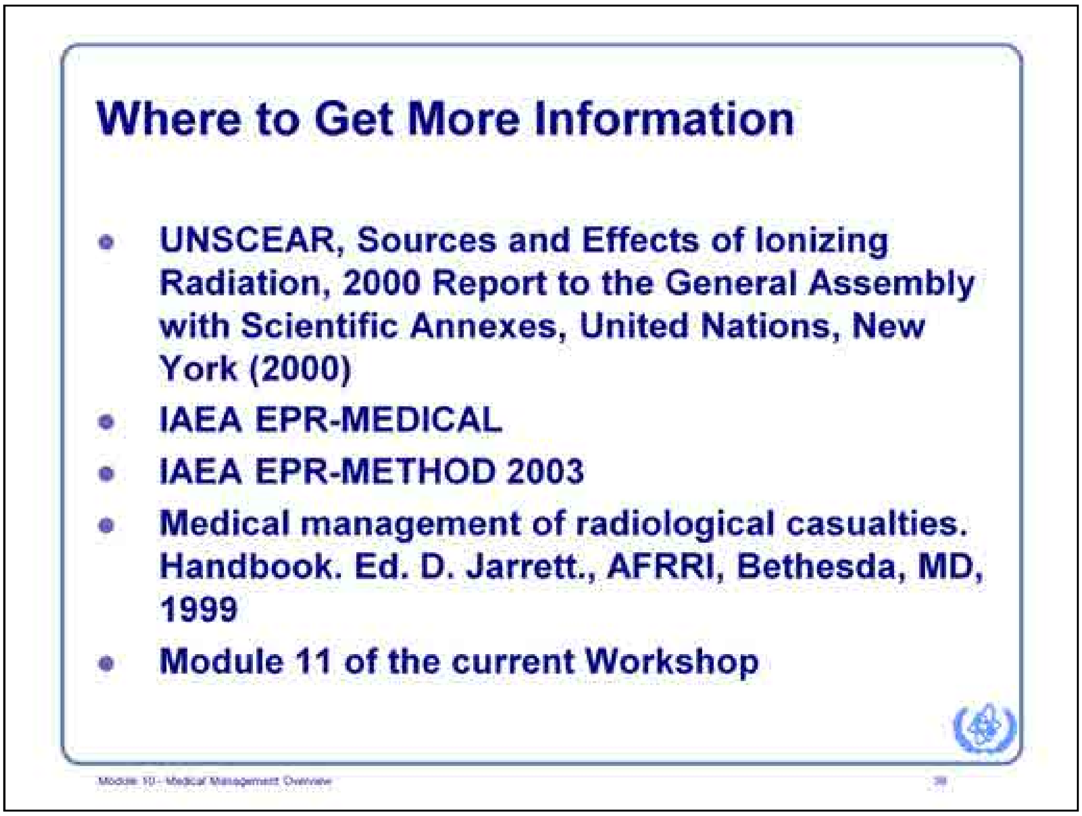
Number of items to be planned depends on planning category. Detailed description and explanation is given in IAEA- EPR-METHOD 2003.



Lecture notes:

Let's summarize the main subjects we did cover in this session. This lecture presented overview of medical management.

We did cover the topics describing health effect of radiation, direct and indirect effects of radiation exposure, objectives and requirements for emergency medical preparedness and response.



Questions

1. What is the cause for all health effects of ionising radiation?

2. List the main health effects of ionizing radiation!

3. Give the examples of deterministic effects!

4. What are the main differences between stochastic and deterministic effects?

5. What are the examples of health effects directly and indirectly caused by ionizing radiation?

6. How can we manage the psychological consequences of radiation?

7. Where is the place of emergency medical response in the generic response organization?

8. What are the requirements for emergency medical preparedness and how are they connected with the requirements for other organizations?

Block 3: Emergency preparedness and response overview

Module 11: On-scene emergency medical response (reviewed and improved by TT)

Learning objectives: Following this module the participants will

- understand the role and tasks of Emergency Medical Responders
- know the basic steps in contaminated casualty handling
- know the interactions between different response groups on-scene
- be acquainted with basic decontamination procedure

Activity: Seminar, questions and discussion

Duration: 1 hr

Materials and equipment needed: none

References:

1. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for assessing and response during a radiological emergency. IAEA-TECDOC-1162, IAEA, Vienna (2000)
2. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Monitoring in a Nuclear or Radiological Emergency, IAEA-TECDOC-1092, IAEA, Vienna (1999)
3. RICKS, R.C., Prehospital Management of Radiation Accidents, ORAU 223, Oak Ridge Associated Universities, Oak Ridge, TN (1984.)
4. Medical management of radiological casualties. Handbook. Ed. D. Jarrett., AFRRI, Bethesda, MD (1999)
5. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic procedures for medical response during a nuclear or radiological emergency, EPR-MEDICAL, IAEA, Vienna (2005)

6. INTERNATIONAL ATOMIC ENERGY AGENCY, Manual for First Responders to a Radiological Emergency, EPR-FIRST RESPONDERS 2006, IAEA, Vienna (2006)

Lecture notes:

The basic principles of the medical handling of exposed persons are based, to a large degree, on the methods used for handling of other types of accidents, taking into account the specificity of the possible health effects of radiation and problems with contamination.

Exposed persons with high levels of external dose will be rare and usually among employees or other emergency workers. Such situation requires special medical care and supportive treatment for the early effects of acute exposure.

Medical handling in an emergency situation is normally divided into medical care on-site (more often for workers) and medical care off-site (for workers and for affected population).

In general, there are three levels of response, according to the degree of complexity, with respect to the necessary resources for assistance and the severity of consequences:

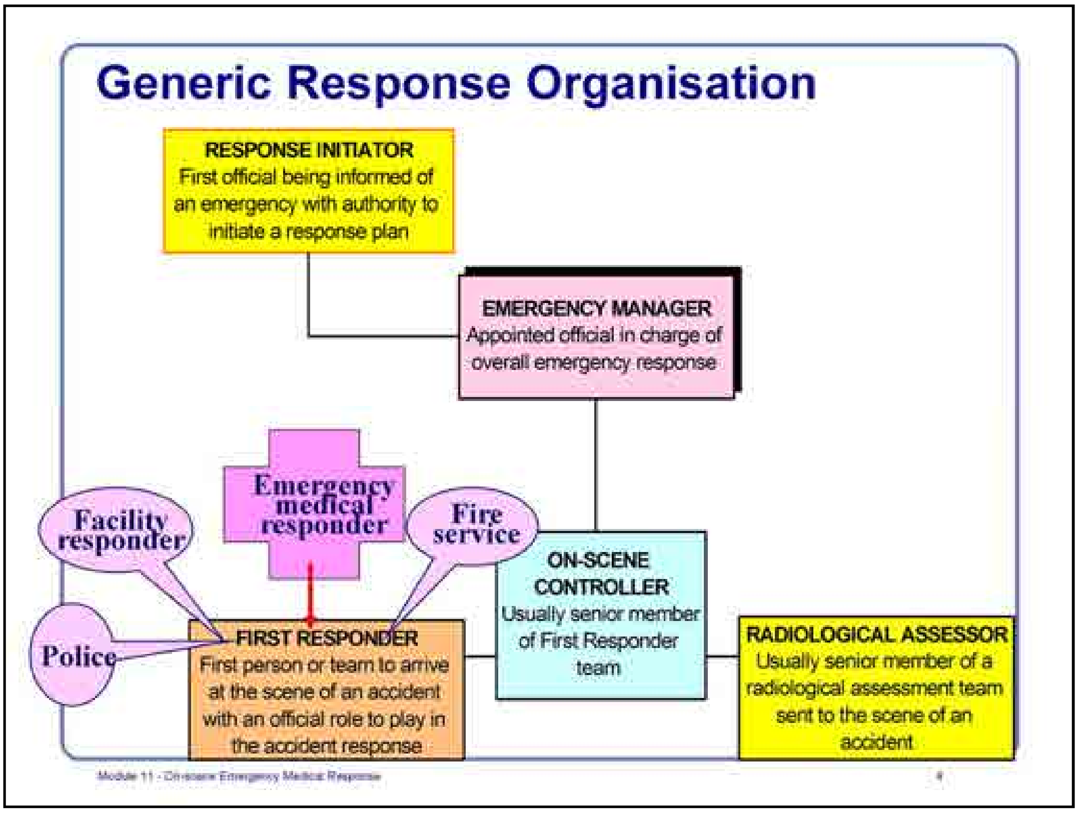
1. first aid provided at the scene of the emergency;
2. initial medical examination, detailed investigation and medical treatment in a general hospital; and
3. complete examination and treatment in a specialised medical centre for treatment of radiation injuries.

In other words, emergency response on-site is called a prehospital response, response off-site – as hospital response. Hospital response or health care in the hospital may include initial medical examination, general medical treatment or special medical treatment depending on patient's condition. Complete radiological monitoring, decontamination and/or decorporation are also done at the hospital level.

Lecture notes:

In this lecture some specific questions regarding emergency medical response will be considered. Role and tasks of Emergency Response teams will be presented in details in accordance with the step-by-step Procedures from *IAEA-TECDOC-1162 "Generic Procedures for assessing and response during a radiological emergency"*. As life saving actions are one of the most important at the early stage of the emergency, therefore the activities performed by other response groups will be also discussed.

In radiation emergency radioactive contamination very often follows the injury of people in an emergency. Therefore, basic steps for contaminated casualty handling is explained here.



Lecture notes:

This chart gives an overview of the generic response organization needed in a non-reactor radiological emergency. Module 9 discussed the organization for reactor emergencies. Medical response is usually no different for the two types of emergencies.

Emergency medical response team will be acting as a First Responder if arriving first at the scene. Actions of Emergency Medical Responders should be coordinated with the joint response efforts. Therefore, not only medical responders have to know and implement the tasks of other responders, but also other first responders should be aware of the basic emergency medical tasks and how to carry them until arrival of emergency medical team.

Local training of potential First Responders with the IAEA material for those organizations can help a great deal. Familiarity of the reactor site should also be a part of such training.

Lecture notes:

Unfortunately there may be accidents where people are exposed to significant doses of radiation.

In any case, one of the primary practical goals of emergency response will be to treat injuries. Some of these injuries may be non-radiological, e.g. thermal burns or injuries associated with the conventional aspects of an emergency. Conventional first aid to save life, reduce pain and aid recovery will be needed and must take priority over treatment for radiological effects. Medical triage groups are:

1 The injured who can be helped by *immediate* transportation

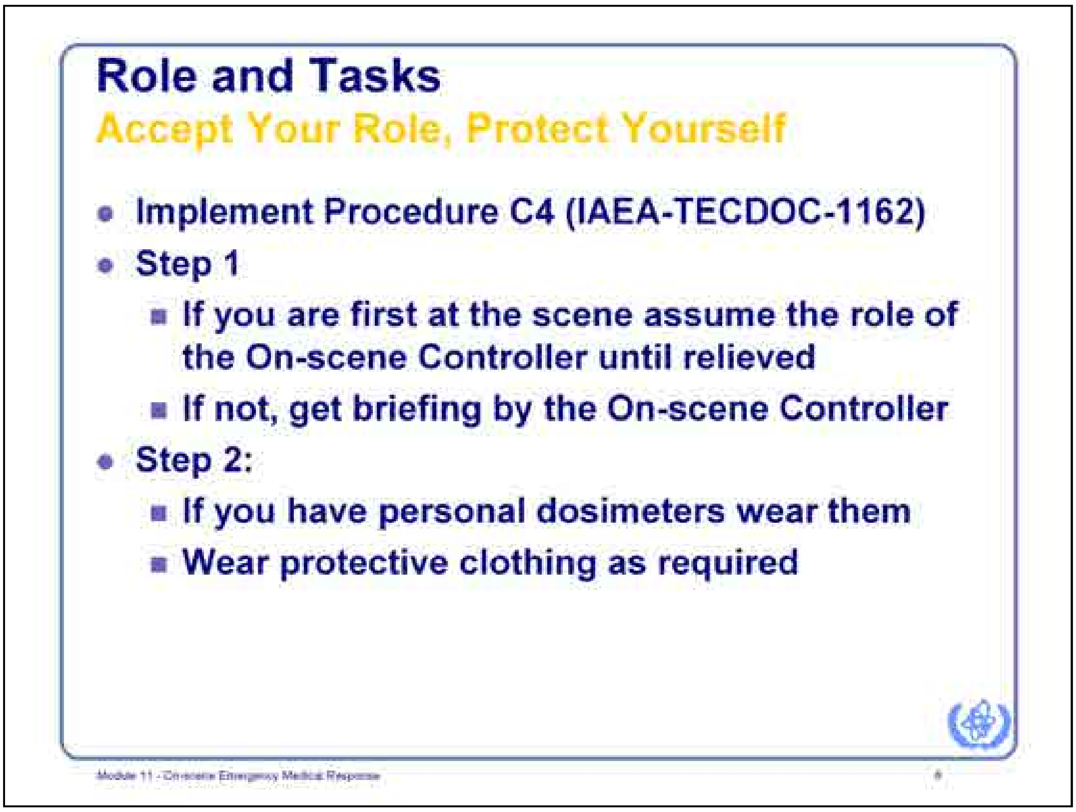
2 The injured whose transport can be *delayed*

3 Those with *minor* injuries, who need help less urgently

However, because of the special nature of radiation accidents, there may be a need to handle contaminated patients. Because patients may not express symptoms of radiation exposure early on, there will be a need to sort and follow up potentially exposed individuals according to their assessed doses. Radiological triage groups are:

1. Contaminated and exposed
2. only contaminated
3. only exposed
4. neither

After the very initial emergency phase, the radiation injuries themselves if they become manifest (usually within days or weeks, but sometimes hours) will need medical treatment and often specialized medical care.



Lecture notes:

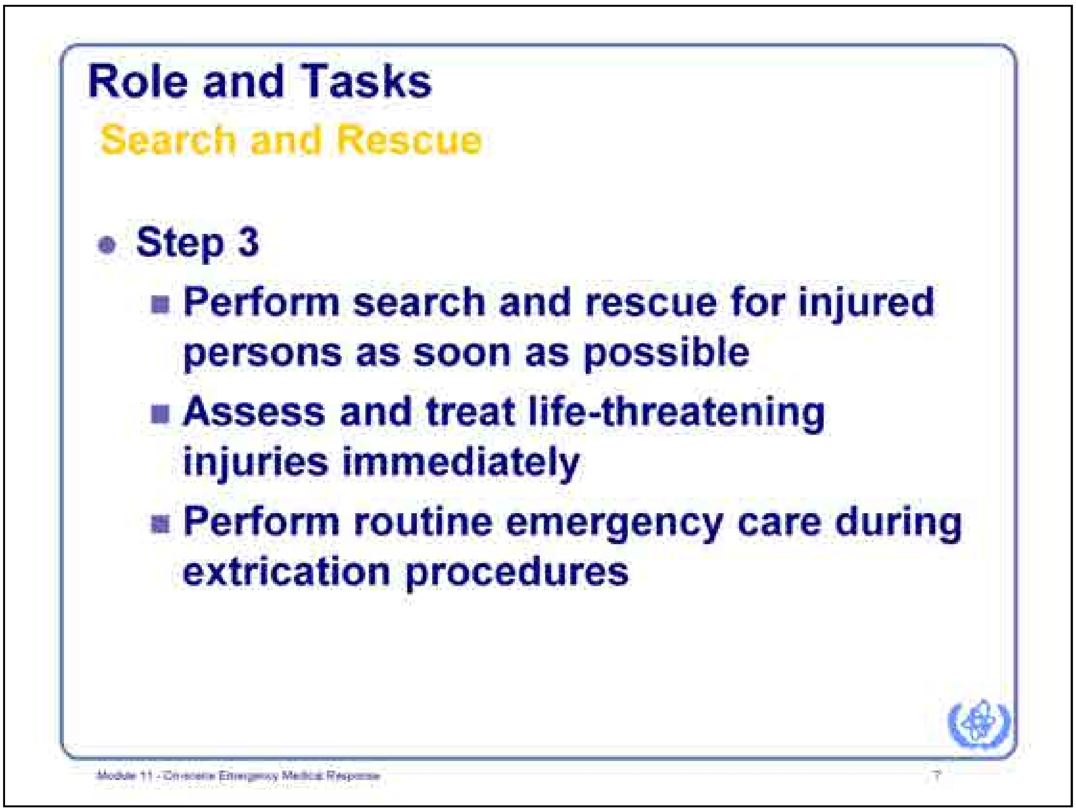
Emergency Medical Responders will most likely arrive on the emergency scene in a short time after the emergency. Until then, police, fire service, or other personnel who have been adequately trained in techniques of basic first aid can provide emergency first aid for injured person(s).

The steps here are recommended for non-reactor radiological emergencies. However, the medical response for reactor emergencies will not differ greatly even though the organization may be different.

If emergency medical team will arrive first on the scene of an emergency, the senior person at the scene normally assumes the role of the On-Scene Controller until relieved by appropriate authorities. In the case of being first on the scene the following actions should be done:

- Approach site with caution – look for evidence of hazardous materials;
- If radiation hazard is suspected, position personnel, vehicles, and command post at a safe distance upwind of the site;
- Notify proper authorities and hospital.

Detailed step-by-step procedure for Emergency Medical Responders on-scene is given in the IAEA-TECDOC-1162 “*Generic Procedures for assessment and response during a radiological emergency*” (Procedure C4).



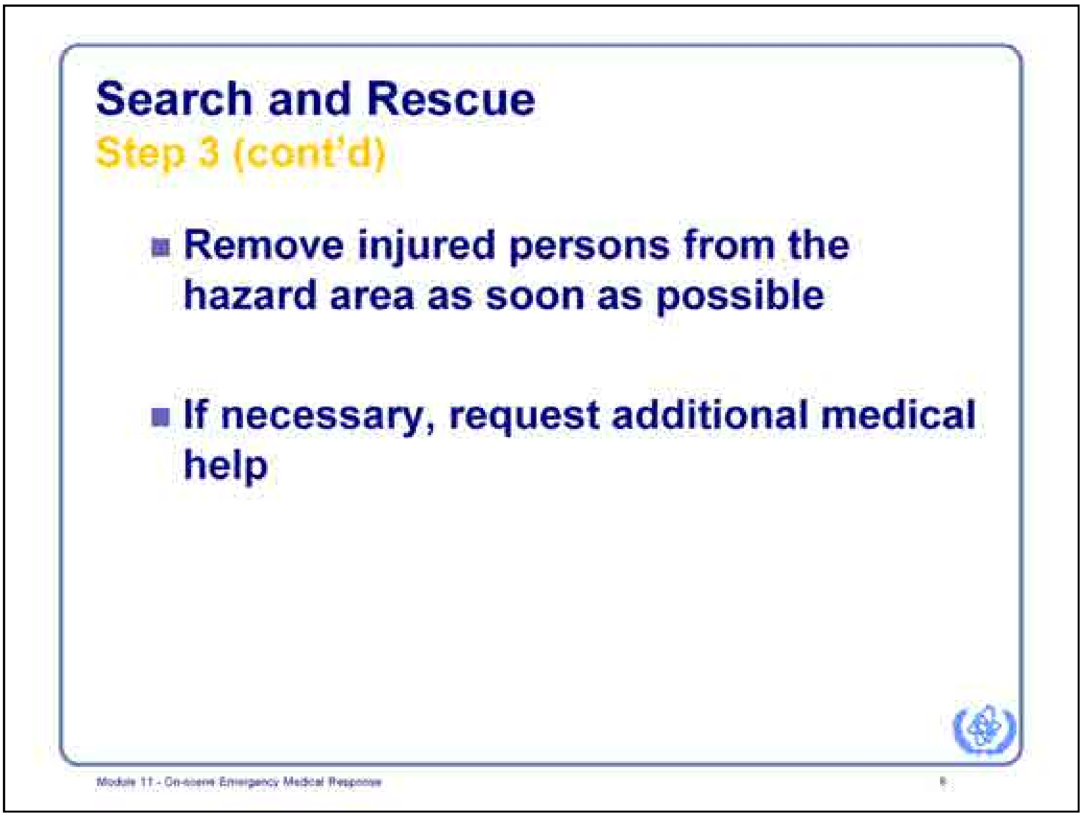
Lecture notes:

At facilities with radioactive sources trained personnel on every shift should normally provide any first aid required. In the case of serious injury medical personnel from suitable off-site medical centres should be available.

The purposes of medical handling on-site are to prevent traumatic injuries from threatening life, as well as possible assessment of contamination and performance of procedures to prevent the spread of contamination. Limited decontamination could be done also.

After searching for injured persons and rescue them it is necessary to assess and treat life-threatening injures immediately. Remember that there should not be any delay in advanced life support if victims cannot be moved or it’s impossible to assess contamination status. After performance of routine emergency care during extrication procedures move victims away from the radiation hazard area, using proper patient transfer techniques to prevent further injury.

Remember also that radiation exposure or contamination do not cause immediate signs or symptoms, therefore if victims are unconscious, disoriented, burned, or otherwise in distress, - look for causes other than radiation.



Lecture notes:

The task of medical staff at the first off-site stage should be to identify the type, origin, severity and urgency of the cases. The basic principle is that treatment of serious or life-threatening injuries must take priority over other actions. A simple classification of the cases may be as follows:

a) Individuals with symptoms and high probability of radiation overexposure and other injuries and/or burns; patients should be transported urgently to a specialised hospital after appropriate medical care.

b) Individuals without signs of radiation exposure but with combined injuries and/or burns; patients should be taken to the specialised hospital where the medical treatment can be adapted to the type of pathology.

c) Individuals with potential radiation symptoms; patients do not require immediate medical treatment but require urgent evaluation of the levels of dose.

d) Uninjured and contaminated or possibly contaminated individuals; these individuals need to be monitored to assess the degree of contamination if any.

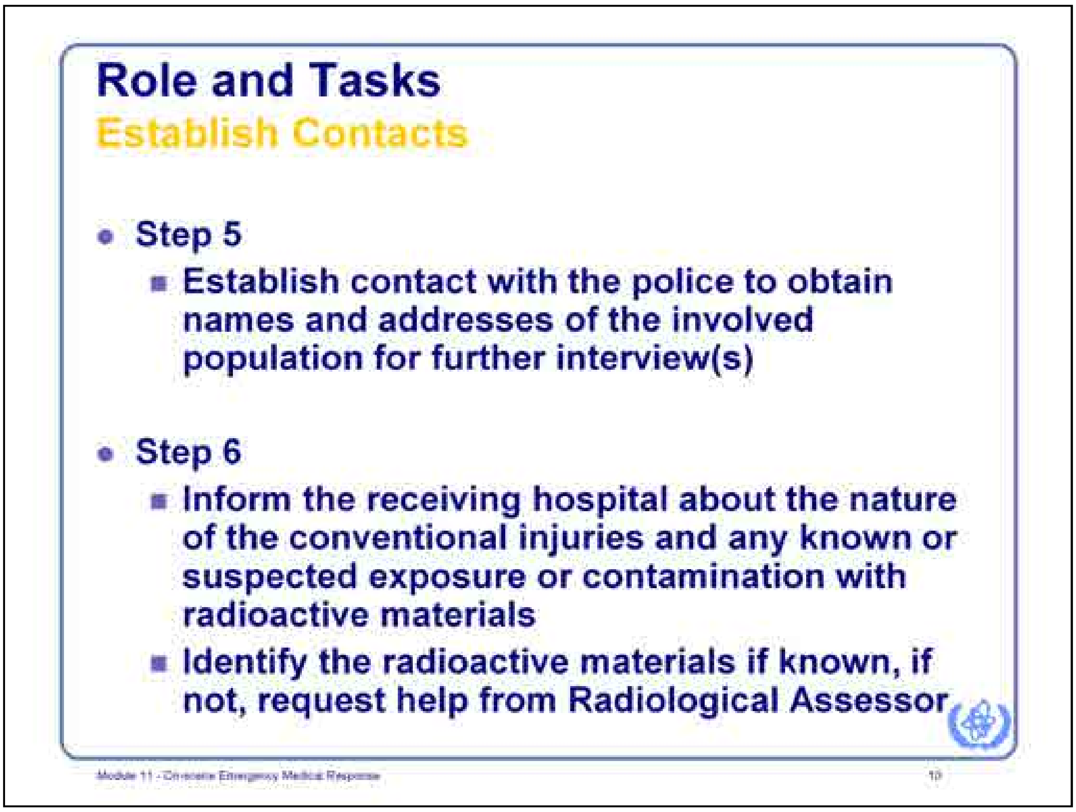
e) Individuals believed to be free of injury and radiation exposure; patients are normally sent home. Sometimes medical follow-up should be provided to ensure that the first assessment was correct and to evaluate the dose more accurately.

Lecture notes:

Victims should be monitored at the control line for possible contamination (at the “dirty” side) only after they are medically stable. Radiation levels above background indicate the presence of contamination.

It is necessary to take all possible efforts to prevent the spread of contamination:

- move the ambulance stretcher to the clean side of the contamination control line and unfold a clean sheet or blanket over the stretcher;
- place the patient on the covered bed and fold the sheet or blanket over the individual to “package“ the patient to aid in contamination control. Do not wrap injured persons in plastic as this may lead to hyperthermia. Do not remove the victim from the backboard if one is used;
- if injured persons are properly wrapped in a sheet or blanket it is not necessary to cover the inside of the ambulance although plastic covering for the floor may be desirable.

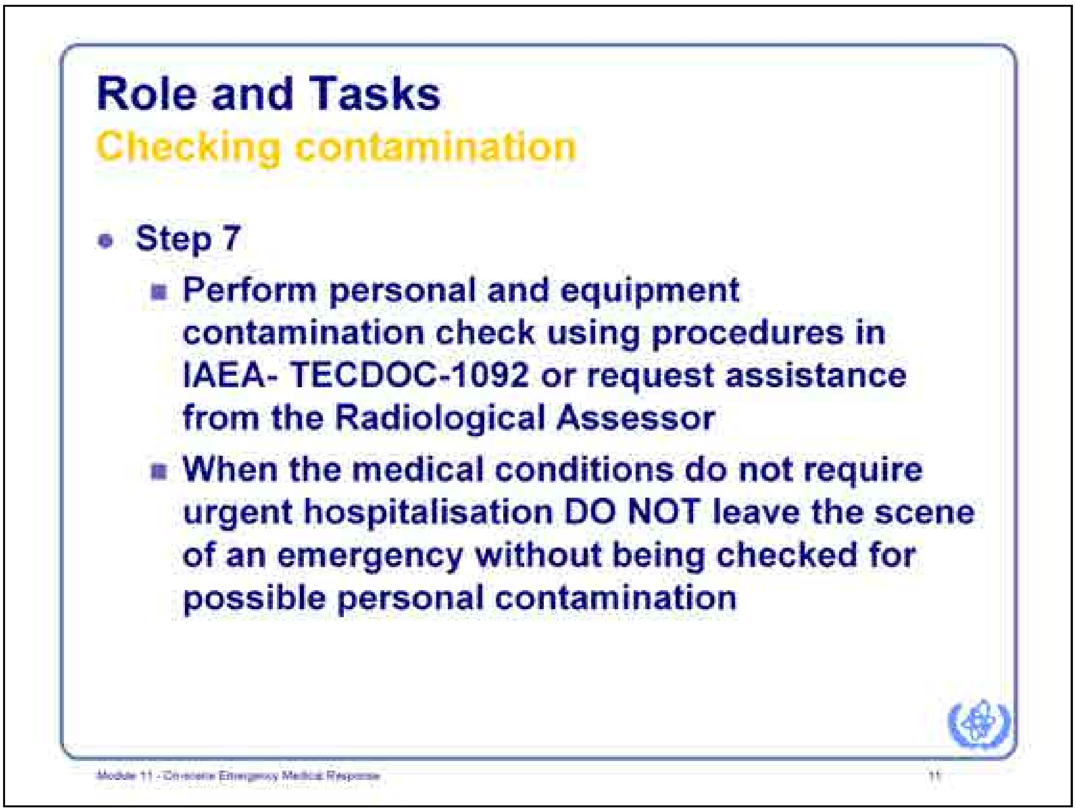


Lecture notes:

All persons involved in a radiological emergency should be carefully interviewed to provide a detailed description of the emergency situation, positions of persons at the scene of an emergency and time spent there. This information will be needed for dose reconstruction.

Registration of those involved in the emergency may be performed by reactor site security officers.

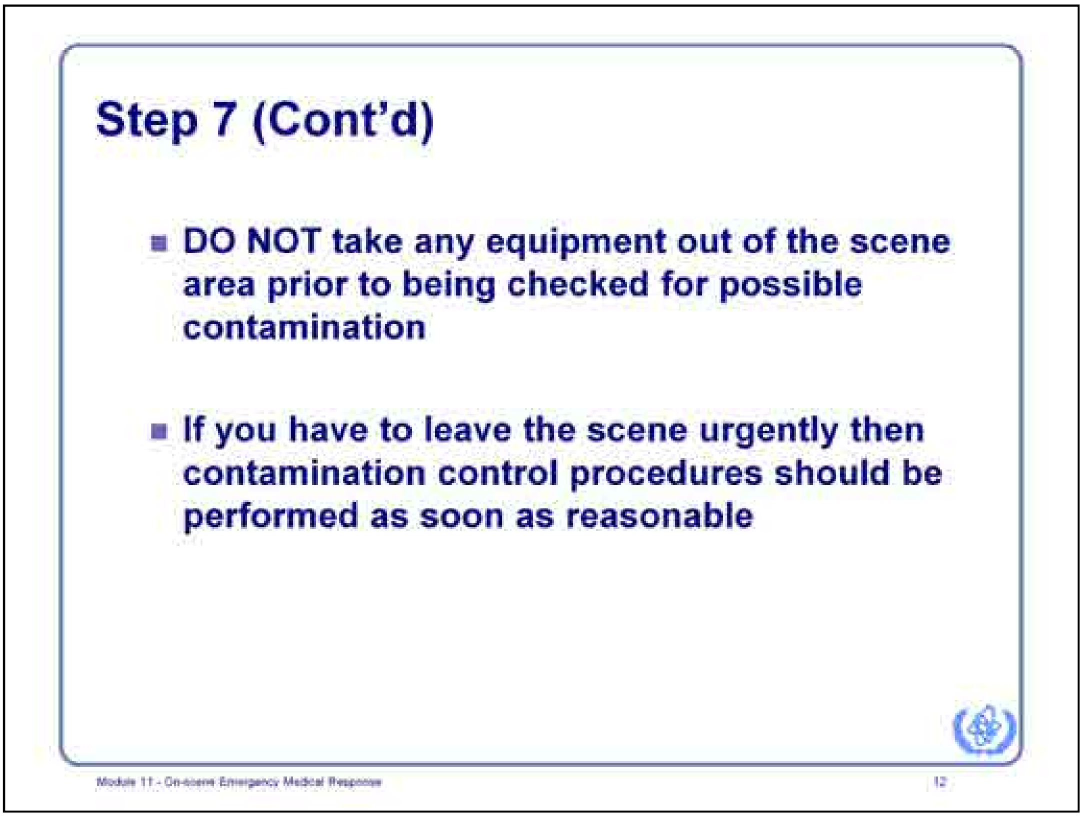
Inform hospital emergency department on the situation and ask for any special instructions the hospital may have. Ensure the hospital is informed if contaminated victims are being sent. Reactor site radiological controls personnel may need to accompany contaminated individuals to the hospital to provide radiological advice or monitoring. Upon arrival to the hospital follow the hospital’s radiological protocol.



Lecture notes:

Before leaving the controlled area, medical responders should remove protective clothing at the control line. If possible, the victim should be transported by personnel who have not entered the controlled area. Ambulance personnel attending victims should wear gloves.

The ambulance and crew should not return to regular service until the crew, vehicle, and equipment have undergone monitoring and decontamination if needed.



Lecture notes:

Emergency medical responders should not eat, drink, smoke, etc. at the emergency site, in the ambulance, or at the hospital until they have been checked and released.

Detailed procedures how to perform personal and equipment contamination check are given in IAEA-TECDOC-1092 (see cover page for reference).

Lecture notes:

If Emergency Medical Responders have not arrived yet and there are injured or affected people on site, other responders on the scene should perform first aid to the victims (if trained).

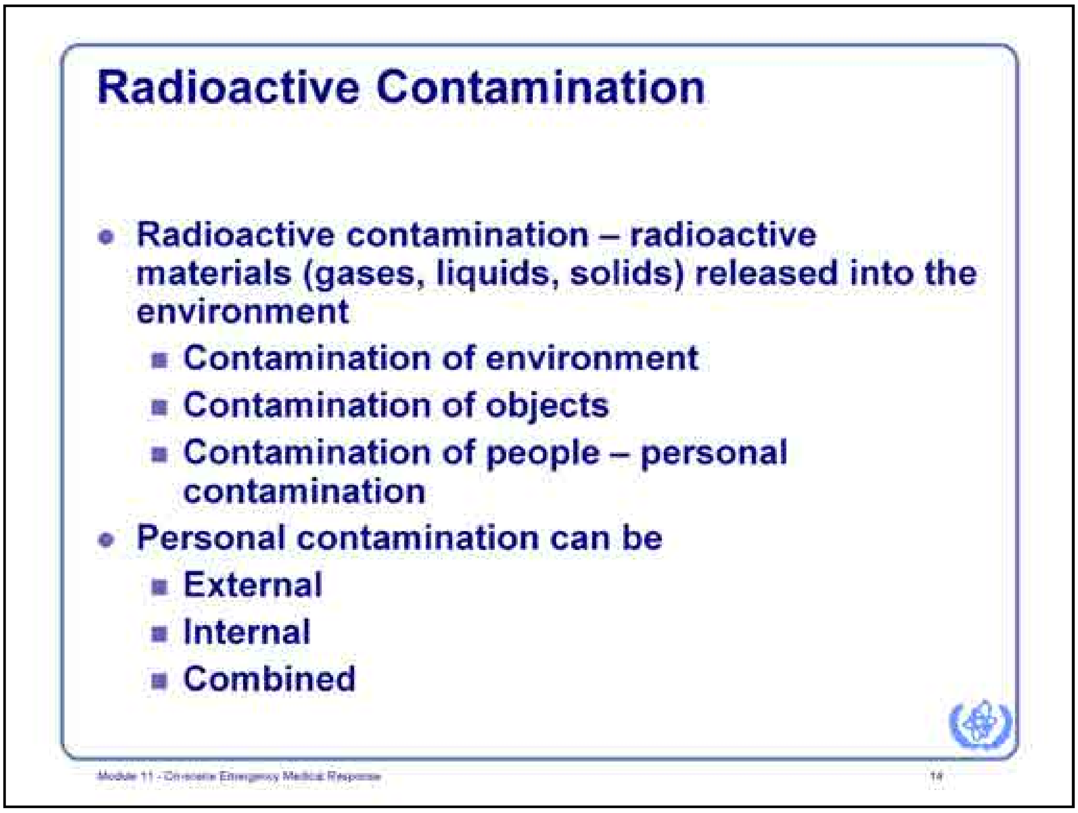
One of the most important rule each responder should know is: "**Do not delay life saving actions due to the presence of radiation**". Be aware that contamination levels almost never pose a serious hazard to responders in time required to perform lifesaving measures and decontamination. Taking care of a contaminated person does not cause significant exposure to the responders. Experience has shown that occupational exposure limits have never been exceeded during such a procedure. It is advisable, however, not to use pregnant women in such tasks.

In IAEA-TECDOC-1162 "*Generic procedures for assessment and response during a radiological emergency*" step-by-step procedures are given for response at the scene. In Section C of that publication steps to be performed by On-Scene Controller, Fire service, Facility Responder and Police in case they will arrive on scene before Emergency Medical Responders are given.

These steps include:

- First aid for injured victims;
- Removal of the victims from the hazard area;
- Notification of Emergency Medical Responders.

There should be continuous coordination between different teams regarding medical aid and decontamination of injured and affected people. For example, Emergency Medical Responders should work together with Radiological Assessor regarding the information about the nature of the emergency and contamination levels (people, equipment). Cooperation with Police is necessary regarding the safety zone and needed information about victims for future follow-up. For details see IAEA-TECDOC-1162.



Lecture notes:

As contamination of a person can cause additional complications for the person itself as well as for others (as a result of spread of contamination), we will go through basic steps of handling contaminated casualty.

First of all, what do we mean by contamination?

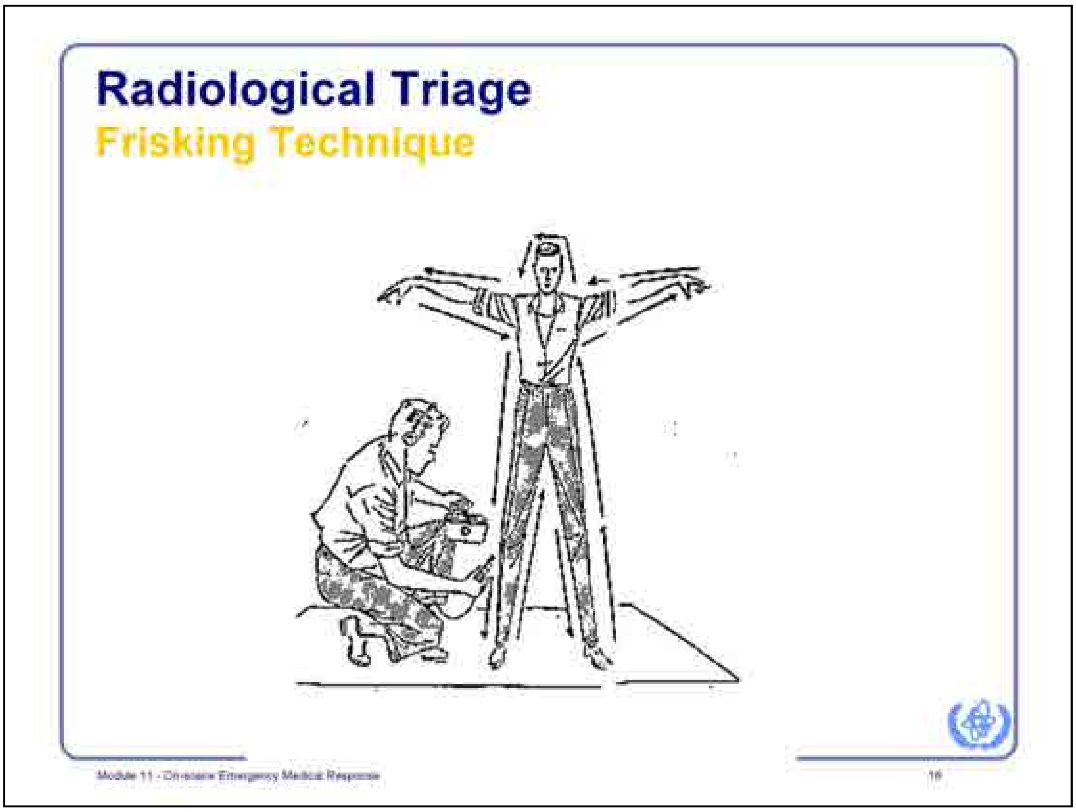
Radioactive contamination may occur when radioactive materials in the form of gases, liquids, or solids (dust) are released into the environment. If that happens, environment, objects and/or people may get contaminated. Persons can be contaminated externally (skin contamination) or internally if radioactive materials get inside the body through the lung, gut or wounds.

To remove or decrease contamination, decontamination methods and techniques have to be used.

Lecture notes:

In case of reactor emergency it’s more likely to expect severe external contamination of employees or professionals, not the public. Nevertheless, the fear of contamination among the general public may be high not only close to but even far from the emergency site.

An effective way to manage this fear is to perform monitoring of the affected individuals and those who believe they are contaminated and then to give clear and fair information about the results of monitoring.



Lecture notes:

For situations involving large number of exposed persons one of the usual screening procedure is perform radiological triage of involved persons – action to identify persons with different contamination levels and kinds of injury. Frisking should pay special attention to the hands and face. Contamination on the face may likely be an indicator of ingestion of radioactive material.

Standard worksheets to record contamination levels may be found in IAEA publications and should be available at the reactor site.

If people are not severe injured and can move and stand – the frisking technique could be used to determine possible external contamination. Procedure is given how in IAEA-TECDOC-1092 .

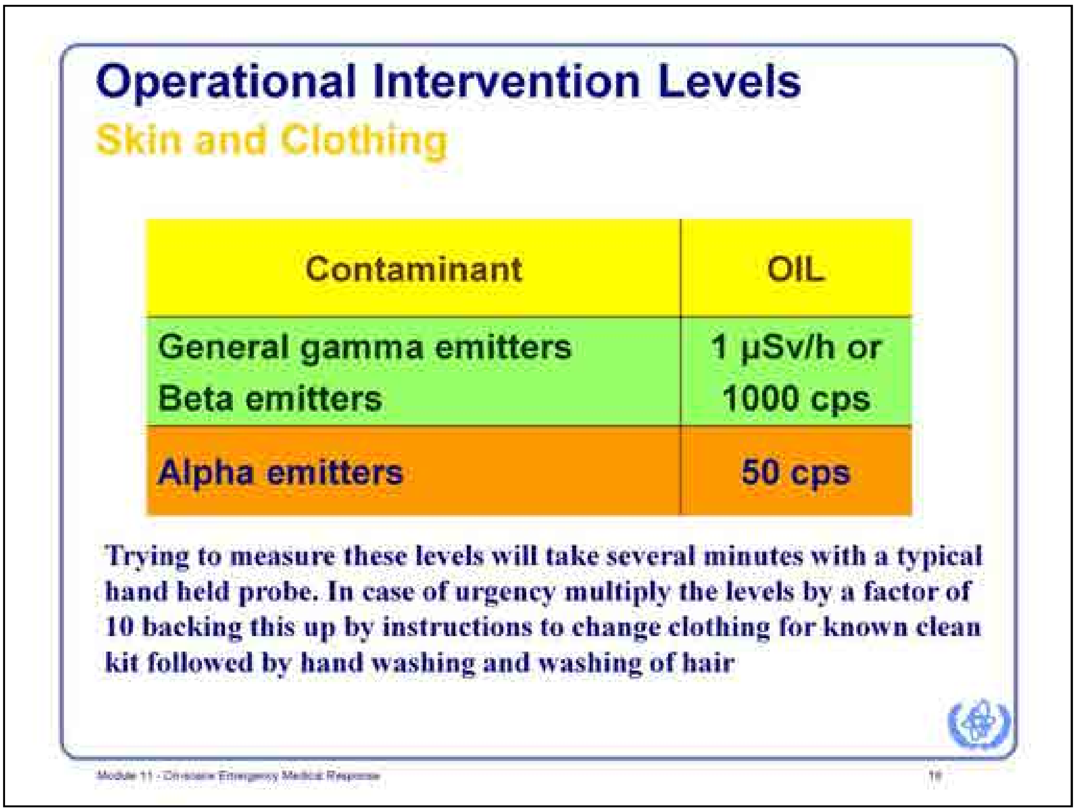
Lecture notes:

If victim is severe injured and laying on the desk or litter – procedure of checking will be more complicated and time consuming. Care should be taken to prevent the spread of contamination and/or contamination of the contamination monitor itself.

Usually seriously injured person will be monitored in the lying position. Surveys of the parts it's possible to access (front parts of the head, hands, legs, and body) should be performed first. Then surveys of the back side of the body should be performed (only if possible by victim's condition). Possibility to survey back side of the body should be used if the victim is turned by medical personnel for the medical purposes.

Checking wound for contamination is even more complicated. However, this should be done as soon as possible, because alpha and beta emitters left in the wound may cause extensive local damage and may be absorbed into the systemic circulation and redistributed as internal contaminants. If possible, the glove-covered probe should be carefully placed into the dried wound, without touching any of the wound surfaces. DO NOT CONTAMINATE THE PROBE with radioactive particles, body fluids, or talcum powder! Tissue fluids or protective gloves may prevent the detection of alpha and weak beta particles. The wound may then be cleaned by gentle scrubbing and irrigation.

If non contaminated open wounds are present, care should be taken that they are not contaminated by the washing procedure.



Lecture notes:

While performing contamination monitoring of the individual, there is a need to have operational levels, which will help in decision-making what to consider as being contaminated. Most commonly available radiation detectors that display cps are adequate for application of these OILs.

Where surface contamination derived limits are not specified by the national competent authority the generic values at this slide are suggested.

If the detector cannot distinguish between alpha and beta, use a piece of paper between the detector and the source. If the reading drops, - alphas can be considered present.

For detail information regarding procedure, refer to IAEA-TECDOC-1092.

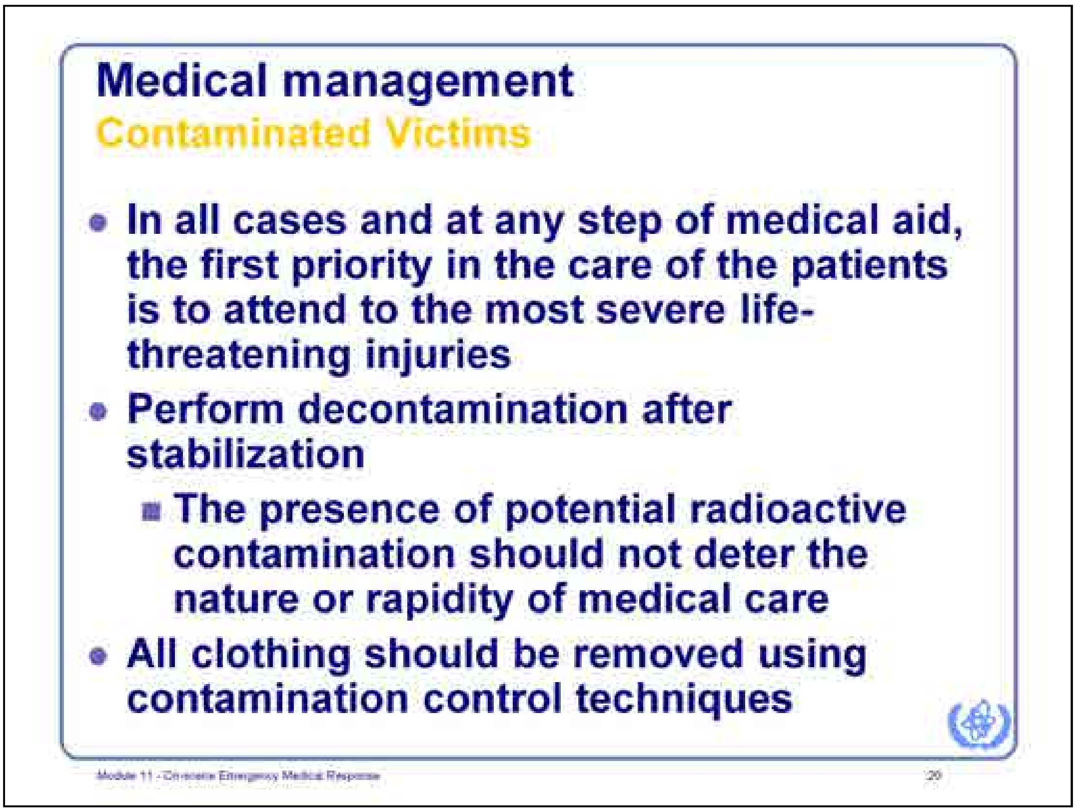
Decontamination Procedures

- Life saving measures first
- Use warm water, soap, or ordinary detergent, soft brush, plastic sheet, tape towel, sheet
- Remove entire clothing and place in plastic bag
- Identify contaminated areas, mark clearly, and cover until decontamination takes place
- Start decontamination from the wound, when present, and move on to the highest contaminated areas

Module 11 - On-scene Emergency Medical Response 19

Lecture notes:

General list of priorities for the decontamination procedure is presented here. This priorities should be followed in all cases of decontamination.

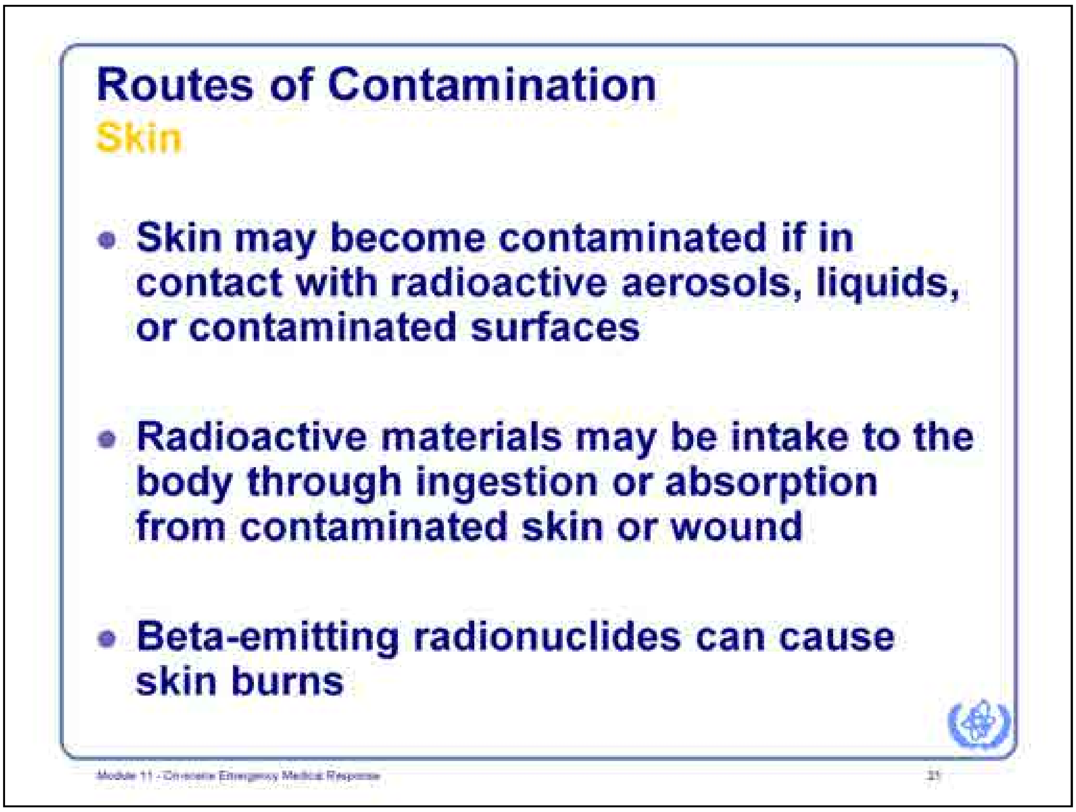


Lecture notes:

In spite this statement was discussed in the previous slides, it should be repeated again and again: handling of injured persons, not counting they are contaminated or not, should be started from first aid. Performing first aid, actions should be started from severe life-threatening injuries.

After that, radiological monitoring of victims and decontamination could be started.

Measures for preventing of the spread of contamination should be performed simultaneously with the above mentioned main actions.

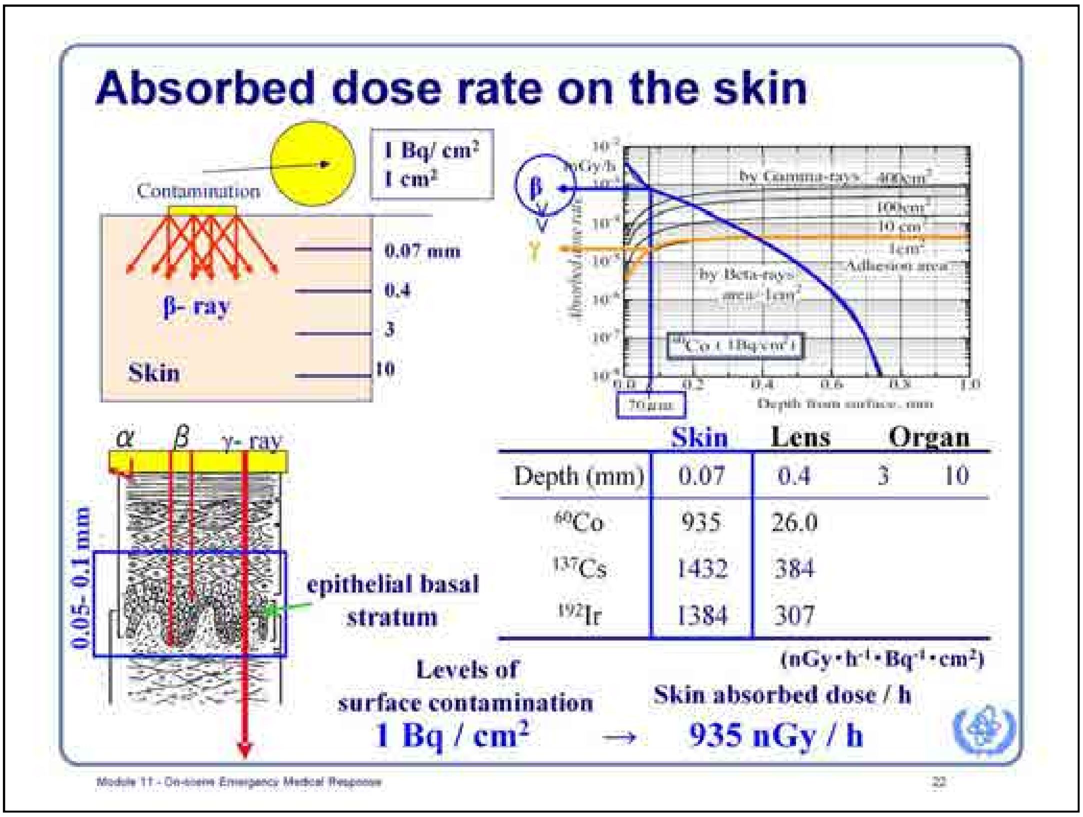


Lecture notes:

Skin, especially skin of the hands, is one of the most frequently contaminated part of the body. Skin may become contaminated if in contact with radioactive aerosols, liquids, or contaminated surface. Skin contamination may occur as a consequence of a radiation emergency (victims) or when responding to the emergency without proper personal protective equipment.

Radioactive materials may be intake to the body (internal contamination) through ingestion or absorption from contaminated skin or wound.

Immediate and effective measure to clean the skin or decrease the level of contamination, is skin decontamination.



The measure of radiation exposure in an organism is the absorbed dose of radiation, which in determined by the quantity of energy absorbed in the unit of the exposed volume. For radiation substances, the absorbed (tissue) dose is the product of multiplying three values: the quantity (concentration) of radionuclide in tissues, the kind and energy of the radiation emitted, and the time of contact of the emitter with the exposed biosubstrate.

Beta rays can only penetrate a few millimeters of tissue. Beta particle ranges are considerably greater than those for alpha particles. Unlike the interaction of alpha particles with matter, the path of beta particles through matter is not in a straight line. While beta particles may only penetrate a short distance into a medium, their mean path length (the average distance that a beta particle would travel in a medium if its path were straightened out) can be quite long.

In addition to a difference in range when compared with alpha radiation, there is also a significant difference in the pattern of energy deposition.

Heavily contaminated with beta emitter cause a beta burn.

Lecture notes:

The aim of skin decontamination is to lower the risk of internal contamination of the victims, to decrease the risk of skin beta burns, and prevent the spread of contamination.

Remember that decontamination should be done by washing with cleaning solutions but not to the extent that the skin is further damaged or abraded.

And remember: only simple decontamination (changing the clothes, overalls and taking shower if possible) may be performed on the scene if necessary.

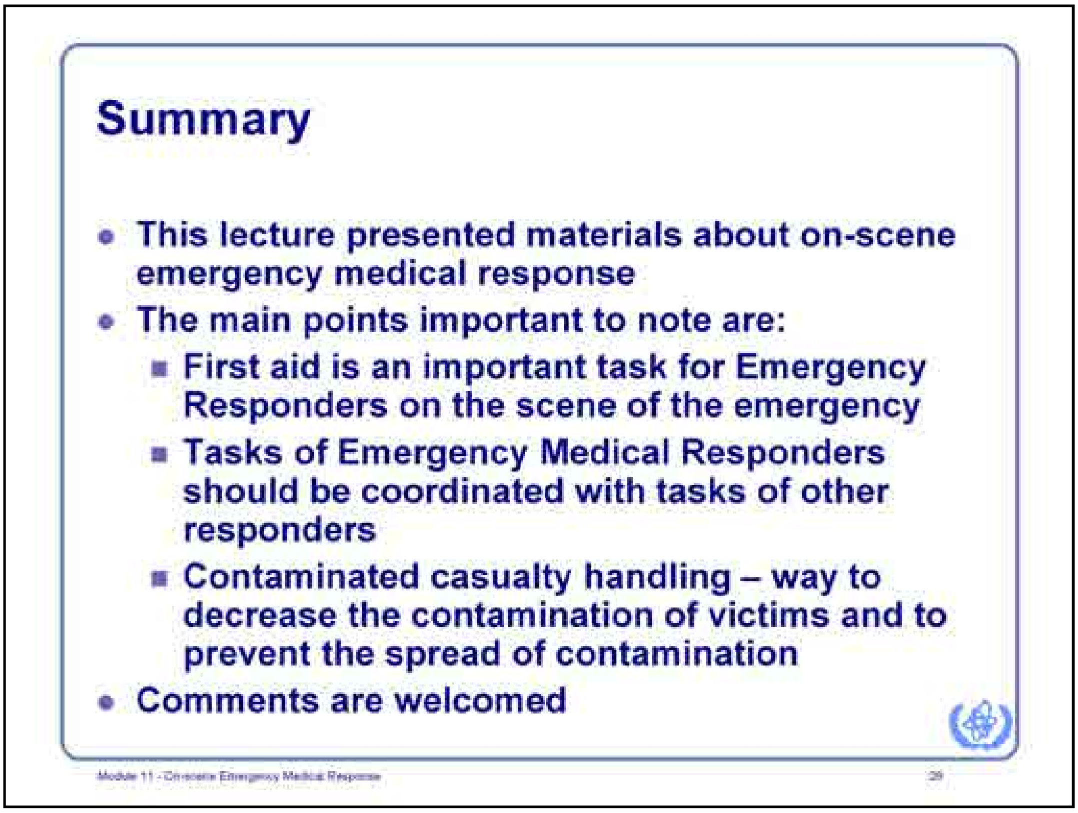
Lecture notes:

After decontamination, apply lanolin or hand cream to prevent chapping. For resistant contamination coat liberally with barrier cream and cover with rubber gloves; radionuclides will move to some extend from the skin into the barrier cream over the next few hours.

Lecture notes:

Special case could be local contamination. In this case take care not to spread contamination while and removing radionulcides from contaminated area.

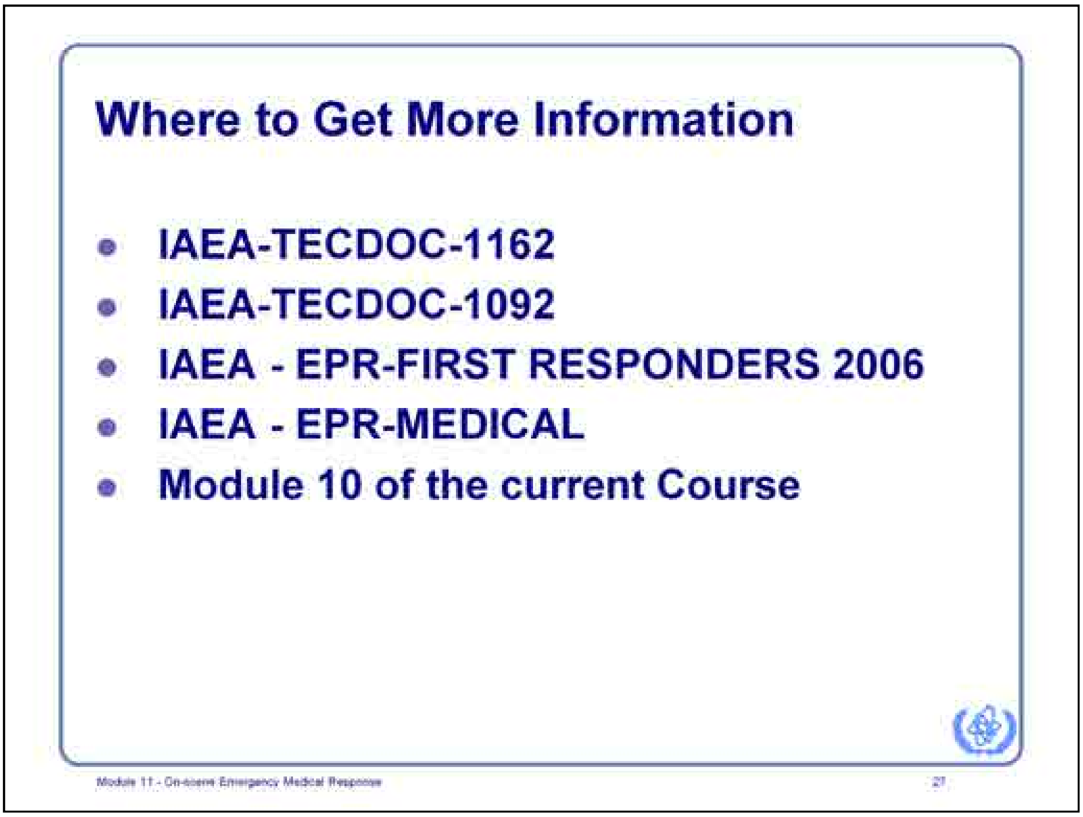
Start from covering uncontaminated area with plastic sheet. Then perform decontamination in accordance with the general rules.



Lecture notes:

Let’s summarize the main subjects we did cover in this session. This lecture presented materials about on-scene emergency medical response.

We did cover the topics describing the role and tasks of Emergency Medical Responders, the basic steps in contaminated casualty handling, the interactions between different response groups on-scene, the basic decontamination procedure.



Questions

1. How the basic principles of the medical handling of exposed people differs from the methods for handling of other types of the emergency?
2. What are the main tasks of Emergency Medical Responders?
3. What is the simple classification of individuals involved in the emergency?
4. What action should be performed first with the injured contaminated person?
5. What are the actions of First Responders regarding life saving before arrival of the Emergency Medical Responders at the scene?
6. What we mean by contamination and decontamination of the individual?
7. What are the priorities in the general decontamination procedure?
8. What are the operational intervention levels for skin?

Block 4: Development of Response Capabilities

Module 12: Infrastructure Elements

Learning objectives: Upon completion of this module, the participants will:

- know and understand what the infrastructure and functional requirements contained in EPR-METHOD 2003 mean in practice in the context of research reactor emergency planning

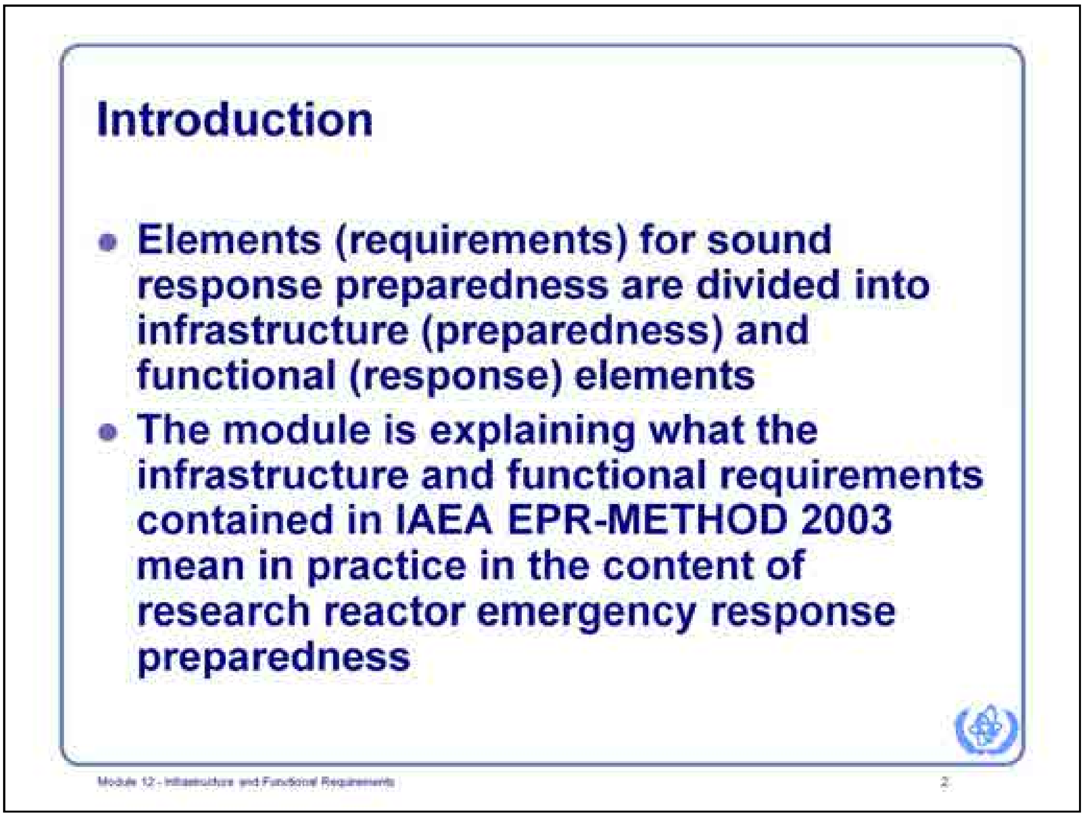
Activity: Seminar, questions and discussion

Duration: 1 hrs

Materials and equipment needed: none

References:

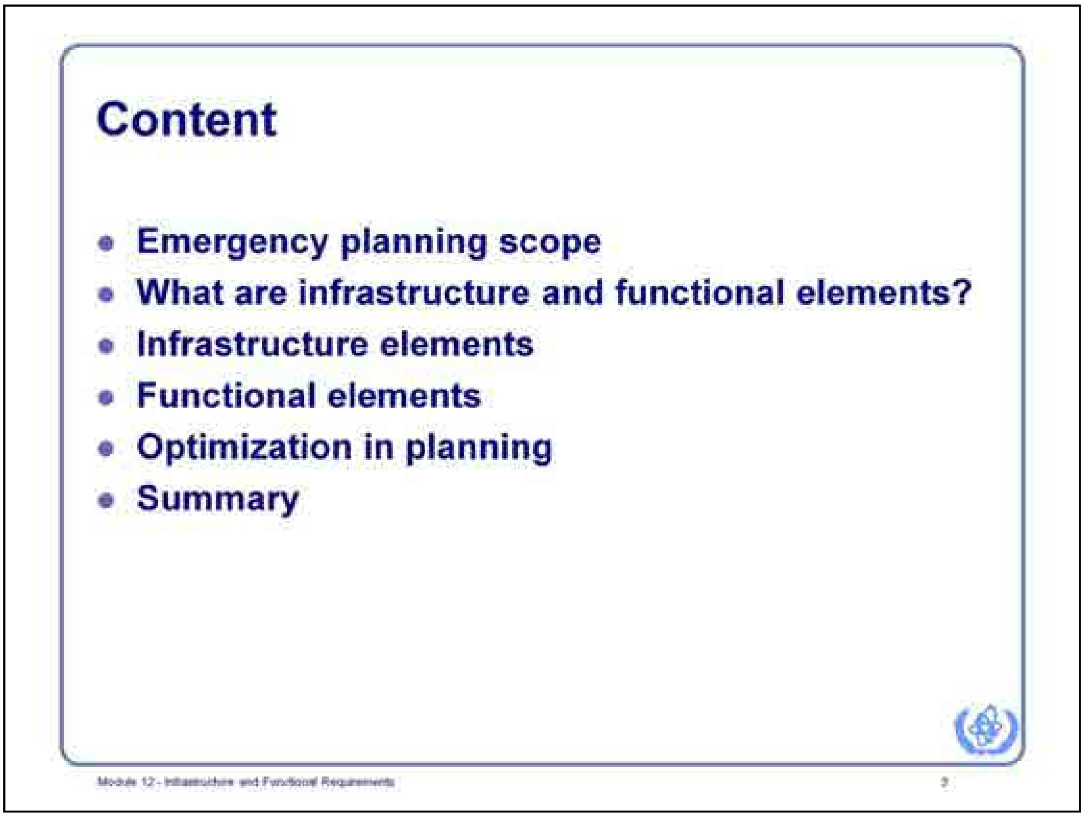
1. INTERNATIONAL ATOMIC ENERGY AGENCY, Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency, EPR-METHOD 2003, IAEA, Vienna (2003)
2. INTERNATIONAL ATOMIC ENERGY AGENCY, Preparedness and Response for a Nuclear or Radiological Emergency, Safety Standards Series No. GS-R-2, IAEA, Vienna (2003)



Lecture notes:

The infrastructure elements must be in place to ensure that the functional elements of a response can be performed when needed.

Response objectives are different from planning objectives in the following way: *preparedness objectives* aim at ensuring that a system, plans, procedures and resources are in place to achieve the *response objectives*. The response objective is what should be accomplished by the response.



Lecture notes:

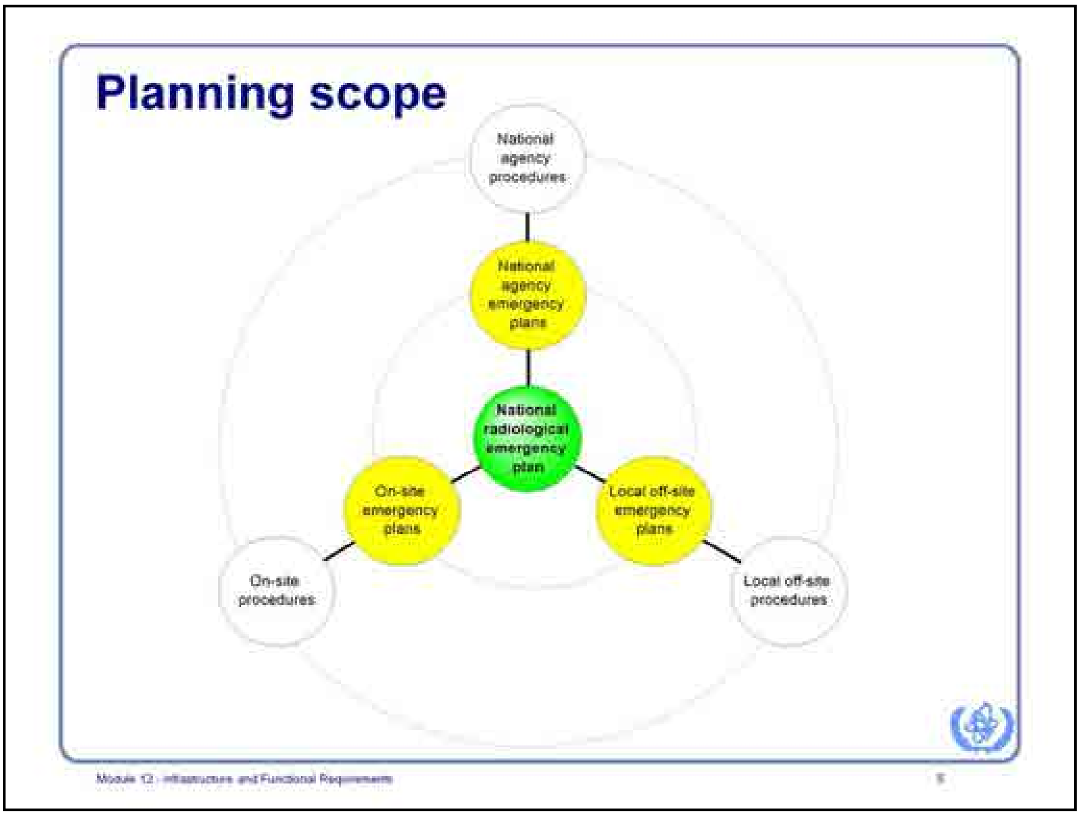
Emergency planning does not simply mean writing a plan. It covers many areas. In this module, we will examine the scope of emergency planning.

We will then looks at the main requirements that need to be addressed in the plans in terms of infrastructure and functional requirements. These are described in the reference, EPR-METHOD 2003.

All these requirements will seem overwhelming and costly to implement. For that reason, we will also discuss how the cost and effort of emergency planning can be optimized.

Lecture notes:

Planning for emergencies involves more than just the plans. It involves the complete spectrum of infrastructure and capabilities necessary to meet the response objectives including: the authorities, the personnel and resources, the plans and procedures, the co-ordination mechanisms, and the training. Planning does not guarantee success of the response, but adequate training, resources and documentation increases the likelihood that the response will be effective.



Lecture notes:

Planning also addresses all organizations, at all levels, which may have a role in the response. Furthermore, the plans and procedures of these intervening organizations must be coordinated with each other.

Next, we will look at the steps suggested to achieve an effective emergency preparedness plan and programme. Note that the process that is proposed in the following slides is not unique, nor is it guaranteed to work. However, it is one that has been tried and has shown to be successful when properly managed.

Lecture notes:

This slide shows some of the greatest challenges you may face in developing national and other emergency response plans.

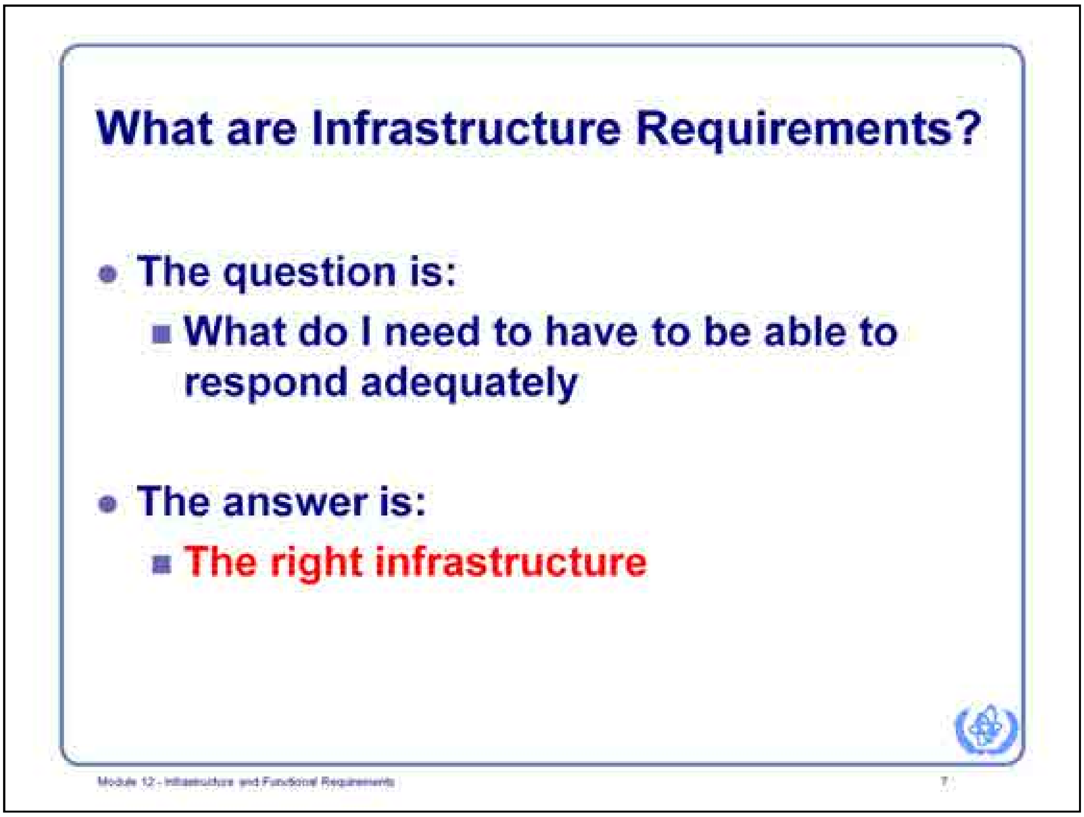
Who is responsible. It is not always clear who in a country is mandated to write and co-ordinate plans. Sometimes, several agencies share the responsibility, which can lead to confusion and disputes in the planning process. Also, what level of government, licensees and agencies are responsible for what part of the planning process is a point that must be sorted out at the outset.

No legal framework. In several countries, the legal and political basis for planning is not clear, so it is difficult to initiate and complete the planning process. Otherwise, the organizations that have a legal role for planning and co-ordination have "no teeth" and are unable to get the other intervening organizations to fulfill their part of the responsibility for planning.

Lack of technical understanding. Sometimes, the organization responsible for planning co-ordination does not have a good understanding of the risk associated with radiological activities, and is reluctant to seek the expertise from those government agencies or groups who do.

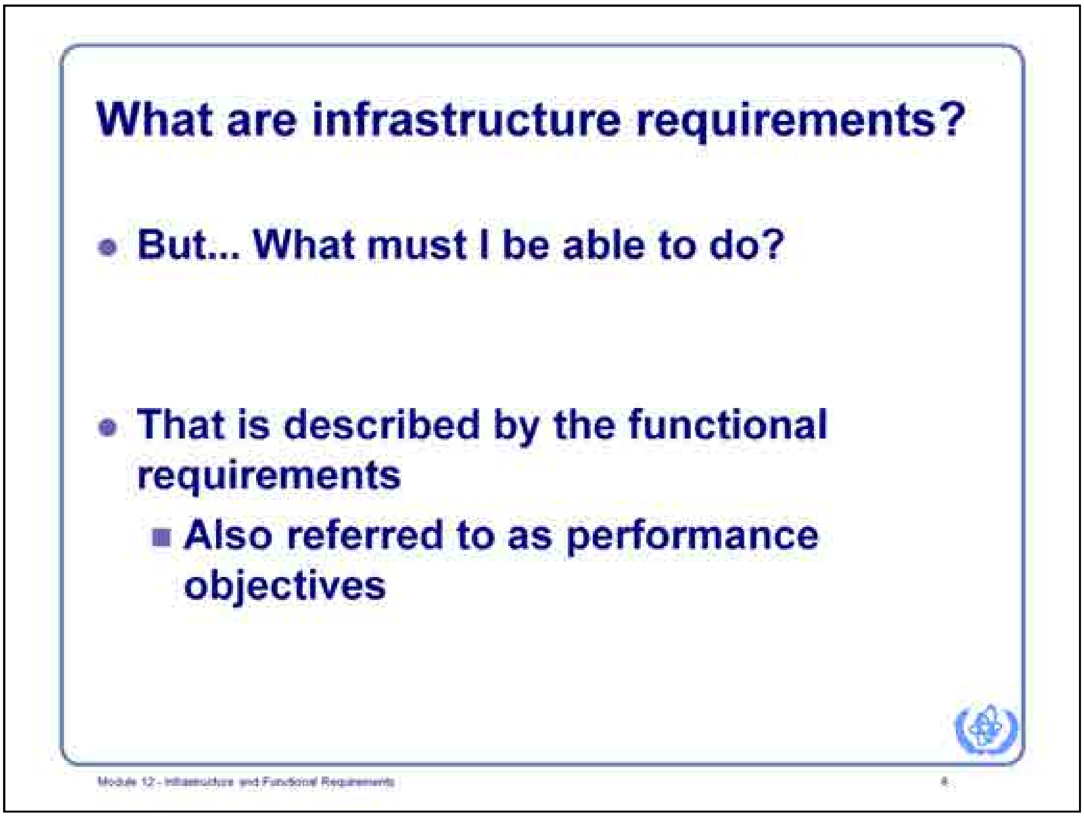
Lack of resources. This is the most common excuse for not planning: "we do not have the resources".

Lack of organization. One of the first steps in the planning process, as we will see shortly, is to establish an overall organization responsible for planning and response. Until this is done, there can be no co-ordinated planning effort.



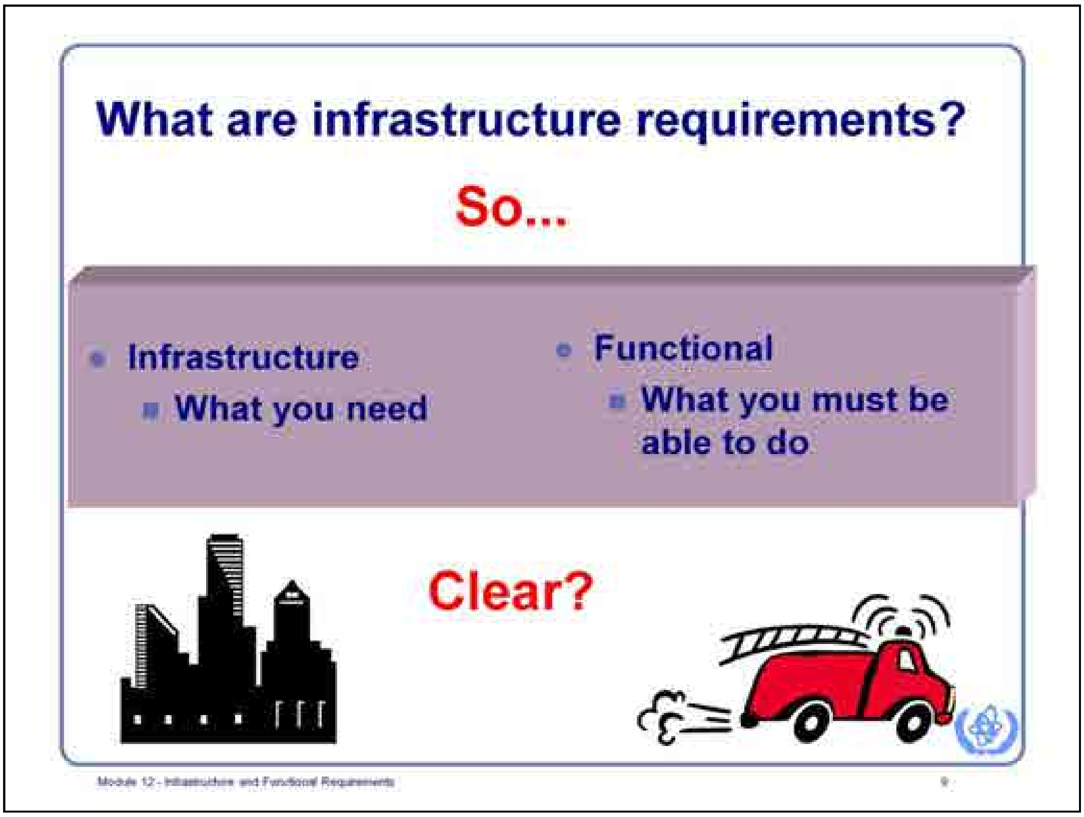
Lecture notes:

But what do we need to develop, implement and maintain emergency plans and capabilities? What we need is an infrastructure.



Lecture notes:

However, the infrastructure cannot be discussed without a clear understanding of what needs to be achieved during an emergency. This is what we call the functional requirements. The functional requirements describe what the infrastructure must be able to accomplish. That is why we sometimes call them "performance objectives".



Lecture notes:

In other words, the infrastructure describes what you have (plans, equipment, programs, etc.) and the functional requirements describe what you need to be able to do.

Lecture notes:

Remember that infrastructure requirements represent what you must "have" in order to have a proper response. An adequate infrastructure does not guarantee that the response will be adequate, but it helps! Indeed, the items listed in this slide are all considered essential elements of a proper nuclear emergency preparedness and response infrastructure.

Lecture notes:

The legal framework forms the basis for the emergency preparedness and response effort. It determines who is responsible for what, in general terms, at the various jurisdictional levels within the country. For example, in some countries, it is the law which establishes who is responsible for the protection of citizens and therefore who has responsibility for making decisions regarding evacuation and other protective measures. This can change depending on the level of emergency and on the protective action considered. For example, in some countries, municipalities are responsible for ordering an evacuation, but the minister of agriculture is responsible for ordering agricultural food countermeasures.

It is essential that a national policy describing these various aspects be established.

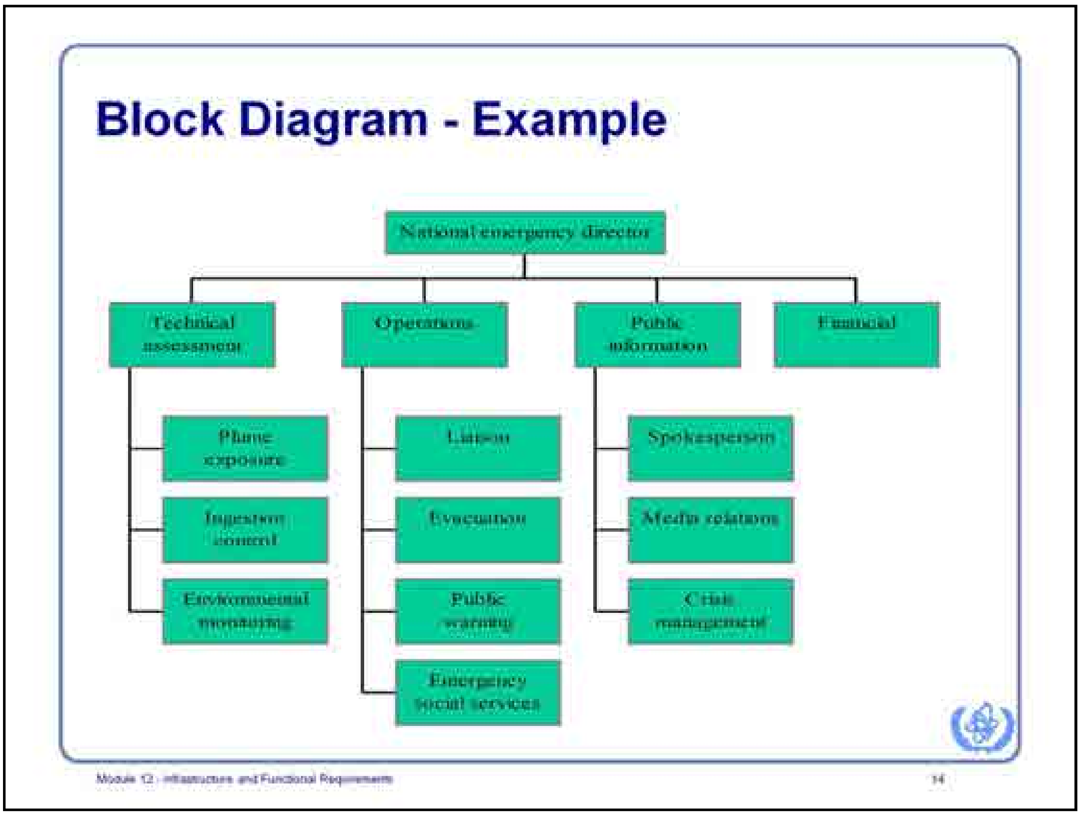
Lecture notes:

Another key infrastructure requirement refers to the assignment of authority. Who has the authority for ordering certain measures? In some cases, a national agency will have most authority during an emergency. In others, for example in Canada and the United States of America, the provinces or states have that authority. Some of the typical problems encountered when trying to clearly establish who has the authority relate to overlapping areas of jurisdiction, in reality or in perception. For example, in some countries, a national agency firmly believes that it has the authority to impose measures on the population and on other government departments, while the local mayors, being elected representatives, feel that it is their responsibility and role to make decisions. This can have repercussions in a number of detailed areas, such as: who gets notified first? We have witnessed conflicts on that issue in several countries. In some cases, these can be highly sensitive issues and can impair good co-operation between jurisdictions and organizations.

Lecture notes:

One of the first elements that we look for when evaluating emergency preparedness is an organization chart. An organization chart is a good overview of the roles and interactions between the various intervening organizations, and within each organizations. It is a very good sign of the "health" of emergency plans. The absence of an organization chart, or ill defined roles and relationship between the various "blocks" often indicates that the concept of emergency response is not clear and that the response to an actual event may not be as effective as it could be.

An adequate organizational system contains a block diagram, the role of each block, the interaction between blocks, and the concept of operation for each. It also assigns staff to each block. Indeed, in some cases, organizations are well defined but under-staffed, or no staff has been assigned, or no replacement has been assigned in case the primary person responsible for that block is unavailable.



Lecture notes:

This slides shows an example of an organizational block diagram. Although your organization may not look like this, it should contain all of the elements and functionality contained in this diagram.

Note the similarities to the organization chart in EPR-RESEARCH REACTOR, and the differences due to the different set of responsibilities to the public.

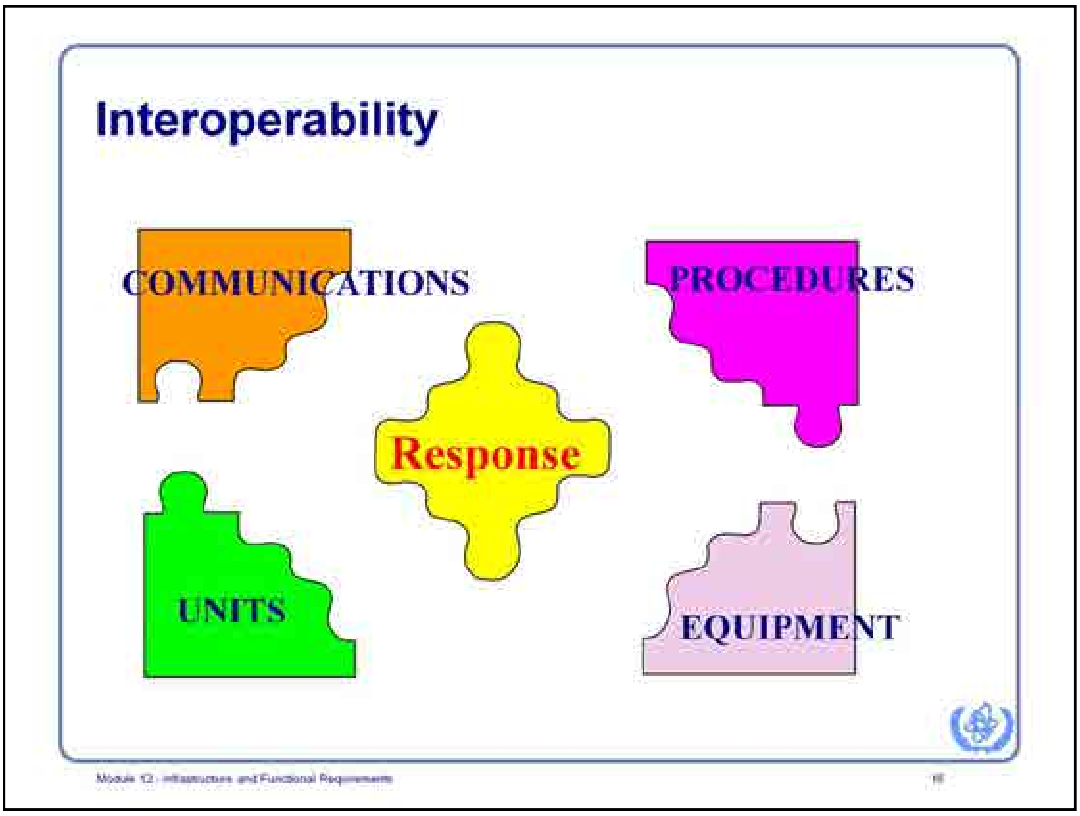
Lecture notes:

This takes us to the need for agreements. Agreements between organizations who are expected to co-operate are absolutely essential to the efficient implementation of protective actions. Agreements cover, for example, the use of emergency facilities for evacuees from another district or region, agreements on the type of units or equipment used by more than one organization expected to conduct environmental monitoring after a release, agreements between off-site emergency services and on-site authorities for assistance during an emergency, such as a fire.

There is often a tendency to rely on verbal agreements. This has been shown to be insufficient. People move and change jobs, and when the memory is lost, so is the verbal agreement. Agreements should be in writing.

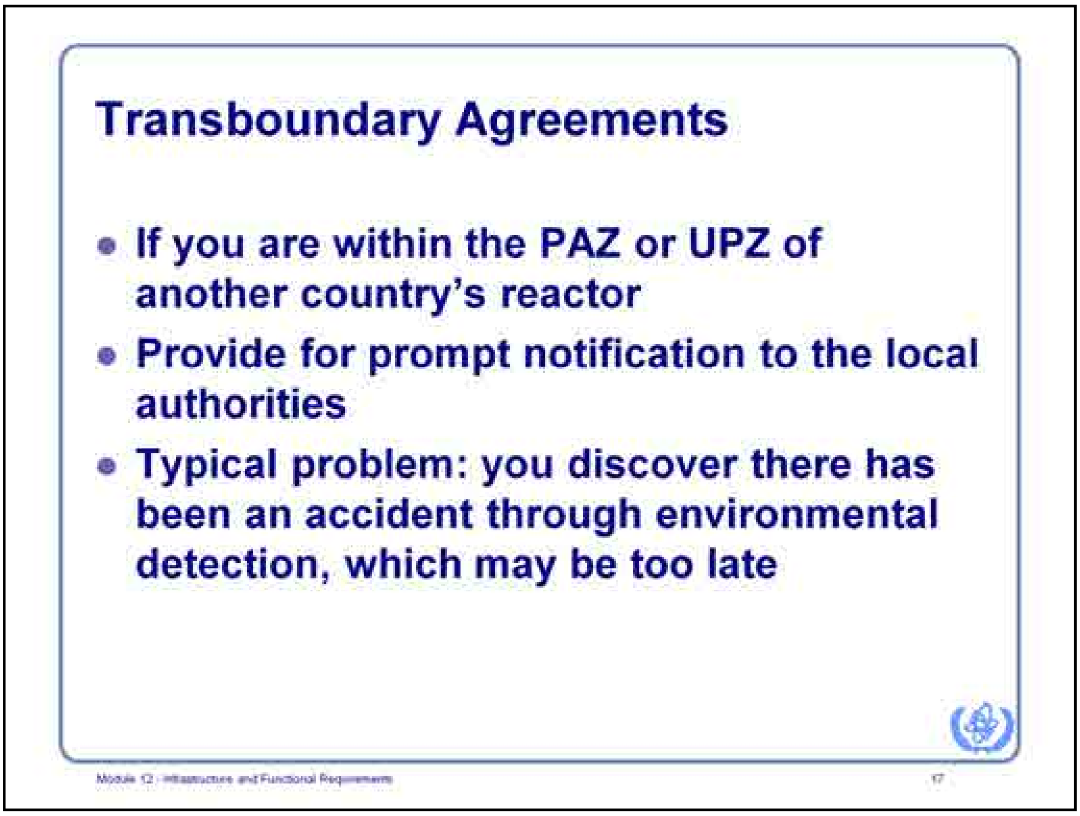
The slide illustrates how many the number of organizations involved in an emergency can be, based on actual events. This reinforces the need for clear agreements before an emergency occurs.

Recall a failed planetary probe to Mars in 2008. It was unsuccessful because the contractor who built the probe provided information in the foot-pound-second unit system while NASA navigated the probe using the meter-kilogram-second units. There was evan a written agreement, which failed to prevent the problem.



Lecture notes:

Interoperability between plans is part of the co-ordination requirement. All interfacing aspects of plans and procedures between organizations that are expected to operate together during an emergency must be co-ordinated. This includes operating on common communication networks or channels (e.g. between police and other security forces), common units (e.g. between groups who perform environmental measurements and those who perform dose projections based on these measurements), common equipment (e.g. between different organizations who conduct environmental measurements), and common procedures.



Lecture notes:

Co-ordination requirements also include the need for international agreements between neighbouring countries. Radioactive releases do not recognize national boundaries. Therefore, a region within a neighbouring country that is within the PAZ, UPZ or LPZ for your reactor should be treated the same as those regions within your own PAZ, UPZ or LPZ, even if that neighbouring country has no reactor. This means that notification agreements and agreements on the exchange of information should be in place with that neighbouring country. This will avoid the problem often encountered, e.g. during Chernobyl, that a country discovers that there has been an emergency through their own environmental monitoring system, at which point the effectiveness of protective actions may be greatly reduced.

Lecture notes:

No response can be effective without some equipment; this is obvious. But just how much equipment is required? There are some obvious requirements for equipment, for example to support the laboratory analysis, field surveys, communications, etc. Indeed, there should be sufficient equipment to support all of the functional requirements that will be described in part 4 of this module.

However, there is often a tendency to “over-equip”, or a belief that the best equipment will ensure the best response. This is not always true. The best compromise between suitable equipment and well trained individuals is probably the best guarantee of a good response. Resist the temptation to spend inordinate amounts of money on equipment that may not be essential but nice to have. Equipment and logistic needs should be based on an objective analysis of the needs. They should be directly related to functions that need to be performed during an emergency.

Lecture notes:

This slide provides some examples of the type of equipment and logistics that may be needed to support nuclear emergency preparedness.

It is important to note that some of this equipment may already be present in your country, although not necessarily readily available during an emergency. It is entirely acceptable, indeed optimal, to develop co-ordinating agreements to render this equipment available rather than to procure new equipment that will only serve during emergencies. In fact, equipment that is only used during emergencies tends to be less effective because it is often less well maintained than the routinely used equipment, and the emergency personnel may not be familiar with its operation.

Lecture notes:

Throughout all of the previous discussion, we have referred to emergency plans and procedures. They are, of course, part of the infrastructure requirements. Plans and procedures are the documented sets of guides, rules and actions for emergency response. They serve as the common frame of reference for the determination of appropriate and co-ordinated response actions. Event sequences during an emergency are unpredictable and usually unexpected. Plans and procedures should not provide a rigid environment for actions, but should rather represent a flexible, yet firm basis for actions.

Plans generally contain the concepts and approach to emergency management. They describe the basis, organization, principles for actions and overall response strategies. They also provide the basis for the development of procedures. Procedures for individuals or for organizations contain the step by step instructions for carrying out specific functions in the response. Plans and procedures must be highly integrated.

Too often, plans and procedures are developed in response to an immediate need (an exercise for example), then left on a shelf to gather dust until the next exercise. This is clearly not to the benefit of the state of preparedness. Plans and procedures are only as good as the quality assurance and maintenance programmes that should be in place to keep them realistic, accurate and up-to-date. The quality assurance and maintenance programmes should be documented, stating clearly who is responsible for quality assurance and updates/revisions, what is the process, and how often the plan and procedures are reviewed and revised.

Lecture notes:

An important part of the infrastructure requirements is the need for a classification system. A classification system is a diagnostic-based scale for promptly determining the severity of an emergency and the need for urgent protective actions, often before a release has taken place, or before the full characteristics of the release are well known. As you have seen in previous modules of this course, in some accident sequences, it is essential to make prompt decisions regarding protective actions before a lot is known about the characteristics of the hazard. One way to do this is by developing a classification system that takes into account plant readings and equipment status to estimate the potential risk to the personnel and the public.

A classification system allows a quick assessment of the risk during an emergency. It also allows for notification and emergency declaration, and quick and unambiguous communication between intervening organizations, provided that they all use consistent definitions.

EPR-RESEARCH REACTOR (DRAFT) suggests a standard classification system for research reactor accidents based on major plant system status. It relates the plant diagnostics to four standard emergency levels: alert, facility emergency, site area emergency and general emergency. Each level triggers standard actions on the part of intervening organizations on-site and off-site.

Lecture notes:

However, in several cases, we have seen classification systems that do not work, despite the best intents, because of a lack of consistency between the systems used by different organizations. In one case, the off-site authorities have imposed a classification system on the licensee, which is different than the one used on-site, but which cannot replace the on-site classification system because of its off-site focus. In practice, this has on several occasions resulted in a delay in the initial notification following emergencies because of the need for the operators to use and interpret two parallel classification systems. Lesson learned: the classification system should be common for on-site and off-site organizations and should be well understood by all.

Note that for non-reactor accidents, a classification may not always be a key requirement, depending on the nature of the accident. For example, for a transport accident, initial precautions are taken on the basis of the package type and situation at the scene. Therefore, in the generic procedures developed for non-reactor radiological accidents (IAEA TECDOC-1162), a classification system is not always explicitly considered.

Lecture notes:

Training is the final building block of the emergency preparedness programme. Training achieves three goals:

- it ensures that the emergency personnel are familiar with the plan, procedures and interfaces;
- it ensures that the personnel are proficient in the performance of emergency functions, or that the personnel selected are the right ones for the tasks; and
- it helps discover weakness in the plans and procedures, which can then be corrected before a real emergency occurs.

The training programme should be documented, stating clearly who is responsible for co-ordinating and/or providing the training. Do not forget that training costs money (lost productivity time, training preparation, delivery of training, travel costs, etc.), and that financial provisions must be available to ensure that training will take place.

Drills and exercises are an inherent part of training.

Finally, training is not an end. It is part of the iterative process to continually improve preparedness, including the plan and procedures. So there must be a feed back mechanism to ensure that lessons learned from training, drills and exercises are used to improve the emergency preparedness documents.

Lecture notes:

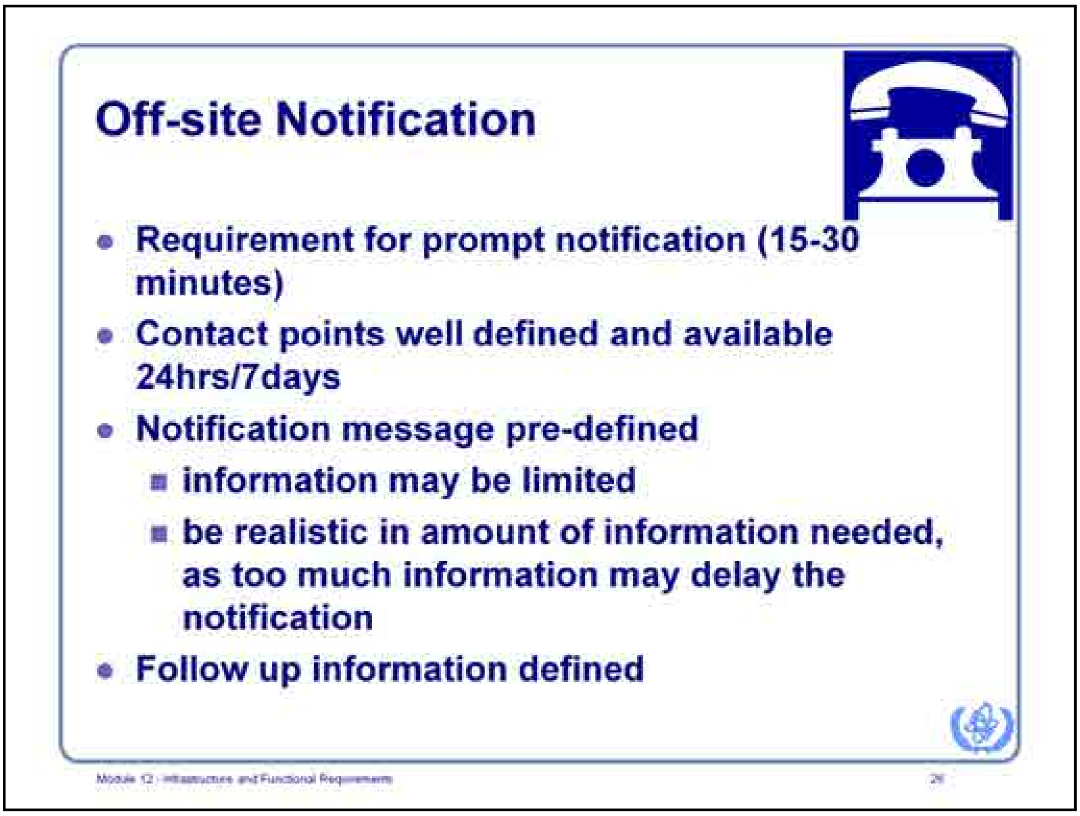
Remember that functional requirements refer to the actions that may need to be taken during an emergency. Therefore, the functional requirements should be read as follows: “organizations must demonstrate that they are capable of performing the following action”.

Functional requirements cover those areas that are listed on this slide.

Lecture notes:

Capabilities for prompt notification should be well established and well known by all the people who may have a role in the notification and alert chain. This includes a notification system between the on-site and off-site authorities for a research reactor or nuclear power station, a system between local police and national authorities (if appropriate) for notification of a large transport accident involving radioactive sources, etc. Notification protocols and messages should be pre-defined and contain, when appropriate, recommendations for initial protective actions. Notification protocols should be developed jointly by the sender and the intended receiver of the information. Notification also includes the need to promptly inform other countries that may be affected.

Each intervening organization should, when appropriate, have an activation system that can alert all the key personnel within the organization at any time, 7 days a week, and 24 hours a day.



Lecture notes:

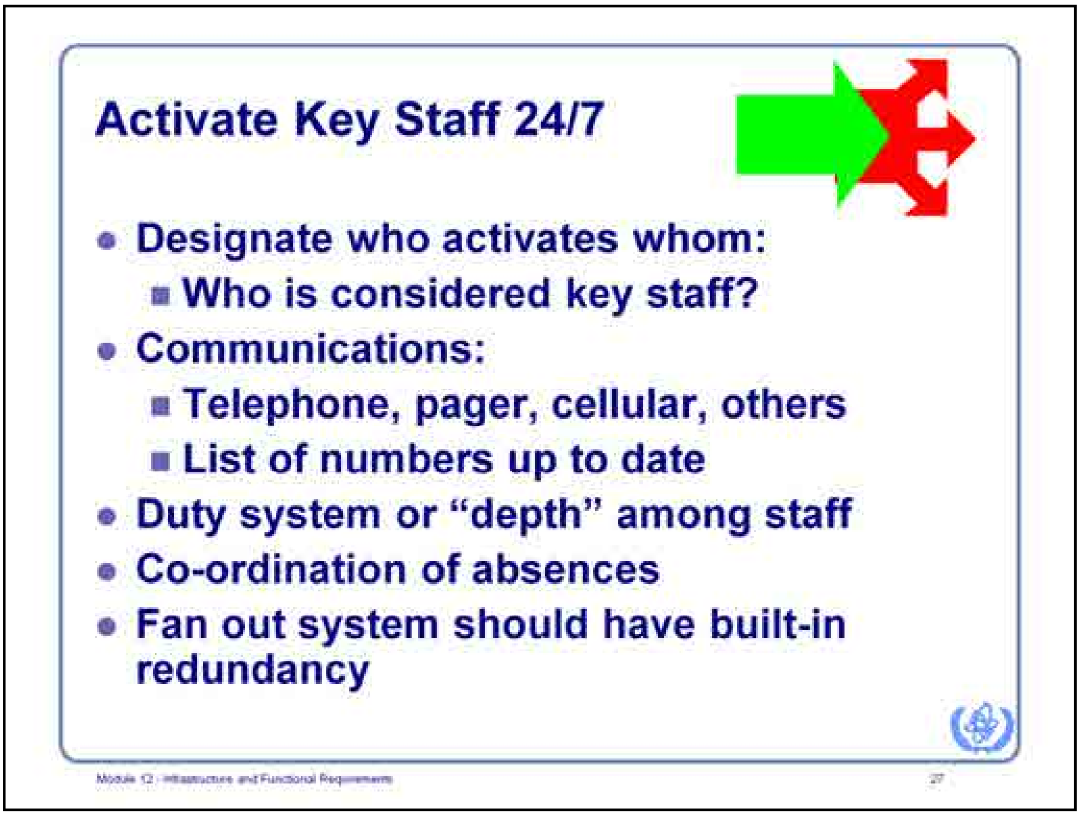
EPR-METHOD 2003 provides guidance on the contents of the off-site notification message for accident involving fixed facilities. This guidance is summarized on this slide.

The notification time requirement is a target based on similar requirements in the United States and in other countries.

One of the most important elements of the notification system is the clear and unambiguous designation of contact points that can be reached at any time.

It is counterproductive to try to put too much information on the notification message. Indeed, this can delay notification. Therefore, the amount of information to include, at least in the initial message, should be concise.

The notification protocol should also define how and when follow-on information will be provided.



Lecture notes:

Some organizations (not all) will need to have a system for alerting key personnel at any time of the day, any day of the week. Each organization should designate in its plans who are the key individuals to alert during a nuclear emergency, and should state what the target time is to reach all the key personnel. Based on these requirements, the best means of communications can be determined.

In case key personnel cannot be reached, it is important to have replacement personnel. It is generally recommended that key positions have one main contact and two alternates. Alternates should not be alternates for more than one position. However, in many cases, this is not practical because of the lack of human resources. The guidance in that case is to avoid, as much as possible, the likelihood that one individual may have to perform the duties of more than one position. This may mean ensuring, for example through co-ordination of travel or vacations, that a large number of key personnel are not absent all at once, leaving the organization vulnerable in case of an emergency.

Lecture notes:

Notification agreements should also be in place with neighbouring countries, particularly for power reactors where the size of the planning zones extends into the neighbouring country. Country-to country notification has traditionally taken place from government to government. This can delay the notification process. It is recommended that notification agreements be established between the utility and the off-site authorities or other suitable contact point in the neighbouring country. This would help ensure that off-site communities are provided with a consistent level of protection, regardless of which country they live in.

Note that the language issue must be considered in international notification agreements.

For informing distant countries that may be affected by the plume, directly or indirectly, it is recommended that the IAEA be notified as soon as possible, in accordance with the Convention on Early Notification of a Nuclear Accident.

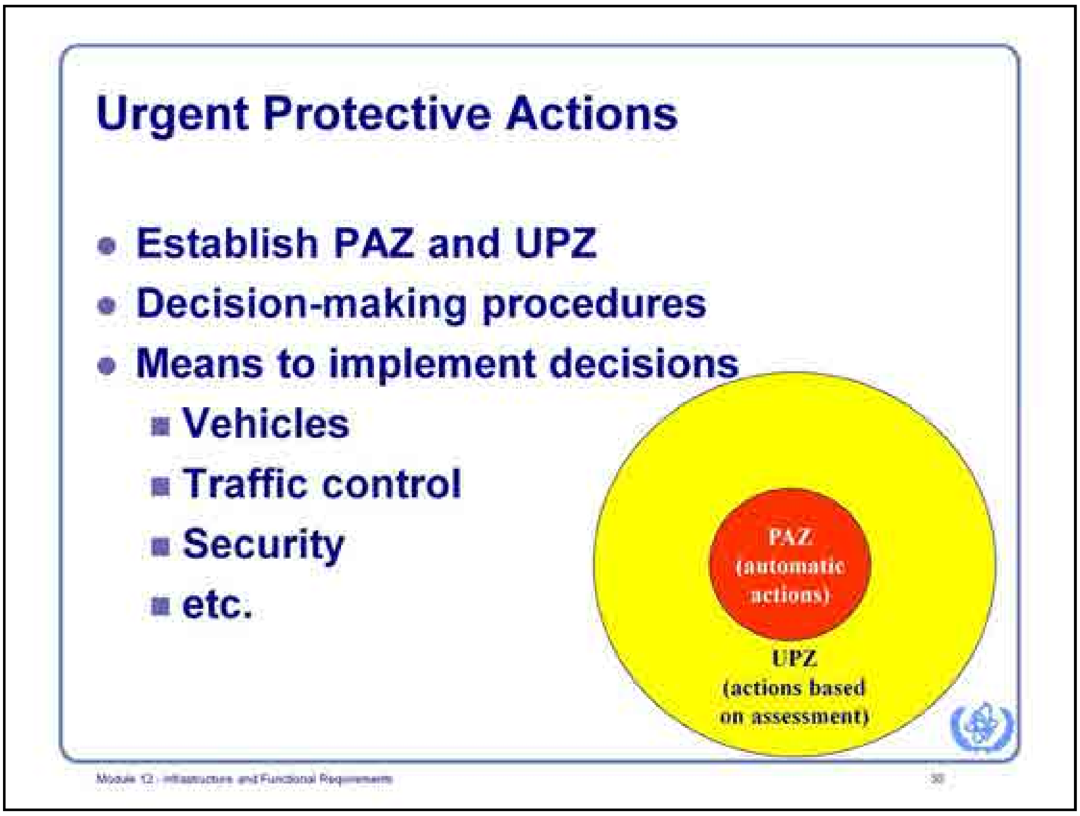
Lecture notes:

The aim of mitigating measures is to reduce the magnitude of the hazard at the source. Mitigating measures include:

a. emergency procedures to be implemented by plant personnel at a facility, or by first responders at the scene of a transport accident;

b. technical support that should be provided to plant operators or first responders. For example, in the case of a transport accident, this requirement means that provisions should be made to ensure that qualified individuals can be promptly contacted to give advice to first responders, and can be dispatched quickly to the scene to support first responders.

In a plant, accurate and reliable equipment readings are essential for proper mitigating actions to be taken. During the Three Mile Island accident, for example, the consequences were worsened by the fact that instruments wrongly indicated that a pressure relief valve was closed.



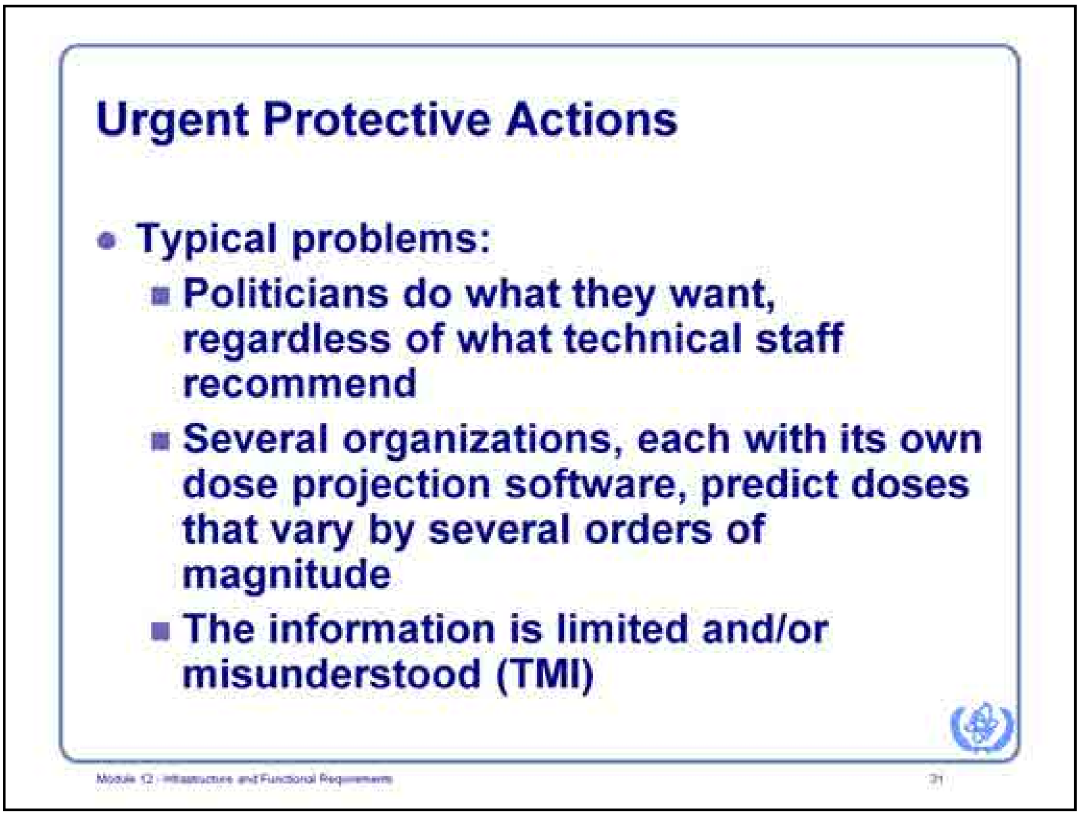
Lecture notes:

There must be a demonstrated capability to implement protective actions within the established planning zones. Remember that this does not mean that protective actions may not be required outside of the planning zones.

There must also be documented procedures for making decisions related to protective actions. These decisions may be based on any of the following:

- plant status and measurements inside the containment (especially early in the emergency);
- effluent monitoring;
- dose projections;
- ambient dose-rates measurements; and
- analysis of samples.

Organizations must also be able to demonstrate that they have the means to carry out the required response actions.



Lecture notes:

The next three slides present some of the challenges that must be recognized when developing plans for urgent protective actions and when making decisions regarding the implementation of protective actions.

One of the most important factors to recognize is that protective actions are inherently disruptive. Therefore, they involve factors that are not only technical - those based on intervention levels and measurements- but also socio-political. Hence, decisions, which are often made by politicians, are inherently also political. For example, a decision to evacuate may involve shutting down industries, disrupting the social network, or moving special populations. It has a cost that is not measured solely on the basis of health. Technical staff who make those recommendations must recognize that these are only recommendations, and that politicians may disregard them. Conversely, a recommendation not to evacuate may be disregarded in favour of an evacuation to ensure that political authorities are seen to be “doing something about the emergency and are in control”.

Another common problem comes from the fact that many recommendations are based on projections and models. When different organizations use different models, the results can vary widely, making it difficult, at times, to justify an action, or lack of action.

Another problem comes from the miscommunication between organizations. This was the case at TMI, when readings taken over the stack were assumed to have been taken at 5 Km from the plant. This led the US NRC to recommend an evacuation, which was not supported on the basis of real readings at 5 Km.

Lecture notes:

There are also problems associated with the implementation of protective actions. Evacuations, for example, may be complicated by the fact that not enough vehicles are available, or by the inadequacy of the evacuation plan, including ill-defined evacuation routes, or insufficient traffic control resources, or traffic jams caused by spontaneous evacuations.

When planning for and conducting an evacuation, due consideration must be given to the need for free circulation of emergency vehicles.

Evacuating special facilities, such as hospitals, old persons' homes, or penitentiaries, require special considerations and may need to be given special treatment during an evacuation.

Finally, when evacuating a population that may have been exposed, it is necessary to ensure that as many people as possible are monitored for contamination before being dispatched to the rest of the country. However, not every one goes to reception centres where this monitoring can take place. It is therefore necessary to have measures in place to ensure that the majority of them will, and that the rest are provided with instructions for personal decontamination.

Lecture notes:

Care must also be taken to ensure that contamination control procedures for the population evacuating a zone do not create bottle necks that could impair the evacuation itself.

A spontaneous evacuation is always possible as soon as the public is notified that an accident has occurred, even if no evacuation order has been given. Spontaneous evacuations can be difficult to manage.

If the timing of the release does not allow a proper evacuation before the plume has reached the sector to evacuate, a decision must be made on whether it is better to shelter until the plume has passed. The answer is not straight forward and depends in part on the expected duration of the release. A grid-locked evacuation while the plume is passing may cause more harm than leaving the population indoors.

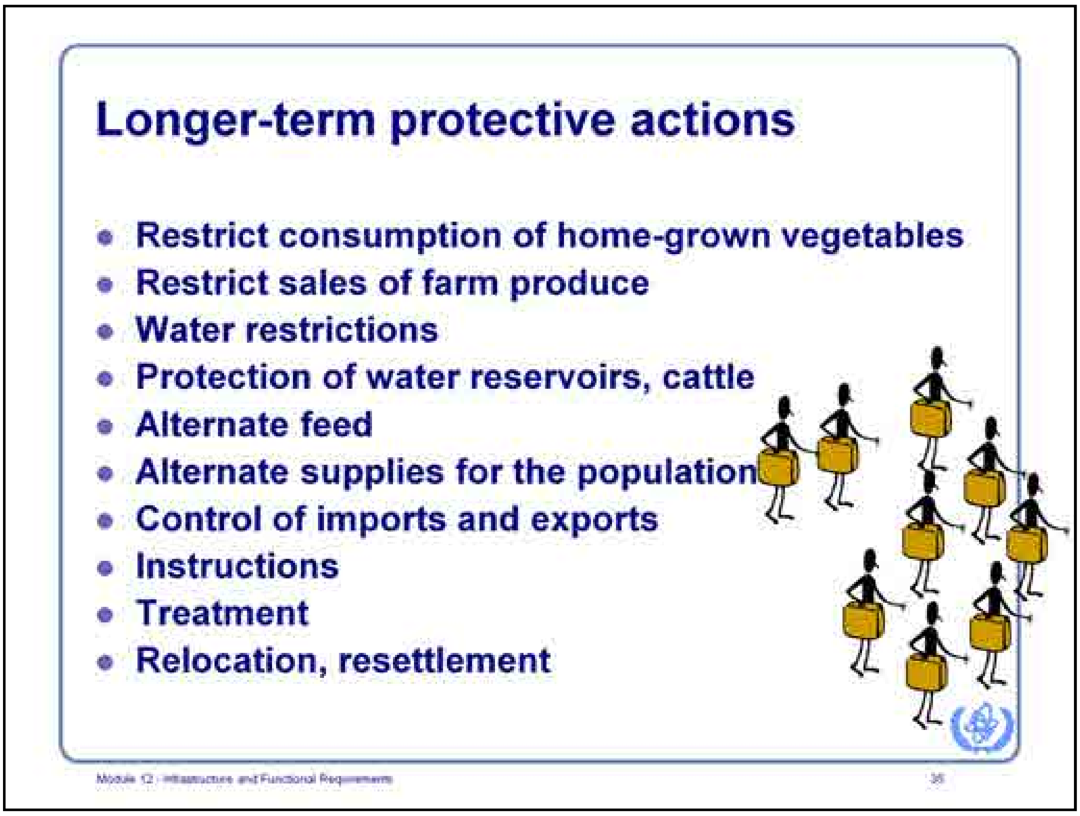
As in any case of evacuation, security of the evacuated area to prevent looting may be required. Provisions must therefore be in place to assure security of the evacuated area while protecting emergency security personnel.

One of the most problematic questions after evacuating an area will be: when can people return home. This is likely to be a great preoccupation of the politicians. There should be guidelines and criteria for allowing a return to evacuated zones.

Finally, a question often forgotten by emergency planners is what to do with animals: pets and farm animals. Most emergency community facilities and shelters do not allow animals for any extended period. Provisions should be in place to deal with them.

Lecture notes:

The implementation of longer-term protective actions such as relocation and agricultural countermeasures usually do not need to be made promptly. The risk is over the long term, which allows decision-makers more time to make a decision. Therefore, longer-term protective action plans must focus on the need for prompt sampling and assessment of the data. Sampling plans for food and ground contamination should be developed before an emergency. The basis for decisions should be well established and should be based on a careful analysis of the contamination, e.g. isotopic concentrations, which are not always available in time for decisions relating to urgent protective actions. Laboratory facilities will be required for such assessments, and co-ordinated plans for sampling and measurements need to be developed. Incidentally, environmental and food sampling, and detailed measurements are usually performed by different organizations at the national level. It is therefore necessary at the planning stage to properly co-ordinate those organizations.



Lecture notes:

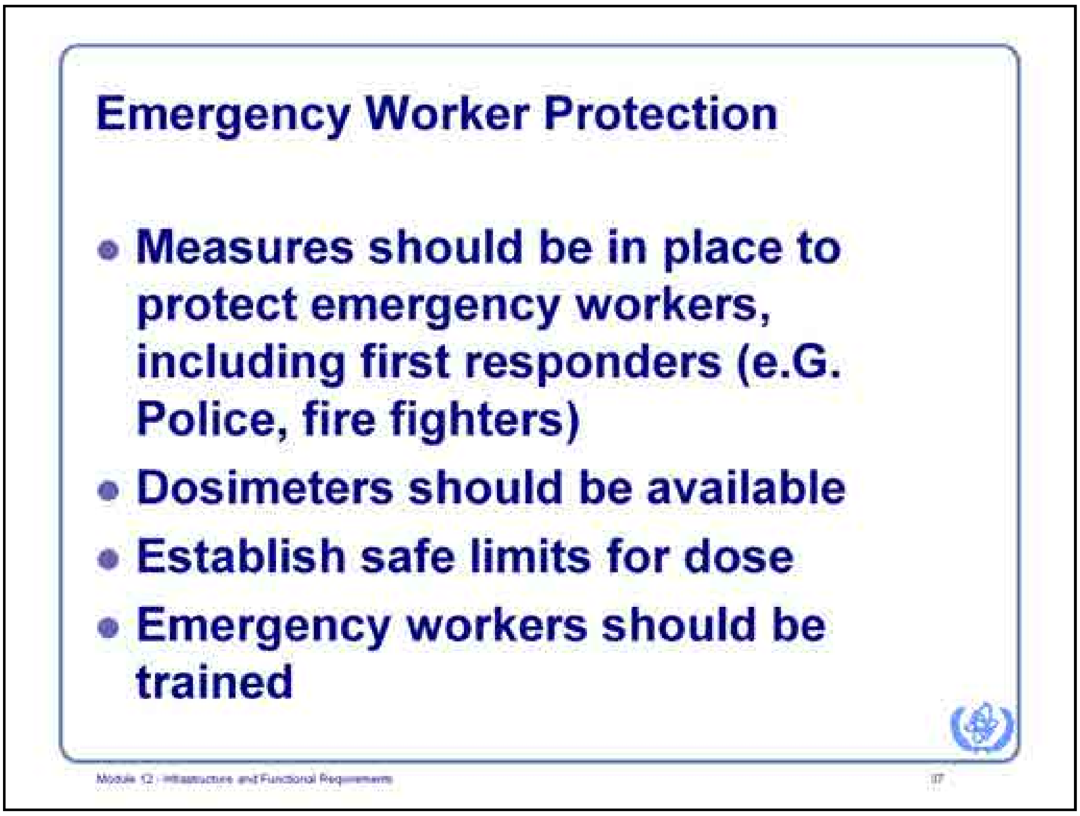
This slide shows a representative set of longer-term protective actions which may need to be considered. It is the task of technical advisers to recommend which of these measures need to be considered. As soon as a release has occurred the general public will want advice on what to do about food. It may be wise to advise them early not to consume fresh home-grown vegetables or fresh milk until food has been monitored; which provides better confidence than taking no action.

Lecture notes:

Longer-term protective actions also include those listed on this slide. Business resumption deals with maintaining the continuity of industrial and government services in the affected area. For example, if an evacuation forces the closure of a government office that normally issues social security cheques to members of the public, it will be necessary to replace that service promptly to ensure that no-one unduly suffers from the lack of essential financial income.

Agricultural countermeasures such as the ban of the processing of potentially contaminated food stuff will have to be supported by an enforcement plan to ensure that the food producers do not circumvent the orders.

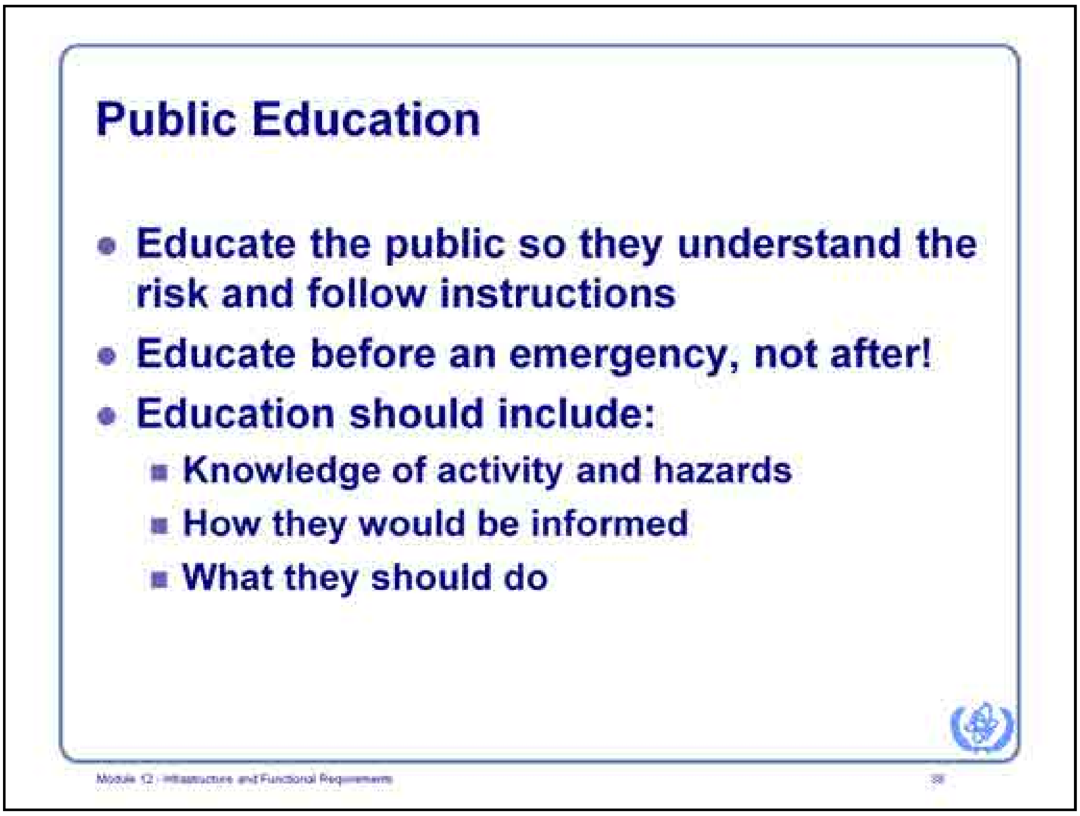
If the affected area is a large food producing region, alternative food supplies will have to be found. Alternatively, if no practical alternative exists, a decision may be taken to allow consumption of some food provided that countermeasures are established. For example, in theory it may be acceptable to consume food contaminated with iodine slightly above the regulatory limits provided that stable iodine is also provided to the affected population for the first few days following the accident. However, this should not be considered unless the local food supply is critical to the well-being of the affected population.



Lecture notes:

Protective actions and emergency management of the affected area will require the participation of emergency personnel in that area. It is therefore essential that appropriate measures be established to protect these emergency workers from radiation. Measures should include dosimeters, assistance by qualified radiation protection specialists, in some cases respiratory protection, stable iodine distribution to emergency workers, and procedures to control and record the dose received by them.

Emergency workers who may have to operate in contaminated areas, or may have to respond to accidents involving radiation, should receive some basic training on precautions for protecting themselves against radiation and for preventing the spread of contamination.



Lecture notes:

Protective actions are likely to be most effective if the public understands them, their purpose and the risk associated with an accident. Public education before an accident is therefore important.

There is some controversy on how much education is required, and who requires it. Some think that too much education can unduly alarm the population. That is a risk. Public education programmes should primarily target the public most at risk. Public education methods need to employ means that will minimize costs and maximize retention. Calendars or phones books are often used as media for the public information material, showing basic radiation hazards, evacuation routes and basic procedures on what to do when an emergency is declared, and how to get the information from public authorities (e.g. which radio station). Calendars and phone books are often prominently displayed and easy to find during an emergency.

Lecture notes:

The media have gained an unprecedented profile in our day-to-day lives. They are everywhere, and they know everything, often before the authorities find out. With this prominence comes a power of information which is difficult, if not impossible, to rival. Therefore, the media cannot be controlled; do not even try.

Emergency plans should recognize this fact of life and build on it. The need to deal with the media in a prompt, accurate and effective manner should be an important component of every emergency plan. Dealing with the media during an emergency is not an exercise in “public relations”; the aim is not to “massage” the facts so that authorities look good. The media want facts, not public relations. And they want it fast! If journalists do not get the information they want from the authorities, there is a good chance that they will find it somewhere else; and it may not be right. Journalists have a job to do, and they will do it. The best way to ensure that the information they publish is accurate is to give them the accurate information!

The media should be educated. They can be a great communications tool during an emergency for conveying information to the public. They can be allies if treated fairly and diligently.

It should be remembered that very few journalists have the necessary technical background to understand all the technical issues. The task of communicators and spokespersons is to bridge the technical gap.

In practice, there should be only one spokesperson for each emergency organization. This will ensure consistency of information, but should not delay that information.

The media should be monitored to detect any false information and steps taken to rectify it as quickly as possible.

Lecture notes:

Lecture notes:

Lecture notes:

One of the great obstacles to emergency planning is the perceived cost. This does not necessarily need to be as high as believed.

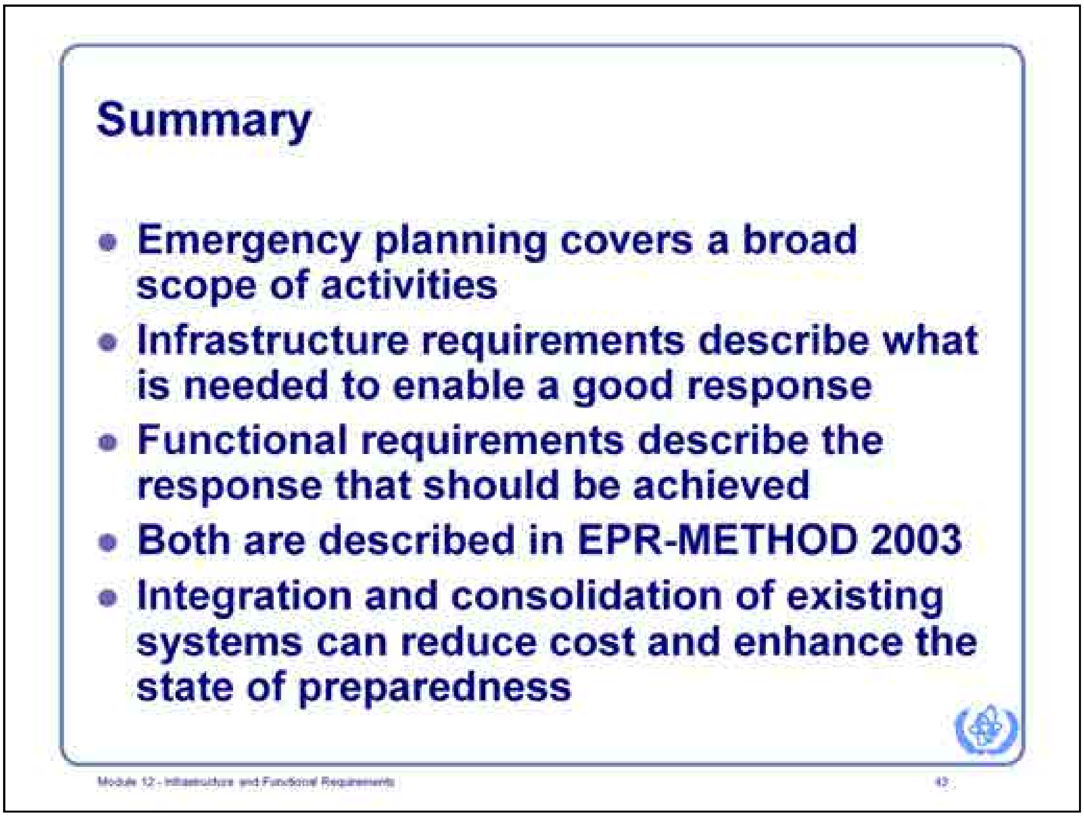
There is a common mistake made to think that only specialized and dedicated emergency response resources can adequately carry out emergency functions. This is not true, and it can represent a high cost in your preparedness efforts.

Most countries have highly competent and knowledgeable resources available. Optimization of the preparedness efforts means that these resources should be integrated and coordinated in the plans before new resources are acquired. For example, there have been instances where government departments in charge of emergency preparedness co-ordination have sought to acquire new and expensive equipment, such as germanium-based spectrometry systems, only to realize that this equipment was available in another department, but that no one had consulted with that department to see if the capability could be integrated in the emergency plan.

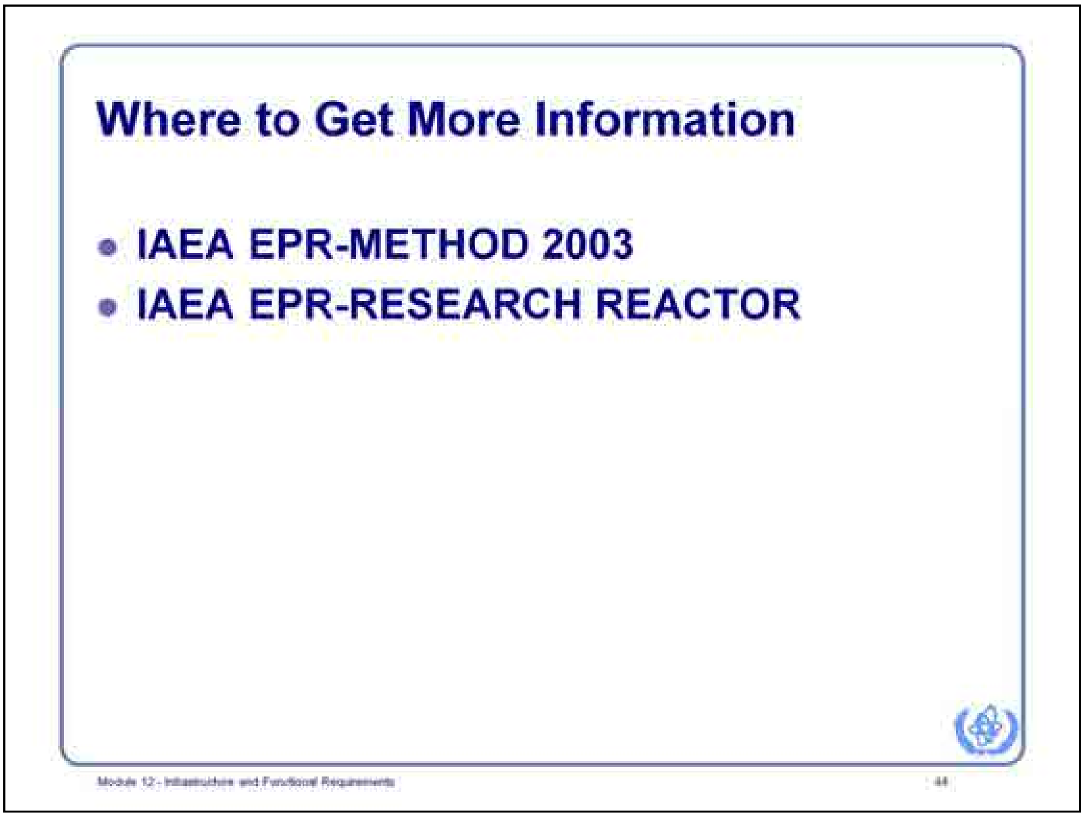
Also, it is not always necessary to have a separate radiological emergency plan and training program. Indeed, as much as possible, this should be integrated with existing plans and programs. For example, maybe there is already a conventional emergency plan. Radiological emergencies could become an annex of that plan and radiological emergency response could build on the existing organization and procedures. The same goes for training course, in which radiological emergency response could become one of the modules.

Optimizing the preparedness effort also means ensuring that plans are maintained. Too often, plans are developed, tested and then left “on the shelf” until the next exercise. This can result in out-of-date plans which require a complete repeat of the initial planning and developmental effort. It is generally less expensive to test and maintain the plan periodically than to overhaul it completely every five years.

Finally, it is important that people “buy into” the plan as it is being developed. Time spent getting people’s input and comments before the plan is finalized will increase the chances of a speedy acceptance of the final product.

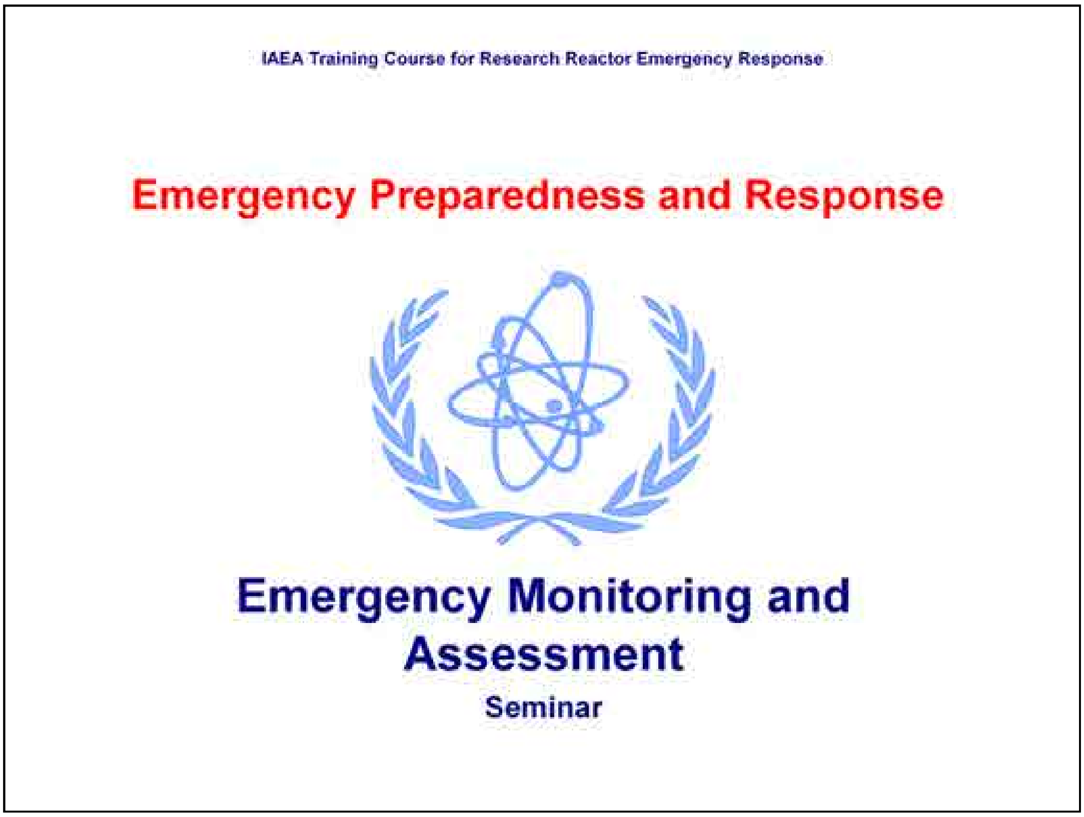


Lecture notes:



Questions:

1. List four areas that are within the scope of emergency planning.
2. How are functional and infrastructure elements related?
3. Name three infrastructure elements.
4. Name four functional elements.
5. List two ways to optimize emergency planning and reduce the potential cost of preparedness.



Block 3: Emergency Preparedness and Response Overview
Module 13: Emergency Monitoring and Assessment

Learning objectives: Upon completion of this module, the participants will:

- list the objectives of emergency monitoring
- understand generic emergency monitoring organization
- describe emergency monitoring and sampling strategy in small and large scale emergencies
- determine staff qualification requirements
- list basic survey methods
- comprehend the QA and QC systems in emergency monitoring and sampling

Activity: Seminar, questions and discussion
Duration: 1 hr

Materials and equipment needed: none

References:

1. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Monitoring in a Nuclear or Radiological Emergency, IAEA-TECDOC-1092, IAEA, Vienna (1999)
2. INTERNATIONAL ATOMIC ENERGY AGENCY, Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency, EPR-METHOD 2003, IAEA, Vienna (2003)
3. INTERNATIONAL ATOMIC ENERGY AGENCY INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Response to a Nuclear or Radiological Emergency at Research Reactors, EPR-RESEARCH REACTOR, IAEA, Vienna (2011)

Lecture notes:

This lecture presents an overview of the IAEA technical publication *Generic procedures for monitoring in a nuclear or radiological emergency* (IAEA-TECDOC-1092).

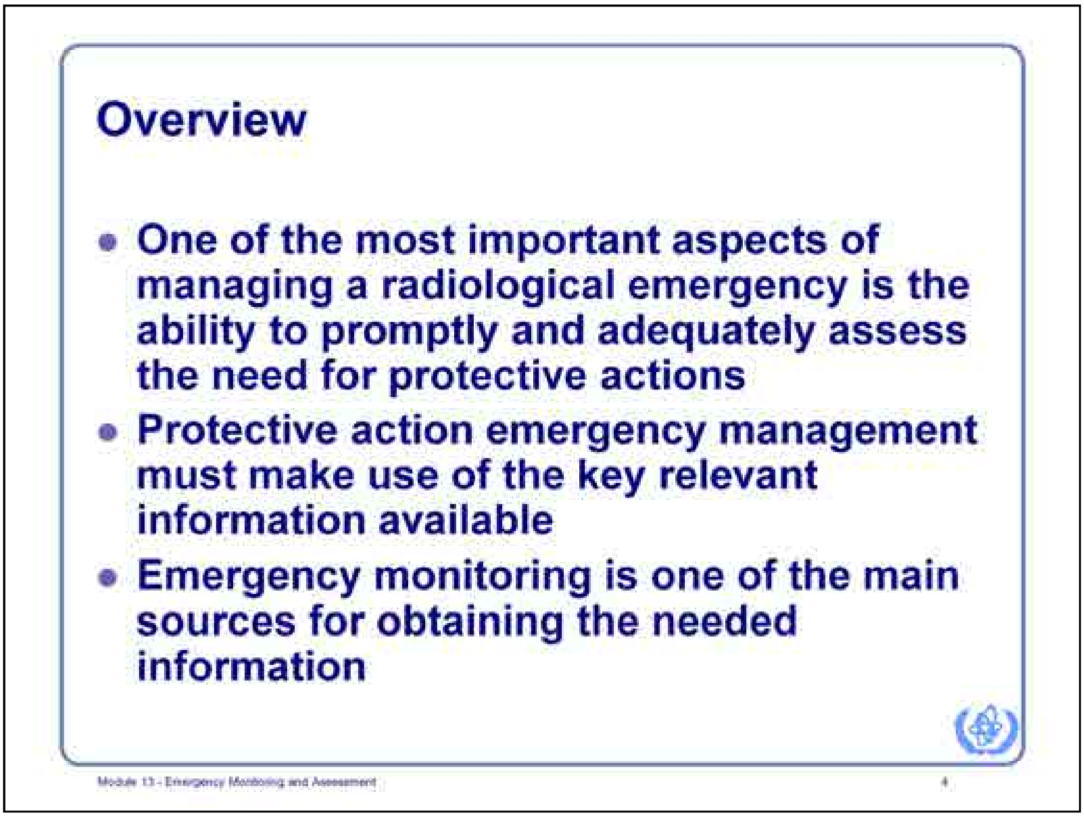
Material is drawn from EPR-METHOD 2003 for the monitoring teams. Environmental monitoring priorities are based on EPR-RESEARCH REACTOR. It covers strategy, manpower and equipment needed in environmental, source, personal and equipment monitoring during a nuclear or radiological emergency. Detailed procedures for monitoring teams are not dealt with in this lesson.

Lecture notes:

This lesson presents the introductory chapter of the IAEA publication *Generic procedures for monitoring in a nuclear or radiological emergency* (IAEA-TECDOC-1092). The publication is in the scope of the *Convention on Assistance in the Case of Nuclear Accident or Radiological Emergency* under which the IAEA is authorized to assist a State Party or a Member State among other matters in developing appropriate radiation monitoring programmes, procedures and standards (Article 5).

INTERNATIONAL ATOMIC ENERGY AGENCY, Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, Legal Series No. 14, IAEA, Vienna (1986).

Photo: Deserted town Pripyat (few km from Chernobyl NPP) 10 years after the Chernobyl accident and routine checking of the residual contamination (ambient dose rate).



Lecture notes:

One of the most important aspects of managing a radiological emergency is the ability to promptly and adequately assess the need for protective actions. Protective action emergency management must make use of the key relevant information available. Decision-making and emergency assessment will be an iterative and dynamic process aimed at refining the initial evaluation as more detailed and complete information becomes available. Emergency monitoring is one of the main sources for obtaining the needed information.

Purpose

- The primary purpose of emergency monitoring is to provide timely information on which decisions on protective actions can be confirmed or revised
- This requires detection of radioactive material, determination of its location and its nature

Module 13 - Emergency Monitoring and Assessment 5

Lecture notes:

The general objectives of emergency response are to:

- reduce the risk or mitigate the consequences of the emergency at its source
- prevent deterministic health effects (e.g. early deaths and injuries) by taking actions before or shortly after exposure and keeping the public and emergency worker individual doses below the thresholds for deterministic health effects
- reduce the risk of stochastic health effects (e.g. cancer and severe hereditary effects) as much as reasonably achievable by implementing protective actions and keeping emergency worker doses below the established levels.

Protective actions are first taken based on the emergency classification of the emergency. These actions are then confirmed or revised based on environmental measurements and assessment.

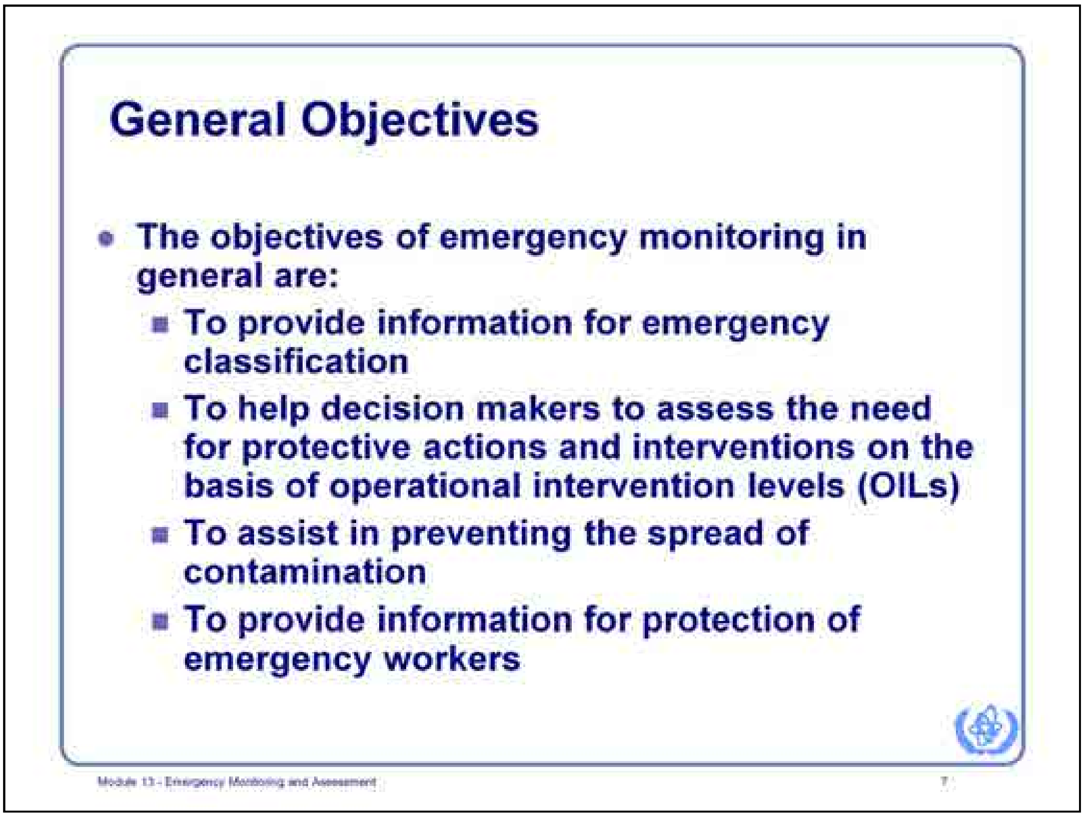
If we are to do this in a timely fashion we must have a pre-planned capability to provide RAPID and targeted monitoring.

Photo: Monitoring the roof of the house - radiological emergency in Goiânia (1987)

Lecture notes:

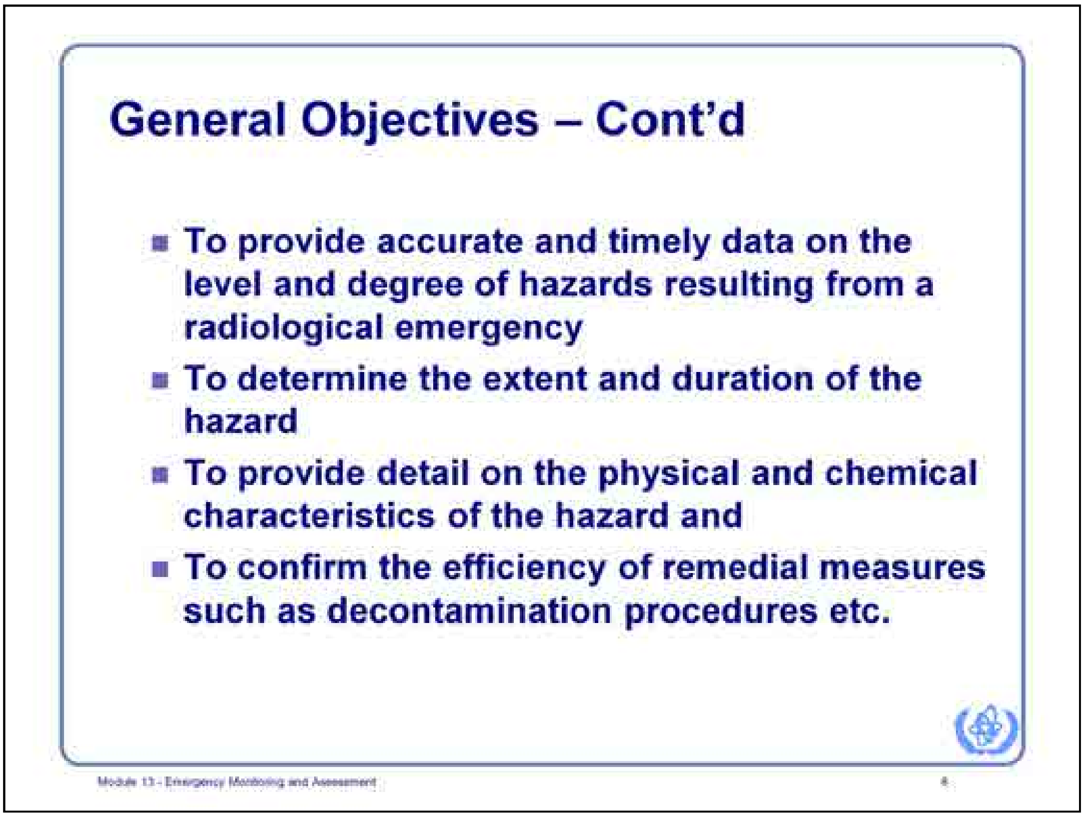
In the context of emergency response, we can say that the general aim of monitoring is to assist the decision-making, and to confirm or revise decisions on **whether** protective actions should be applied, and if so, **when** and **where** they should be applied.

Capability to provide rapid monitoring is essential if an effective and meaningful emergency response is to be implemented.



Lecture notes:

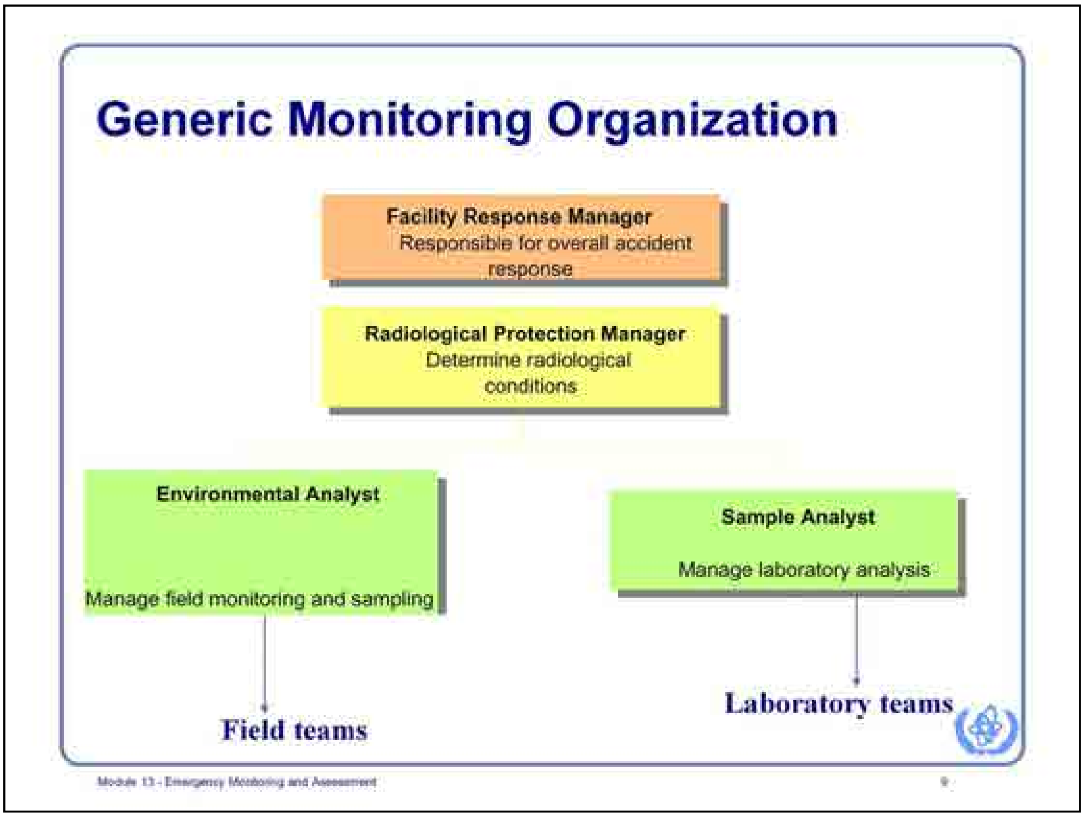
The aim of the IAEA publication *Generic procedures for monitoring in a nuclear or radiological emergency* is to provide practical guidance for environmental, source, personal and equipment monitoring in a nuclear or radiological emergency. The emergencies covered range from a major reactor emergency to emergencies involving small amounts of radioactive material. It DOES NOT deal with in-plant monitoring. So you will not find here objectives relevant for that subject.



Lecture notes:

So having got clear the overall aim of monitoring for assisting emergency response decisions, what **specific** objectives do we have? Here are some of them in the context of an emergency at a research reactor:

- to identify unsafe areas at the reactor facility
- to detect major release from the plant and locate plume direction;
- to identify where ambient dose rates from deposition indicate OILs are being exceeded;
- identify where deposition concentration indicate food should be restricted until sampled and analyzed for comparison to OIL5 and OIL6;
- to take and analyze deposition samples to determine if OILs may be revised.



Lecture notes:

The slide gives an overview of a generic monitoring organization and functions compatible with the following publication:

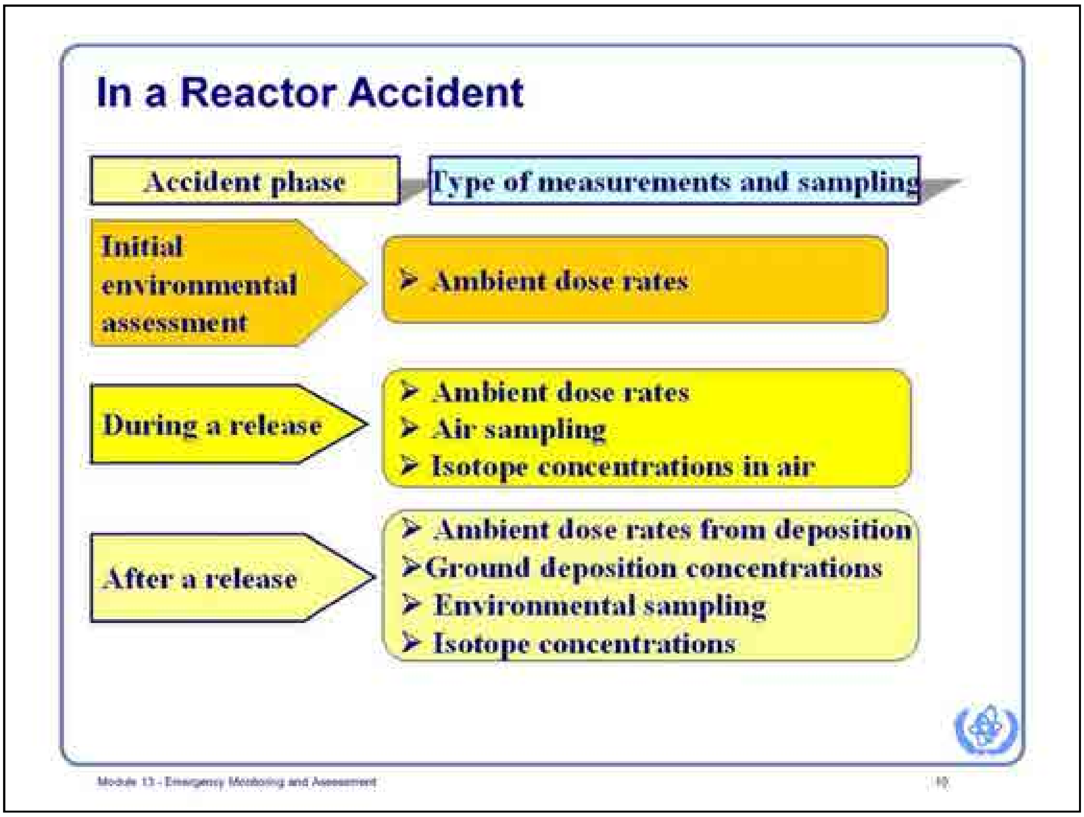
Emergency Manager , *Radiological Protection Manager*, and *Environmental Analyst* as defined in "Generic Procedures for Response to a Nuclear or Radiological Emergency at Research Reactors, EPR-RESEARCH REACTOR, Vienna (2011)

Many official organizations and bodies routinely monitor environmental radiation and radioactive contamination levels for a variety of purposes.

It is important in emergency planning to:

- identify such organizations,
- be aware of their resources in terms of equipment and trained personnel,
- enlist their support and
- periodically exercise or drill as responding agencies in the event of a nuclear or radiological emergency (where possible).

EPR-RESEARCH REACTOR excludes the Sample Analyst position. All Monitoring Teams in the organization report to the Environmental Analyst.



Lecture notes:

This is an overview of the type of measurements and sampling needed in different phases of a reactor emergency.

Air sampling is included here, but won't be found in EPR-RESEARCH REACTOR. The reason is that the plume from any reactor is difficult to accurately characterize and is transient. Deposition is simpler to identify and characterize. That should not be taken to ignore air sampling information if the reactor facility desires.

OILs for urgent and some longer term protective actions are based on these measurement.

Monitoring Priorities in a Research Reactor Accident (EPR-RESEARCH REACTOR)

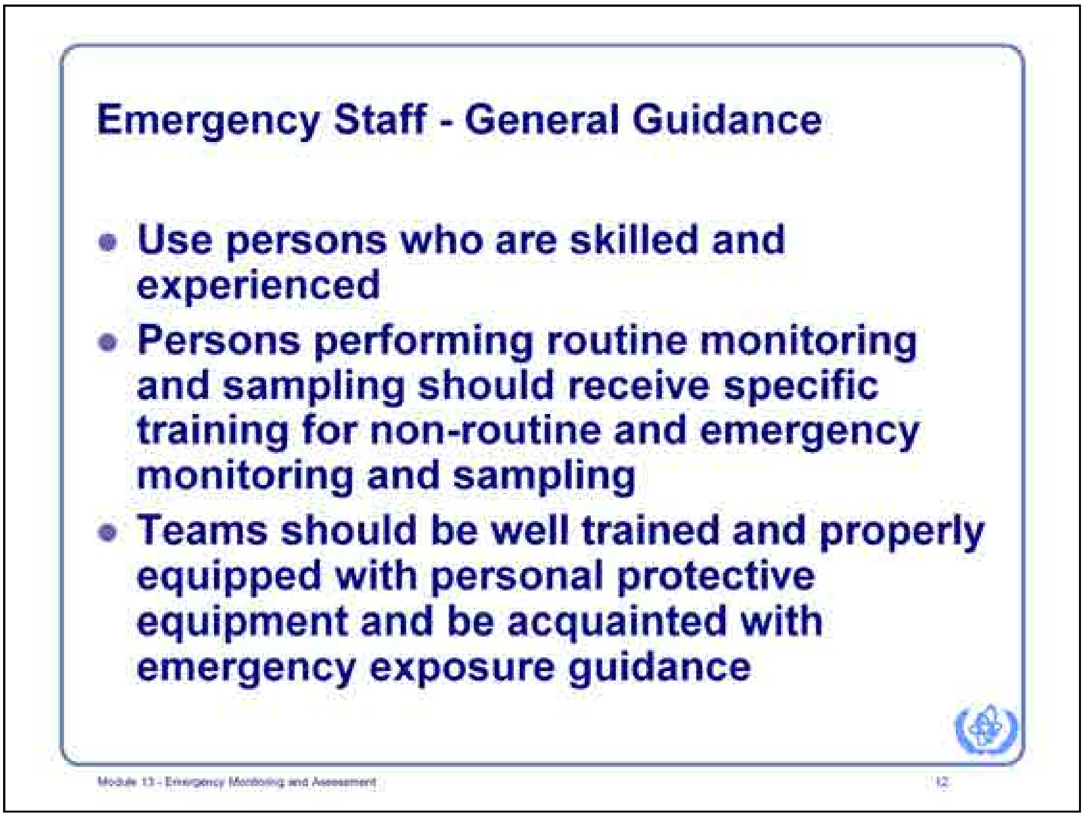
PRIORITY	OBJECTIVE	WHEN	WHERE
1	• Detect release • Identify safe areas	• Immediate, repeat once an hour	• On-site, to boundary in all directions
2	• Determine where OIL-1 exceeded	• After classification • During release	• Off-site, start downwind, survey in all directions
3	• Determine where OIL-2 exceeded	• During release	• Off-site, start where OIL-1 not exceeded
4	• Determine where OIL-3 exceeded	• During release	• Off-site, start where OIL-2 not exceeded
5	• Determine where OIL-6 exceeded	• After plume passage • After release ends	• Off-site, start where OIL-3 not exceeded
6	• Determine where OIL-6 exceeded	• After plume passage • After release ends	• Twice the distance from where OIL-3 no longer exceeded

Lecture notes:

Priority 1: Immediate monitoring in and around the facility out to the site boundary to evaluate the adequacy of immediate on-site urgent protective actions and to provide early detection of a release.

Priority 2: Determine that no urgent protective action is necessary off-site, or to define the region affected if a release is occurring with first priority given to determining if the OIL-1 limits are being exceeded

Lesser priorities are based on determining the less urgent protective action zones.



Lecture notes:

Use persons who are skilled and experienced and familiar with the monitoring equipment, sampling collection, preparation procedures, and sample analyses in their routine work. Persons performing routine monitoring and sampling should receive specific training for non-routine and emergency monitoring and sampling. They have to be properly equipped with personal protective equipment and be acquainted with turn back guidance.

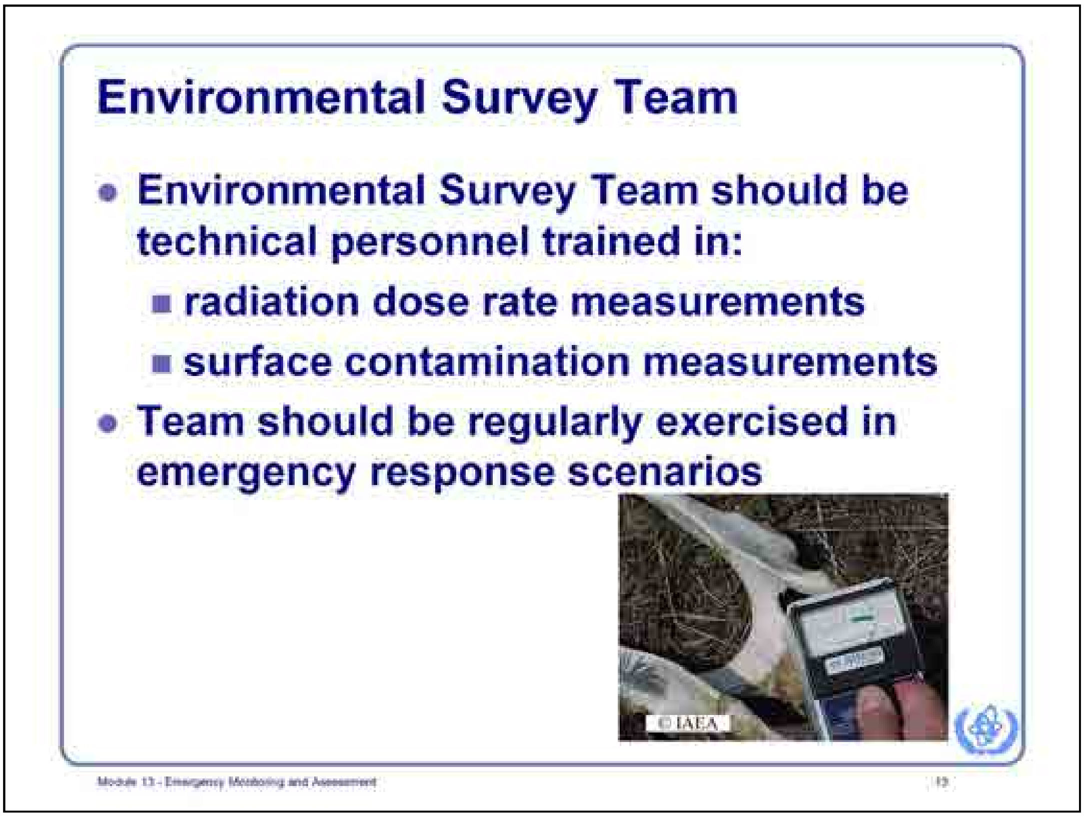
In emergency monitoring higher readings may be expected, greater care in sample handling techniques may be needed, and novel methods such as screening large numbers of samples using less sophisticated techniques may be required.

Use of inexperienced personnel or untried techniques may lead to inappropriate and/or faulty technical information, which may cause decision makers to make wrong judgements or allocate scarce resources inappropriately. Therefore training requirements should be established for each position and team, and a programme should be developed that provides the training identified for each member of the monitoring team, including:

- teams drill to ensure they can perform as unit
- exercises are conducted to test procedures

Develop a process to record lessons learned from training, drills and exercises and take corrective actions. It is essential that key environmental and source monitoring staff are well trained and regularly exercised in their assigned roles. Operational experience in routine and non-routine monitoring is highly desirable as technical staff responding to an emergency need to be skilled in the measurement and sampling techniques they are to apply.

Technical staff skilled in measurements and sampling may also need training in the use of emergency communication equipment such as two-way radio, map reading and global positioning system (GPS) equipment. For each key position in the emergency organization the qualifications required are described in the following slides.



Lecture notes:

Purpose:

- Measurement of gamma/beta dose rates from plume, ground deposition or source; evaluation of unknown situations

Minimum staffing per team:

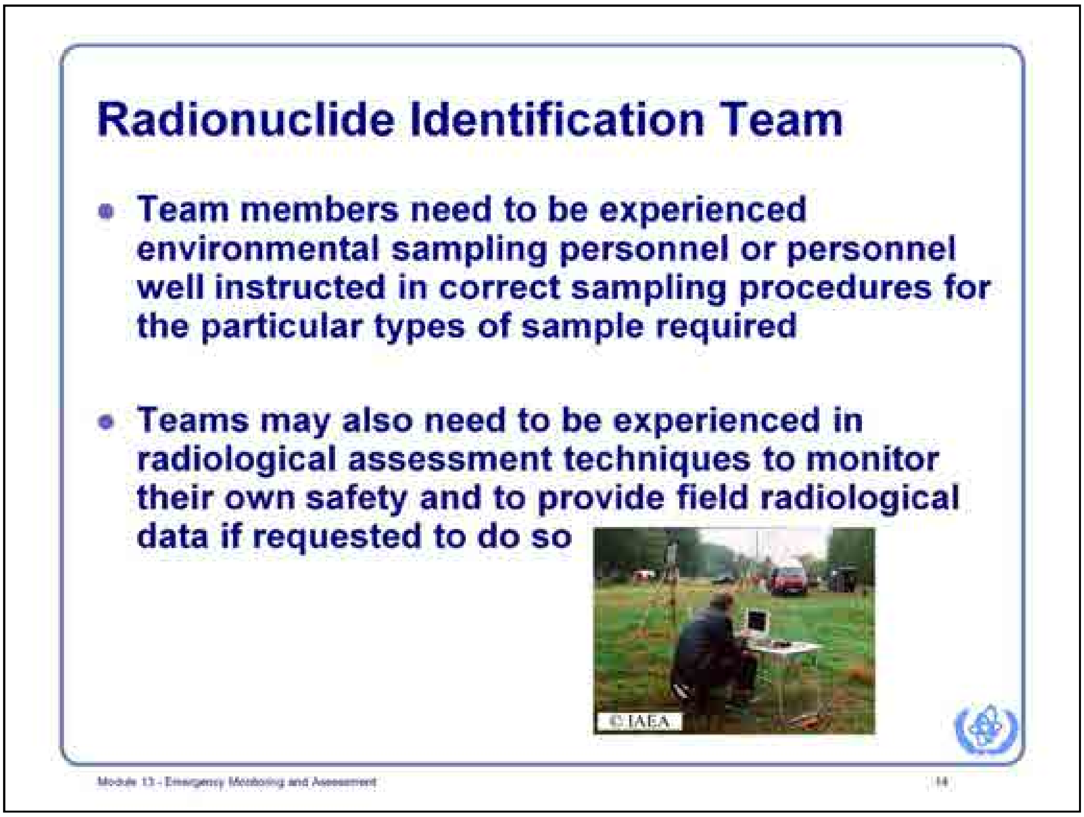
- 2 persons, trained annually in radiological assessment

Minimum equipment per team:

- Radiation survey instruments
  - high range gamma survey instrument - 1 piece
  - low range survey instruments - 2 pieces
- Check source for low range survey instruments

Consult IAEA EPR-METHOD 2003, Appendix 15 for the full listings.

Photo: Soil monitoring in radiological emergency in Goiânia (1987)



Lecture notes:

Purpose:

- Gather samples of potentially contaminated soil, food and water

Minimum staffing per team:

- 2 persons, trained in radiological assessment and sampling, 1 local guide

Minimum equipment per team:

- Radiation survey instruments:
  - low range survey instrument
  - check source
- Sampling equipment:
  - sample bottles and bags, sample tags
  - knife, spoons, shovel, measuring tape

Photo: Soil sampling - IAEA team at one of the missions.

Lecture notes:

Purpose:

- Personnel and equipment monitoring; decontamination of people; to assess personal contamination of skin and clothing and of contaminated objects, surfaces, equipment and vehicles.

Minimum staffing per team:

- 3 persons, trained annually in radiological assessment and decontamination procedures

Minimum equipment per team:

- Radiation survey instruments
  - contamination monitors - 2 pieces
  - low range survey instruments - 2 pieces
- Check sources

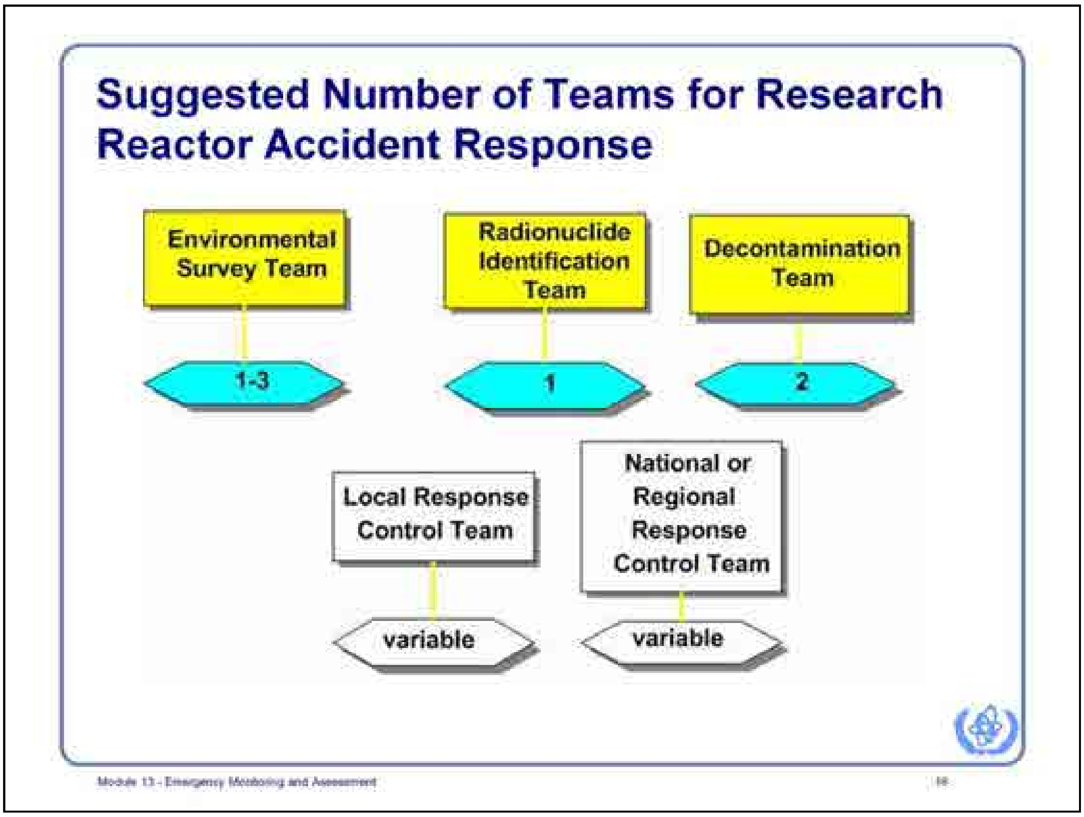
Decontamination equipment:

- Personnel decontamination supplies (towels, soap, detergent, brush, etc.)
- Water supply container, pressurized water spray
- Wet-dry vacuum cleaner
- Plastic covers, waste bags, bags for radioactive waste (with warning labels)

Consult IAEA EPR-METHOD 2003, Appendix 15 for the full listings.

Such persons may also need to be skilled in safe disrobing techniques and in personal and surface decontamination techniques as well as thyroid measurement (screening).

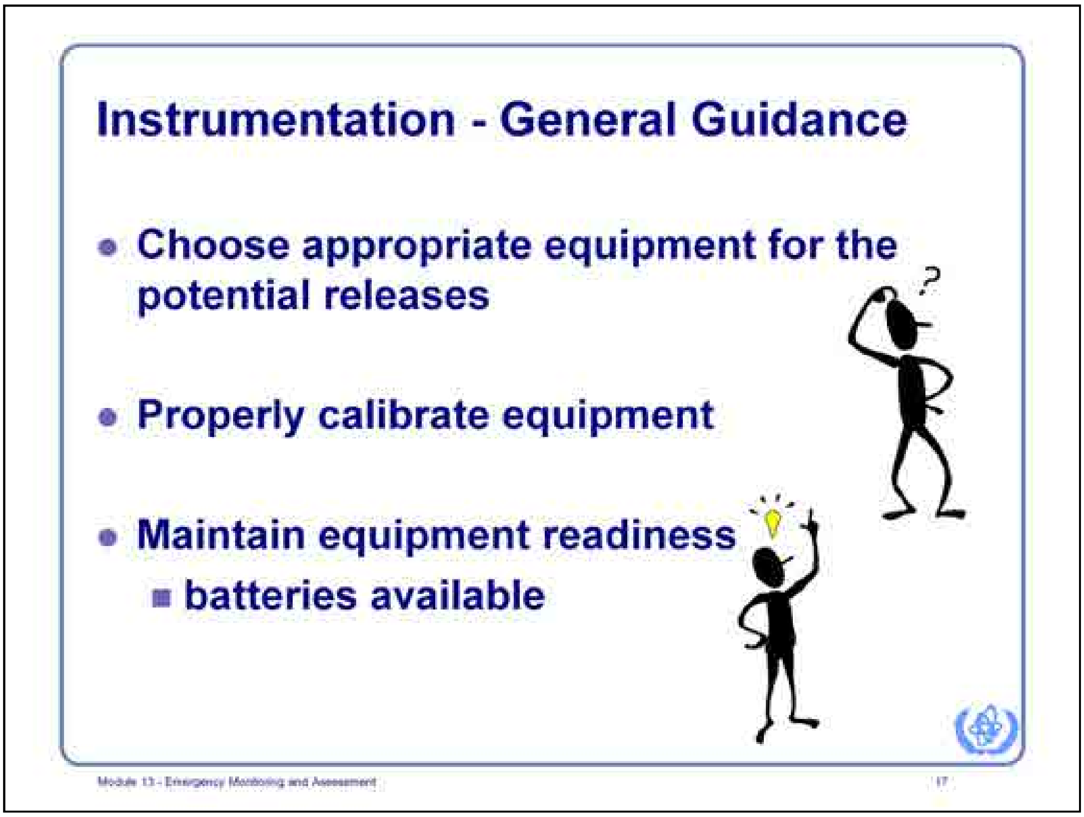
Photo: Personal monitoring of people during the radiological emergency in Goiânia (1987).



Lecture notes:

This slide shows the minimum number of environmental radiation monitoring teams recommended for research reactor sites in emergency planning Category II and III based on IAEA-EPR-METHOD 2003, Appendix 15 recommendations.

The reference also shows teams for medical response, source recovery, aerial surveys and laboratories. Size and number of teams will vary depending upon postulated responses for the potential emergencies and the shared monitoring role between the reactor site and the local or national responders.

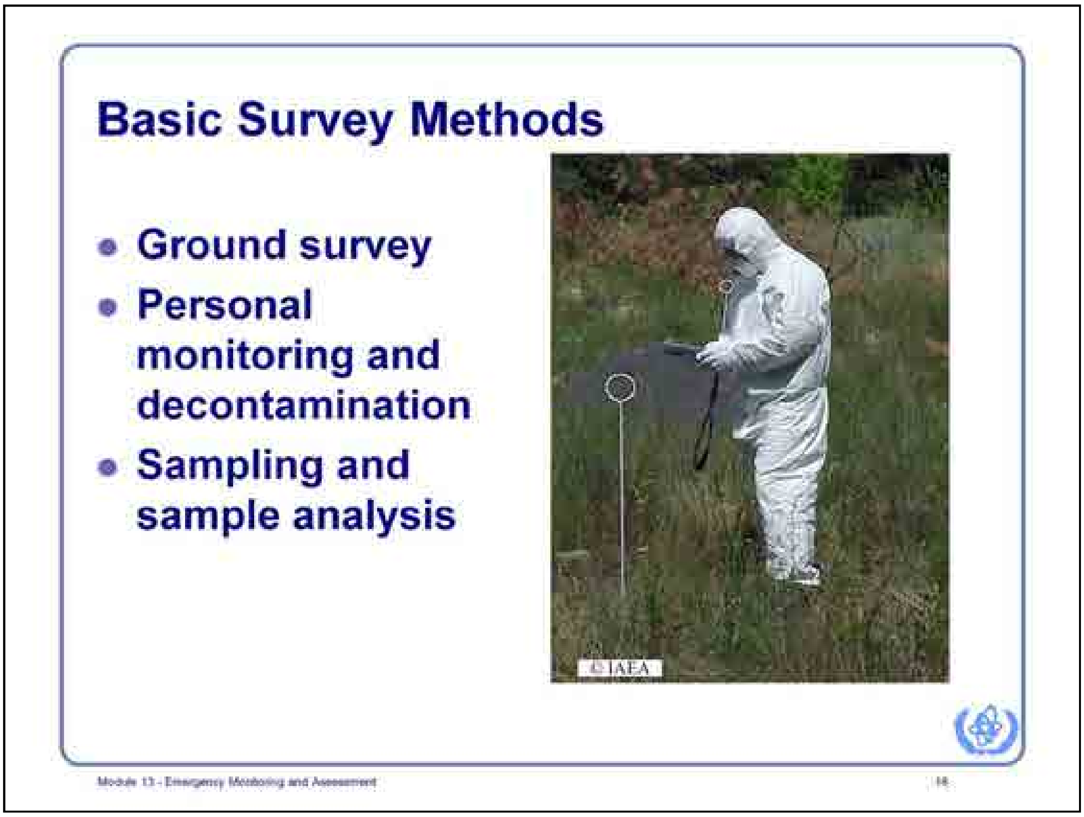


Lecture notes:

It is extremely important to choose appropriate equipment to meet the relevant objectives. For example, while a TLD can be used to register the total dose of a radiation worker, it provides no alarm before he or she receives that dose. A standard germanium detector for routine gamma spectrometry can become distorted in high contamination levels, etc.

In all cases, the equipment must be properly calibrated and maintained. An emergency may be the only time you really need to use an instrument to save lives and it is as good as no instrument at all if it doesn't work or gives misleading results.

CAUTION: Using field instrumentation with different unit systems — that is "old units" and SI units — may create confusion. Units that are consistent with the instruments are to be used. In case of using instruments with both unit systems a high degree of awareness should be exercised.



Lecture notes:

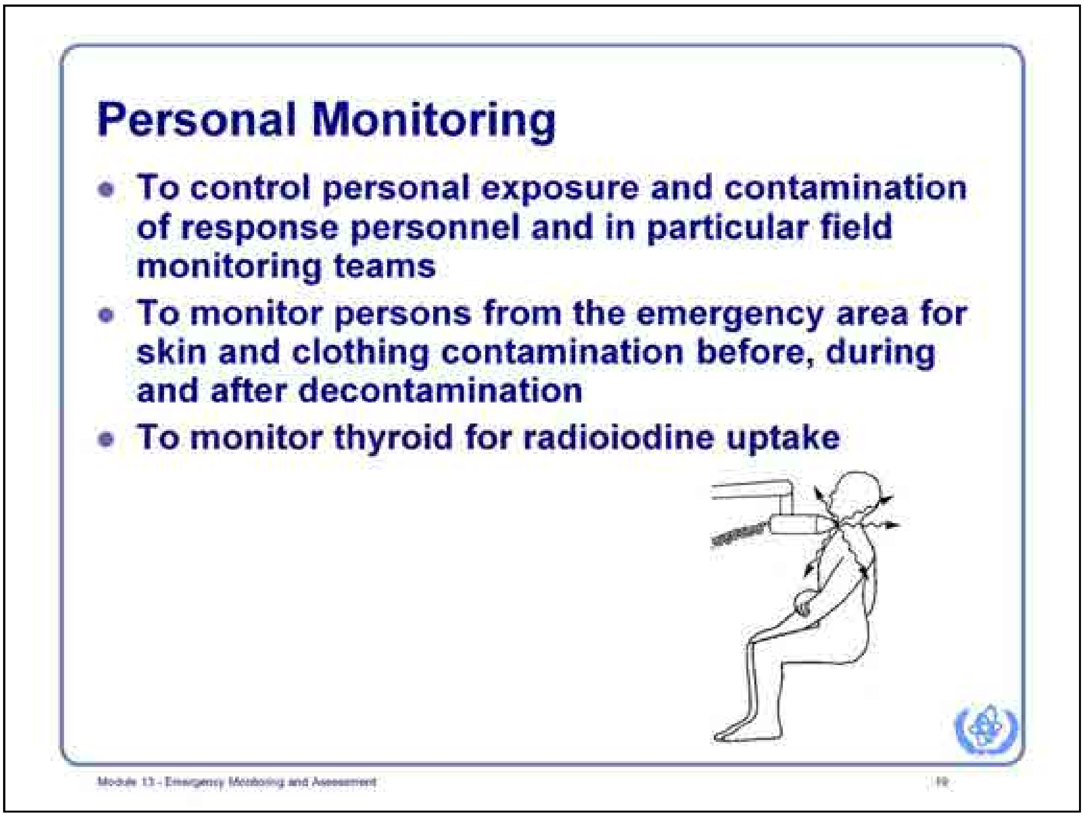
Ground survey: To conduct plume transverse/tracking and to identify plume boundaries by measuring ambient dose rates; to measure ambient dose rate from deposition; to provide information on contaminated areas, objects, tools, equipment and vehicles.

Personal monitoring: To control personal exposure and contamination of response personnel and in particular field monitoring teams; to monitor persons from the emergency area for skin and clothing contamination before, during and after decontamination; to monitor thyroid for radioiodine uptake.

Sampling and sample analysis: To determine concentrations of gamma emitters in air, soil, food, water, milk or in any other sample.

Consider the need for aerial survey. This would be unlikely for a research reactor except in the case of a core melt and release of a large reactor.

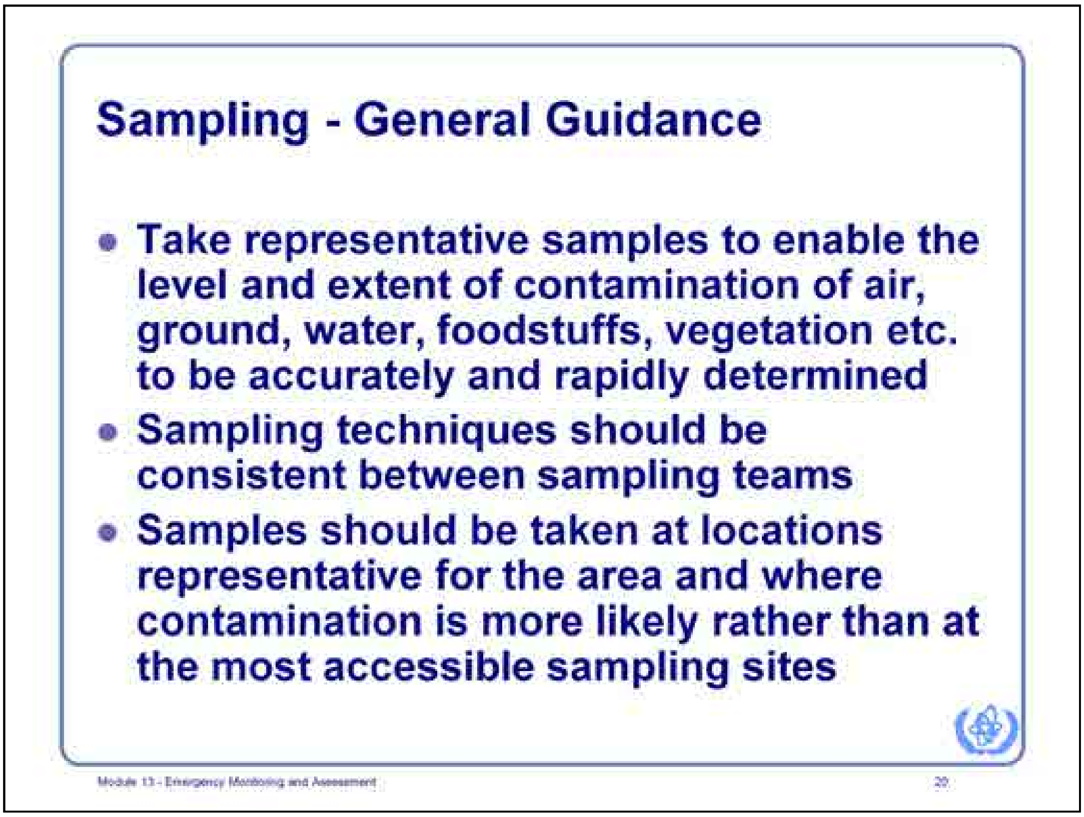
Photo: Measuring ambient dose rates - ground survey. The photo was taken in the Chernobyl Exclusion Zone.



Lecture notes:

It is important in responding to an emergency to avoid unnecessary exposure to response personnel, to record and control their exposure, to authorize their entry into high dose rate areas, to employ time, distance and shielding to protect emergency workers, to be aware of ambient dose rates where personnel are working and their accumulated doses and to work within pre-determined dose limits. Emergency personnel entering an emergency area where a spill or airborne release has occurred need to be checked on leaving the contaminated area for personal skin and protective clothing contamination. Their equipment and vehicles should also be checked. Also, persons working or living in the affected area may become contaminated and where this is suspected, they need to be monitored. This can be done in-situ or at designated contamination control or assembly points or on arrival at evacuation centres, where whole body surface contamination monitors are advantageous for rapid and sensitive personal contamination monitoring. Iodine taken in by inhalation or ingestion is concentrated in the thyroid gland where it is needed by the body as an essential part of its function. Radioiodines taken into the body therefore concentrate in the thyroid giving rise to a radiation dose which may lead to thyroid cancer in the longer term. If stable (non-radioactive) iodine is administered to the person prior to exposure or within the first few hours of exposure, it has the effect of blocking the thyroid (prophylaxis), reducing the uptake of radioiodine, which is then rapidly excreted from the body.

Photo: Improvised thyroid monitoring for radioiodine uptake during the Chernobyl accident.



Lecture notes:

Air sampling: Air samples can be assessed in-situ in the field and subsequently re-assessed in the laboratory to determine the radionuclide composition and concentrations. Air samples from the field can be categorized as low, medium or high activity prior to arrival at the laboratory to assist in priority analyses and also in determining how samples may be handled and processed. The results are used to estimate inhalation hazards and they can give some information for assessment of the potential for ground deposition.

Soil sampling: In the early phase, soil sampling and subsequent measurement of radionuclide concentration is an appropriate method for evaluation of levels of ground contamination due to dry or wet deposition. Ground contamination may vary significantly from place to place (hot spots); local dose rate averages are helpful in choosing a representative sampling location. Soil sampling is to be done after a release has ended and after plume passage; exposure to external radiation is possible but inhalation hazards may only be due to re-suspended materials.

Water sampling: The sources of drinking water are rather diverse (wells, surface water, precipitation, cisterns, distribution systems of a public drinking water). Collection of rainwater from a defined area may be used for ground deposition assessment. Since the sampling is supposed to be done after the end of a release and after plume passage, no significant inhalation hazard is to be expected.

See also next slide.

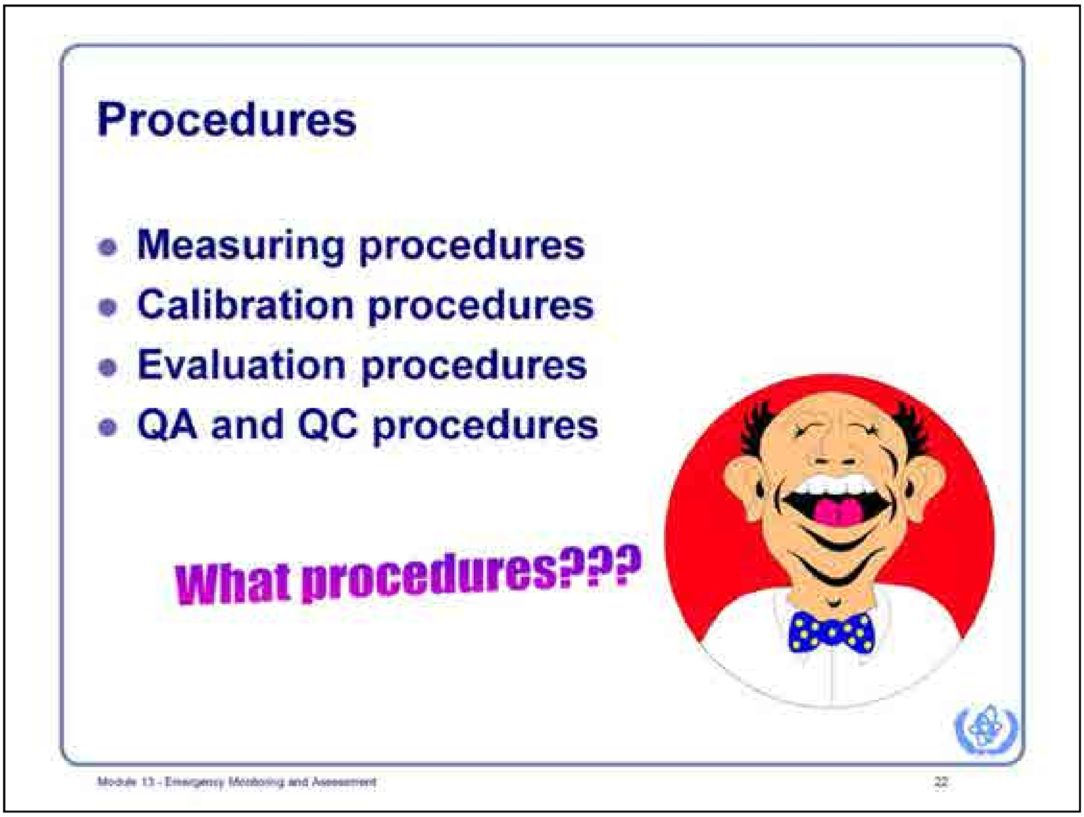
Lecture notes:

Quality Assurance (QA) involves all those planned and systematic actions necessary to provide adequate confidence that the emergency monitoring system, or component will perform satisfactorily and safely in service.

Quality Control (QC) which is included within QA, comprises all those actions necessary to control and verify the features and characteristics of equipment and measuring techniques used to specified requirements.

Audit/Appraisal is a planned and documented activity performed in accordance with procedures to determine, by examination and evaluation of objective evidence, the adequacy of and extent to which applicable elements of the QA programme have been developed, documented, and effectively implemented in accordance with specified requirements.

An important aspect of the QA system is written documentation - Quality Manual - where the policies, procedures, guidelines, and implementation practices with regard to its QA programme are presented. For the QA programme to be effective, corrective actions must always be taken when substandard results are detected, and subsequent follow-up audits must be made to verify that any problems have been solved.



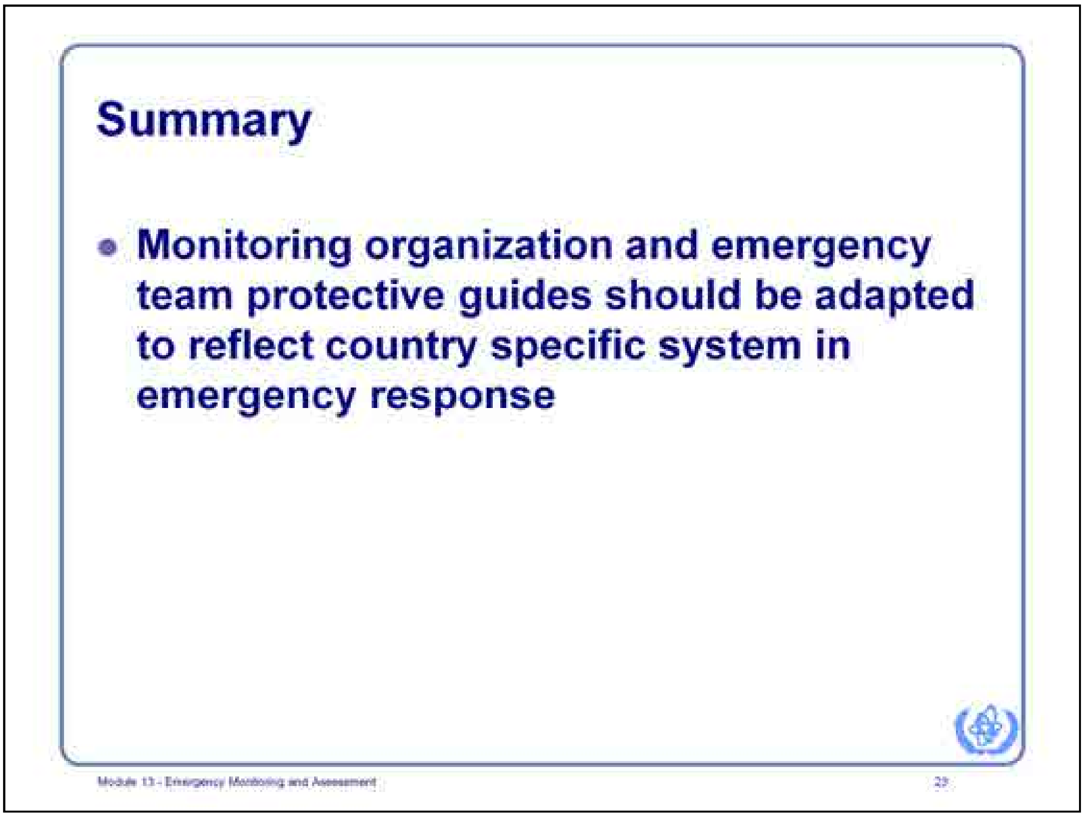
Lecture notes:

Develop procedures that cover all critical tasks. These procedures should provide detailed instructions and other required information. Technical procedures should use units that are consistent with the instruments used. Technical procedures common to several groups or used by several groups should use standard units.

Use a standard format for procedures, identifying each response position, date approved, and steps to be performed. The usability of the procedures should be confirmed during drills and exercises.

Establish a quality assurance process to control changes to procedures that may affect the plan or other procedures. Procedures and changes to procedures should not be implemented until the appropriate personnel are adequately trained. Develop and maintain a distribution list.

Conduct a regular quality assurance review of the procedures. Take into account lessons learned during drills and exercises.

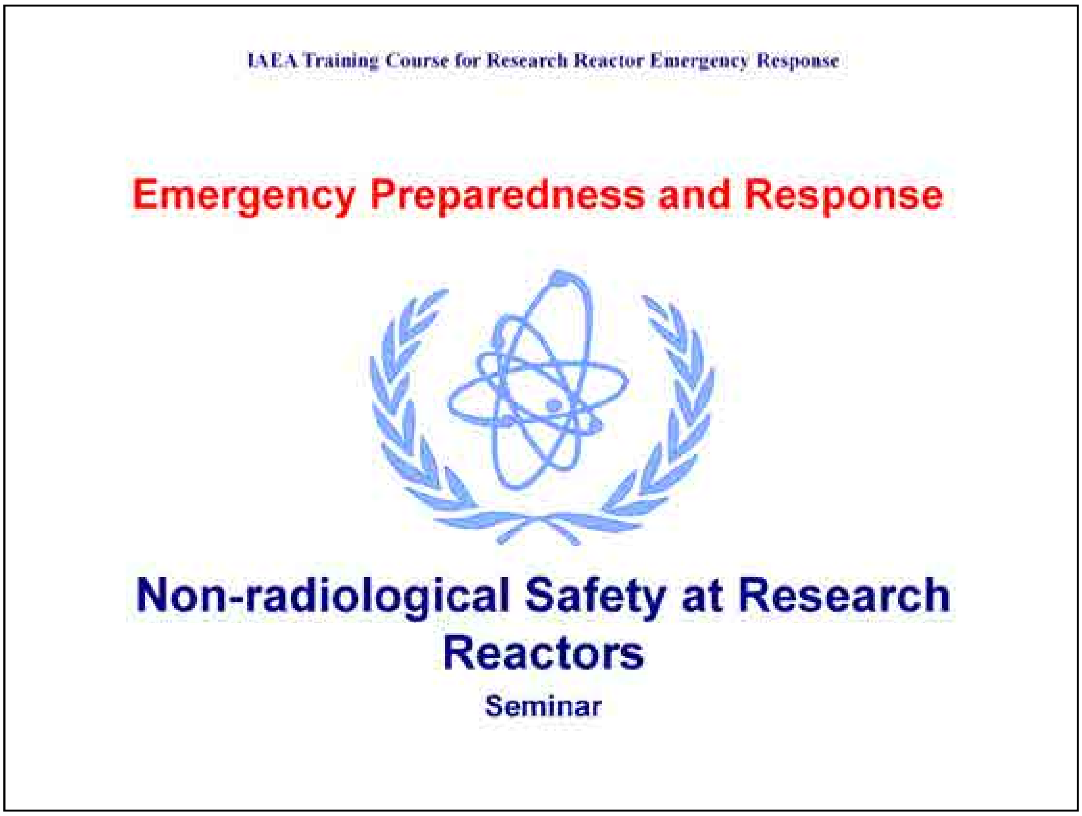


Lecture notes:

In this lesson we covered the following items: objectives of emergency monitoring, generic monitoring organization, emergency monitoring and sampling programmes, staff qualification, basic survey methods, mobile laboratories, aerial survey and finally quality assurance and quality control system regarding monitoring.

Where to Get More Information

- IAEA TECDOC-1092
- IAEA EPR-METHOD 2003
- IAEA EPR-RESEARCH REACTOR



Block 3: Emergency Preparedness and Response

Module 14: Non-radiological Safety at Research Reactors

Learning objectives: Upon completion of this module, the participants will:

- be aware of non-radiological safety issues at research reactors

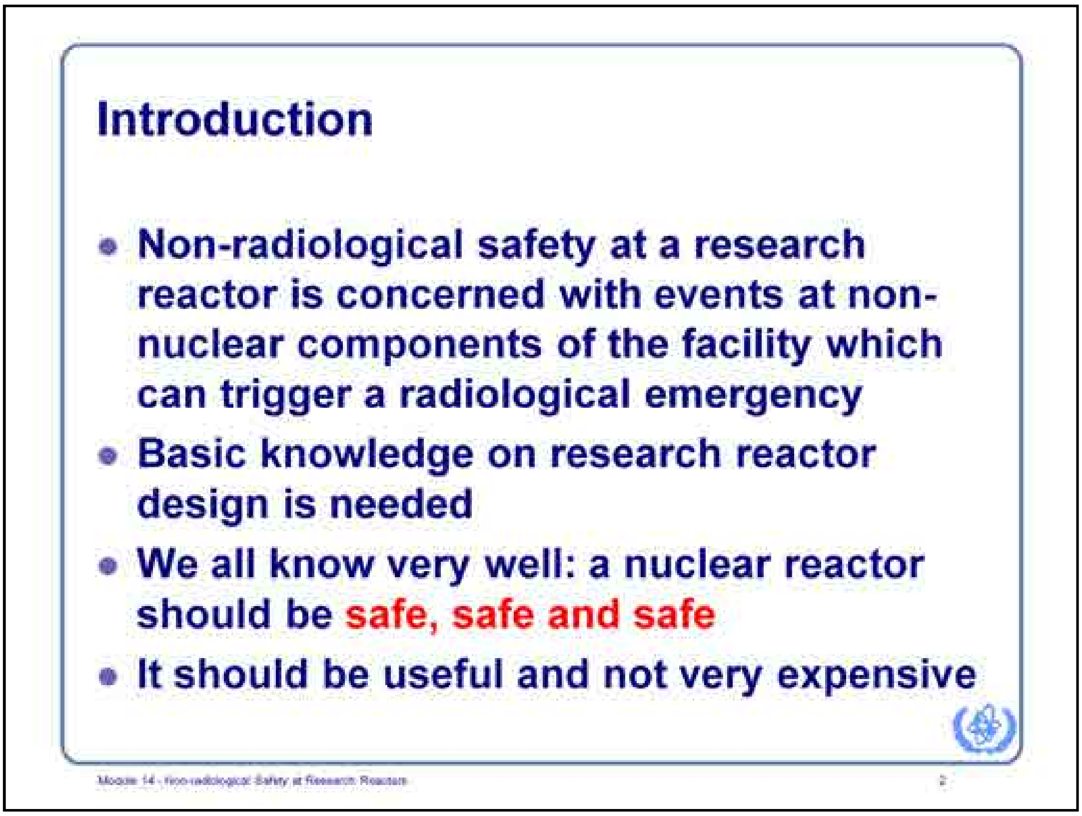
Activity: Seminar, questions and discussion

Duration: .5 hr

Materials and equipment needed: none

References:

1. INTERNATIONAL ATOMIC ENERGY AGENCY, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996)

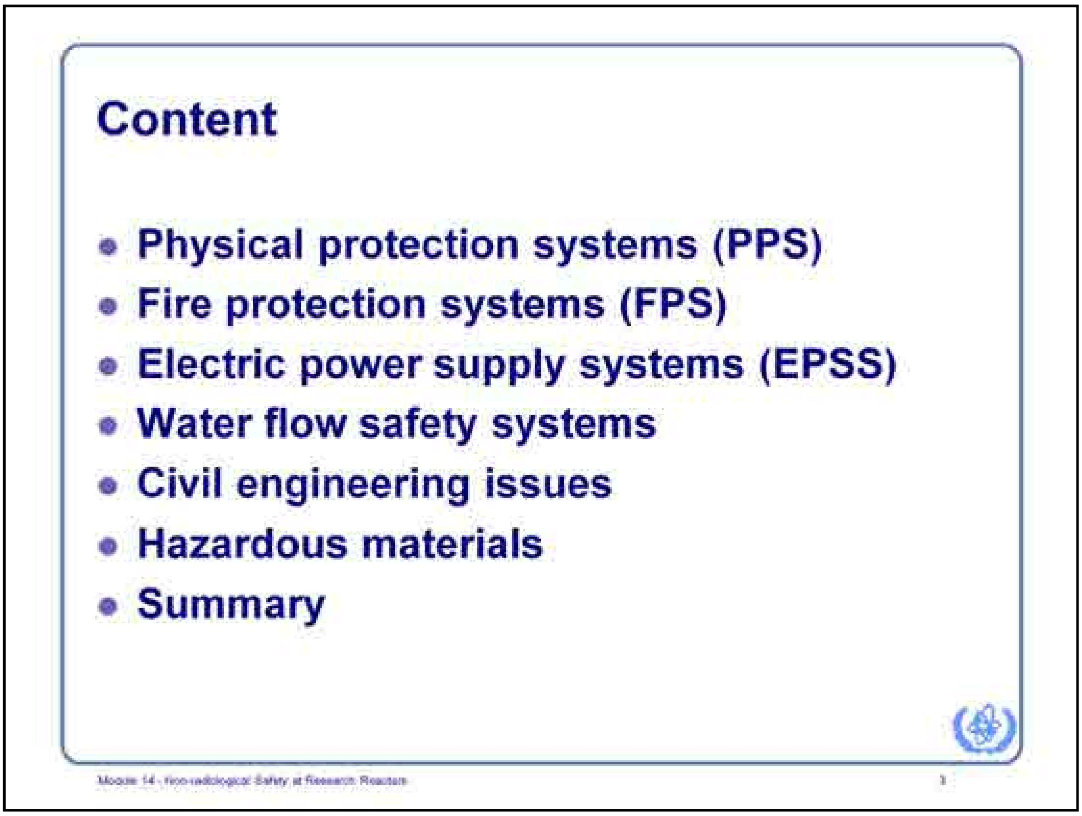


Lecture notes:

Research nuclear reactors are now an integral part of research, medicine, technology, education. Although safety issues, safety questions regarding to the potential accidents are not disappearing.

The potential hazard associated with a nuclear reactor accidents is quite large because of the large amount of radioactive fission products “stored” in a reactor.

We will examine the potential accidents that could lead to radiological consequences but which initiating events were out of radiological sensitive part of a reactor facility.



Lecture notes:

Those are the most important issues which do not concern directly the radiological aspects of a nuclear research reactor but which are integral part of a facility.

Safe operating of an electrical supply system for instance, is the fundamental condition of the safe operation of a nuclear reactor. There are the basic guidelines to design the electrical supply systems for the nuclear reactors.

Effectiveness of a physical protection system existing to protect a nuclear material and protect the facility to illicit use and to terrorize action is also inevitable part of a reactor facility because liberty is a fundamental human privilege. But it should not be forgotten that the liberty is for all then for malefactor too. We, the human beings, we must protect ourselves to malefactors.

Nuclear accidents are very rare but a fire can burst much more often if we are not sufficiently protected. A fire on a nuclear reactor facility can lead to dangerous radiological consequences.

Catastrophic cases with partial destruction in consequences, of the civil engineering structure of a nuclear reactor building by an explosion of a hazardous material or by a huge water flow or by an earth quake, if we are not reasonably protected, lead directly to an accident with radiological consequences.

Lecture notes:

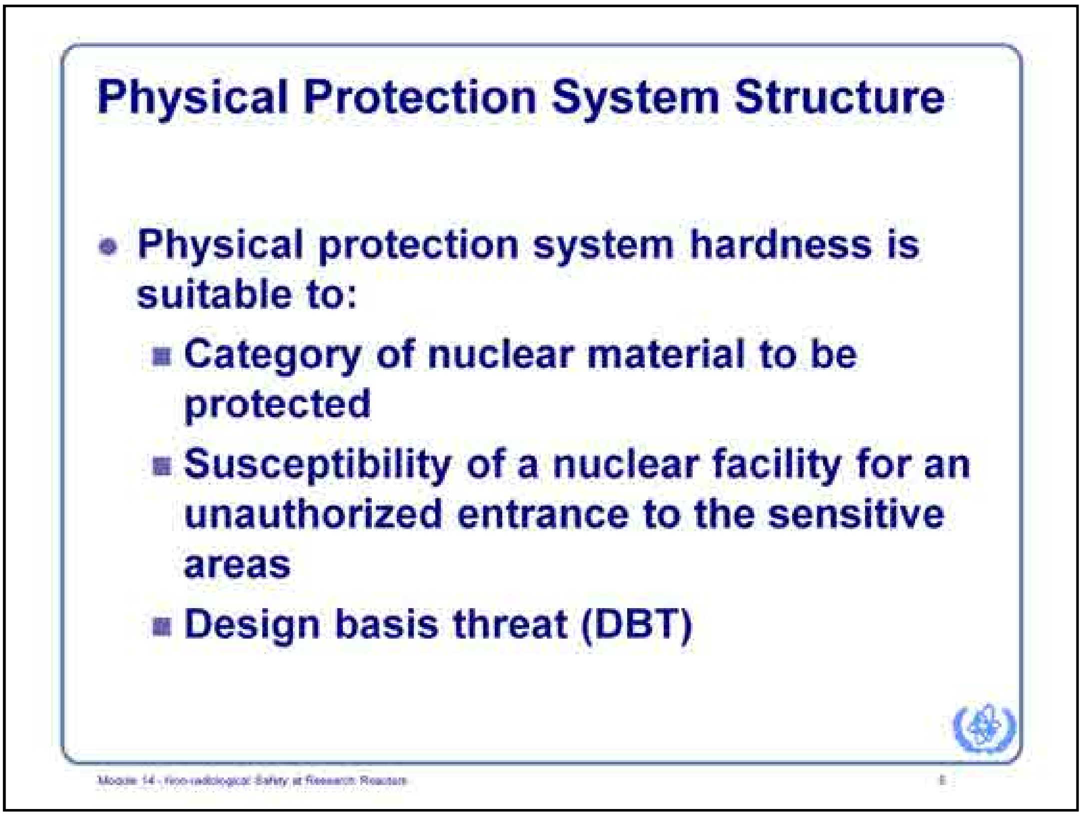
The physical protection hardness depends to category of nuclear material to be protected, defined in national nuclear safety rules, in international nuclear safety involved agencies recommendations, as well as in international conventions concern physical protection of nuclear materials and nuclear facilities.

Mentioned above, nuclear material category means, an usefulness of the material to construct a nuclear explosive facility.

Then, the nuclear material can be stolen to sell or to try construct an explosive charge.

A nuclear material out of control hurts the public security because it is unknown in what moment and in what place a threat of a nuclear explosion will be proclaimed.

It is known the existence of different groups of people and even organisations contesting uses of atomic energy at all. Not all of them use peaceful method to present their view. Some times the contestators are out of good manners and try to present their reasons by force. That is why a nuclear reactor facility must be protected and an access to the sensitive parts of the facility must be limited to the persons having special permission.



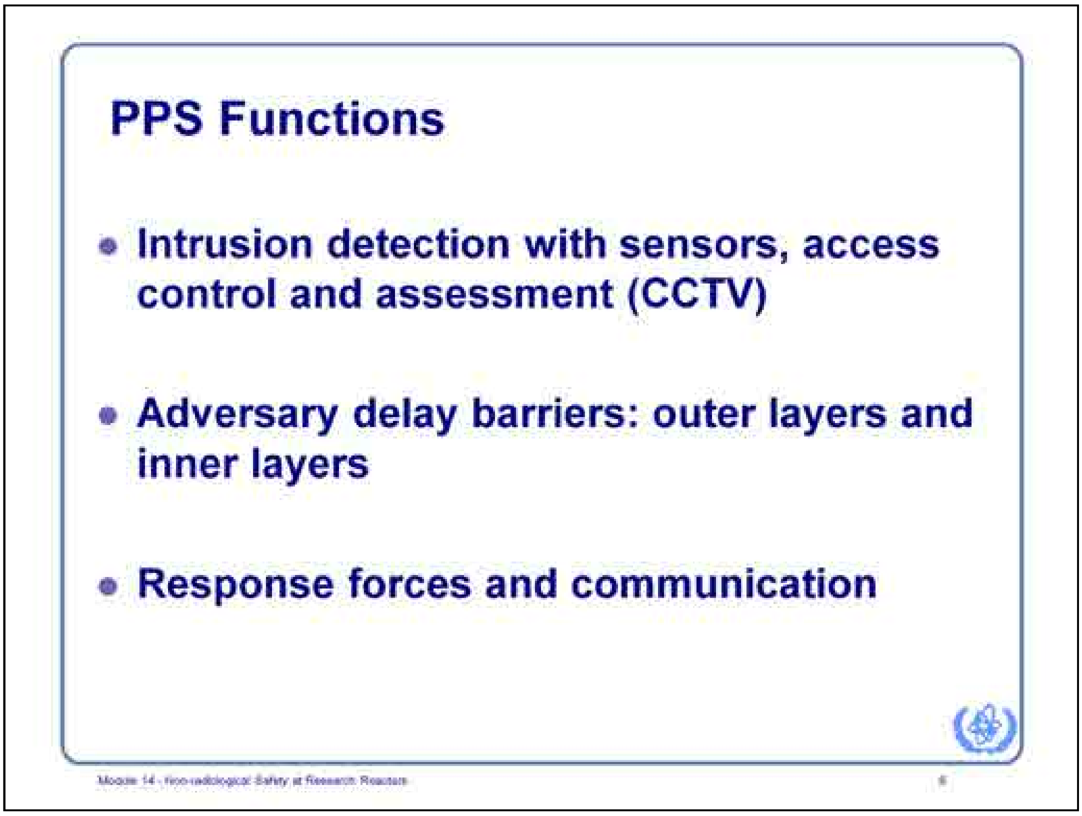
Lecture notes:

Physical protection system of a nuclear reactor facility is an answer for the question: „what to protect against whom". Namely the PPS structure is adequate to the reactor facility operation and condition, to the factors of potential adversaries i.e. a class of adversary, adversary's capabilities and range of adversary's tactics (DBT), to identified targets and attractively and desirability of the material.

The PPS structure consists of the best combination of fences, vaults, sensors and assessment devices, entry control devices, communication devices, procedures and protective forces personnel.

The PPS is, as a rule, structured in several layers. The concept of layered or in depth protection should be incorporated in the IAEA information circular (INFCIRC/225/Rev.4). The paper provides the general guidelines for the design of physical protection system it does not address analysis of cost and operational effectiveness that is why each reactor facility owner constructs the physical protection system, after the financial capability, in several stages of the system effectiveness.

The system improvement is carried out as a result of the design basis treat new assessment and formulation.



Lecture notes:

The PPS functions should be performed in the order within a length of time that is less than the time required for adversaries to complete their risk.

An effective PPS has several specific characteristics. A well designed system provides protection in depth, minimises the consequences of component failures and exhibits balanced protection.

The three functions should be fulfilled consistently i.e. the detection system is adequate to the delay barriers and to response forces capability.

Lecture notes:

Fire protection system (FPS) on a reactor facility is important to safety item of the reactor design. I is located so as to minimize, consistent with other safety requirements, the probabilities and effects of fires caused by external or internal events. The FPS is to have the capability for the reactor shutdown, core residual heat removal, confinement of radioactive material and make possible monitoring of the state of the research reactor facility shall be maintained. These requirements are achieved by suitable incorporation of redundant parts, diverse systems, physical separation and design for file-safe operation of safety important installation.

Lecture notes:

The objectives are realized concerning:

- nuclear safety
- occupant (emergency workers) safety
- economic losses

The analysis of the facility to fulfilling of the main objectives of the fire protection is carried out by assess all areas inside the facility done by fire protection specialist with background in the facility design, by assess specific areas with significant potential for radiological release, using more quantitative methods.

The analysis considered fire hazard, balanced air differentials, separate smoke ventilation, fire area isolation and smoke removal, filtering gases, fresh air inlet remote from exhaust air outlets, fire damper to be provided and equipped with thermal elements. There are interconnecting individual fire areas to be avoided.

Operational requirements are to have: a plan for smoke removal, to have portable smoke removal equipment, use portable air ducts to move smoke from fire areas.

And finally conduct training and training and training.

FPS Structure

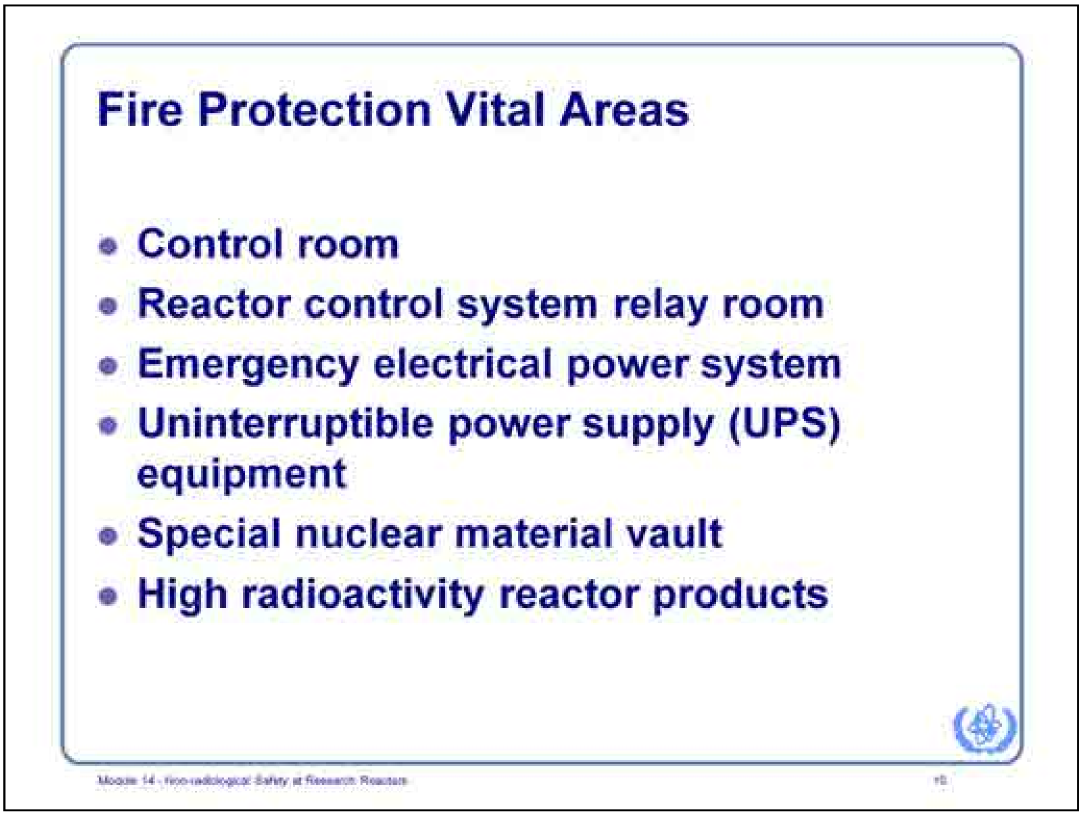
- Fire protection system consists of
  - Fire detection
  - Fire signalization
  - Extinguish installations and equipment
    - Stationary extinguish installation
    - Portable extinguish equipment
    - Auto-extinguish installation (sometimes)

Lecture notes:

A fire hazard analysis of the reactor facility is carried out to determine the necessary rating of the fire barriers. The analysis results the fire protection system structure then the reactor facility is provided with fire detection and fire fighting systems of the necessary capability.

Sometimes, the analysis shows that an automatically initiated fire fighting systems are indispensable. That systems are designed and located so as to ensure that their rupture or spurious or inadvertent operation does not significantly impair the capability of installations important to safety, and does not simultaneously affect redundant safety groups, thereby rendering ineffective the measures taken to comply with the “single failure” criterion which means that no single failure can result in a loss of capability of a system to perform its safety function.

In such locations as the reactor building and the control room, non-combustible or fire retardant and heat resistant materials are obviously mused.



Lecture notes:

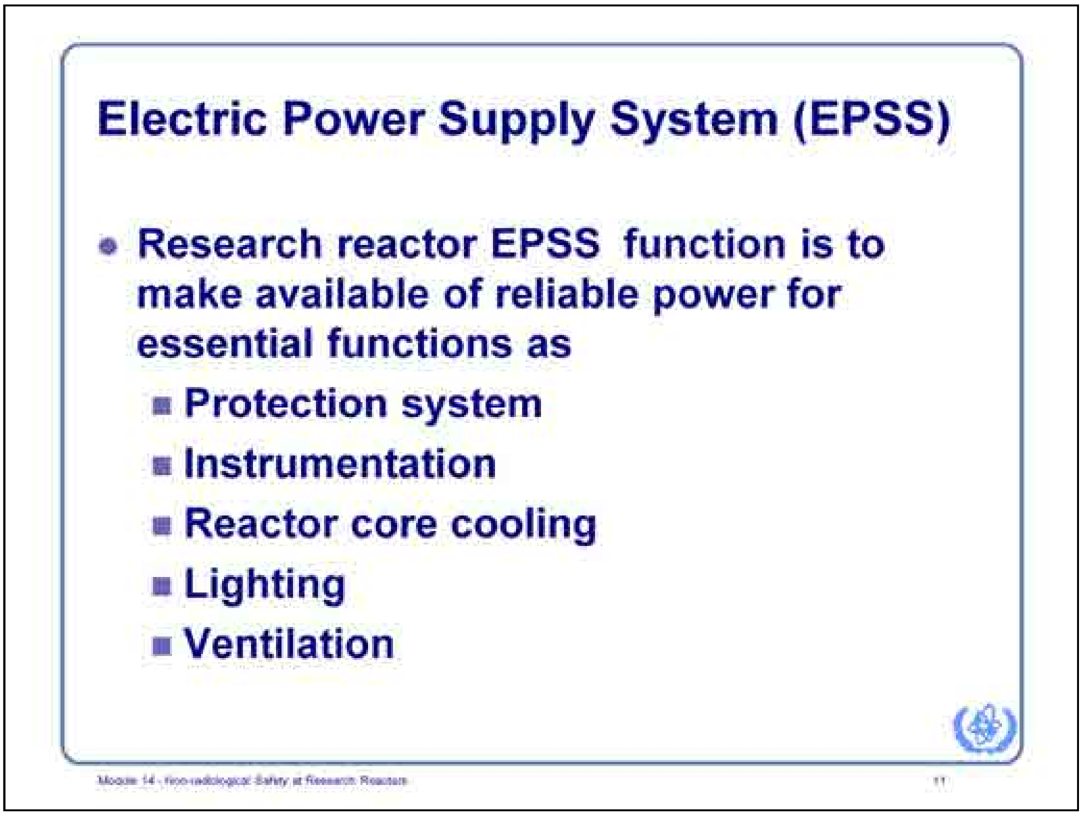
It is not possible to name every vital for safety areas which should be considered particularly from the fire protection point of view.

Variety of research reactor facilities requires to list the vital areas for every one separately.

Nevertheless it is evident that the control room(s), relay room(s), as the integral parts of safety and control of the rector systems, as well as emergency electrical power systems should be always treated as very important to support any reactor in safe state.

A special nuclear material vault i.e. storage of the fresh nuclear fuel is the very special room. The contents of the storage, very valuable and expensive can not be evacuated before arrangement the physical protection meeting the requirements to the nuclear material category and the local treat conditions.

On the research reactors used as the neutron sources to radioisotope production, especially high neutron flux reactors, there are the areas or rooms in which the high activity radiation sources are collected and stored temporarily. As a rule the radiation sources are kept in lead containers (named lead castles), because of lead high effectiveness to the radiation shielding. It is well known that lead is a fusible metal, that is why it should be obviously cooled if the fire is in the proximity of the lead containers. In case the container with high activity sources melt, the neighborhood of the sources is inaccessible to fire attenuation action (see the special remarks in the next slide).

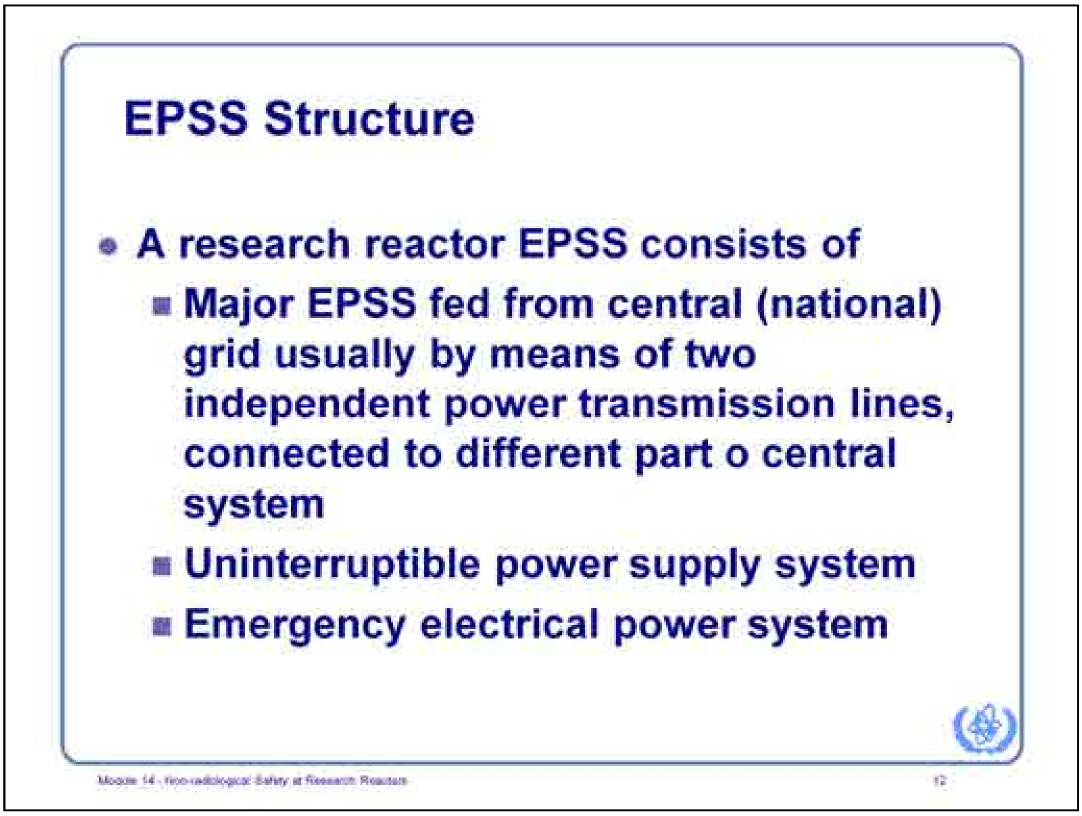


Lecture notes:

The electrical power supply system on research reactor is to provide enough power of suitable quality to systems and equipment in order to ensure their capability to perform their safety functions when required. This is the basis for the design of normal and emergency electrical power supply system.

A consideration is given to the need for an interruptible power supply (UPS).

When on a research reactor facility, emergency electrical power is required for coolant circulating pumps, emergency ventilation system of other systems important to safety, an emergency electrical power system is provided with sufficient reliability to provide assurance of its continued availability.



Lecture notes:

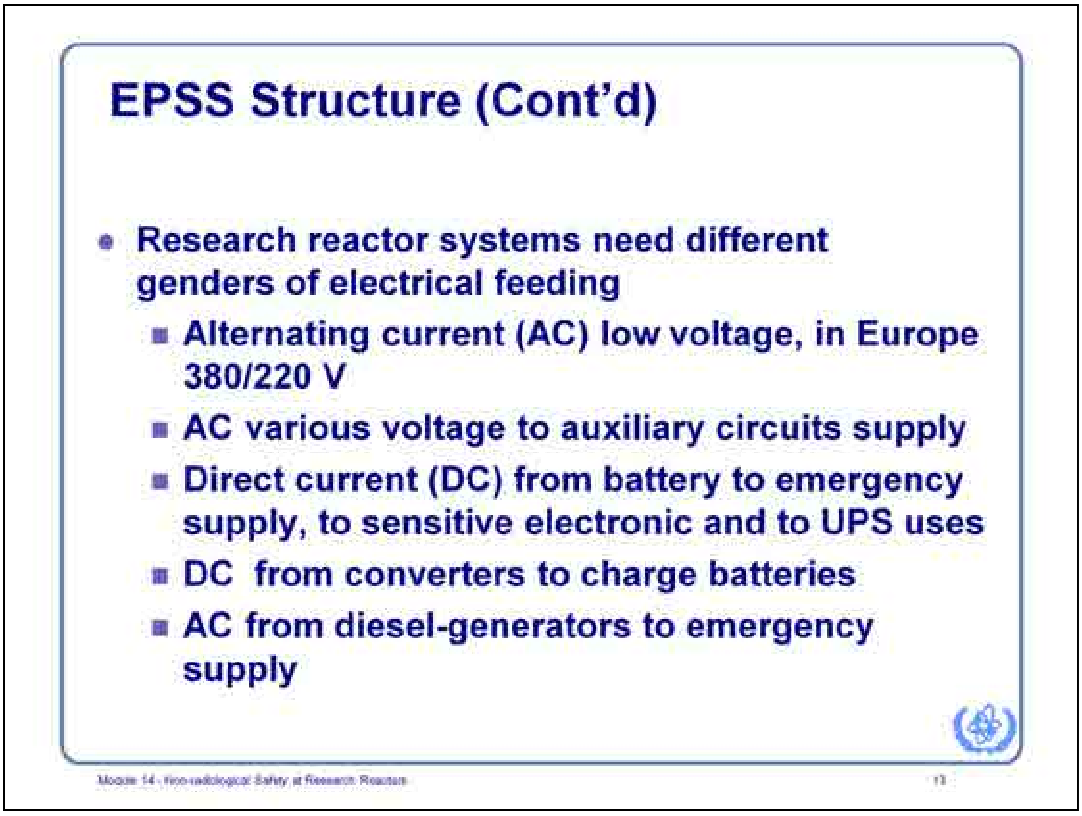
There are two reasons to design and construct a special electric supply system to a research reactor.

The first is the nuclear safety issues which need the reliable electric supply system to operate.

If a research reactor is a neutron source (or high neutron flux), the nuclear safety issues are strictly connected with the core cooling at the time the reactor is under operation and a certain time after shut-down to carry away the residual heat. Thus, the electrical power is required to supply the coolant circulating pumps after reactor shut-down resulted by the main electric power supply system is cut-off.

The second reason is the reactor operation reliability. It is well known that the medium and high flux reactor after its shut-down starts to be poisoned by xenon 135 generated in the nuclear fuel as a result of the nuclear decay of iodine 135, an uranium fission product, collected in the fuel during the reactor operation. The phenomena causes that after the reactor shut-down as a result of an electric supply cut-off for some short while (e.g. atmospheric discharge) the reactor operator has no lot of time to start-up reactor again. If he has no time to manage to do the start-up of the reactor in the short time he will have to wait with the start-up a couple of days.

That is why the specially designed electric supply system is needed for the reactor reliable operation.. The time of the self-acting switch-on is important to strictly adjust.



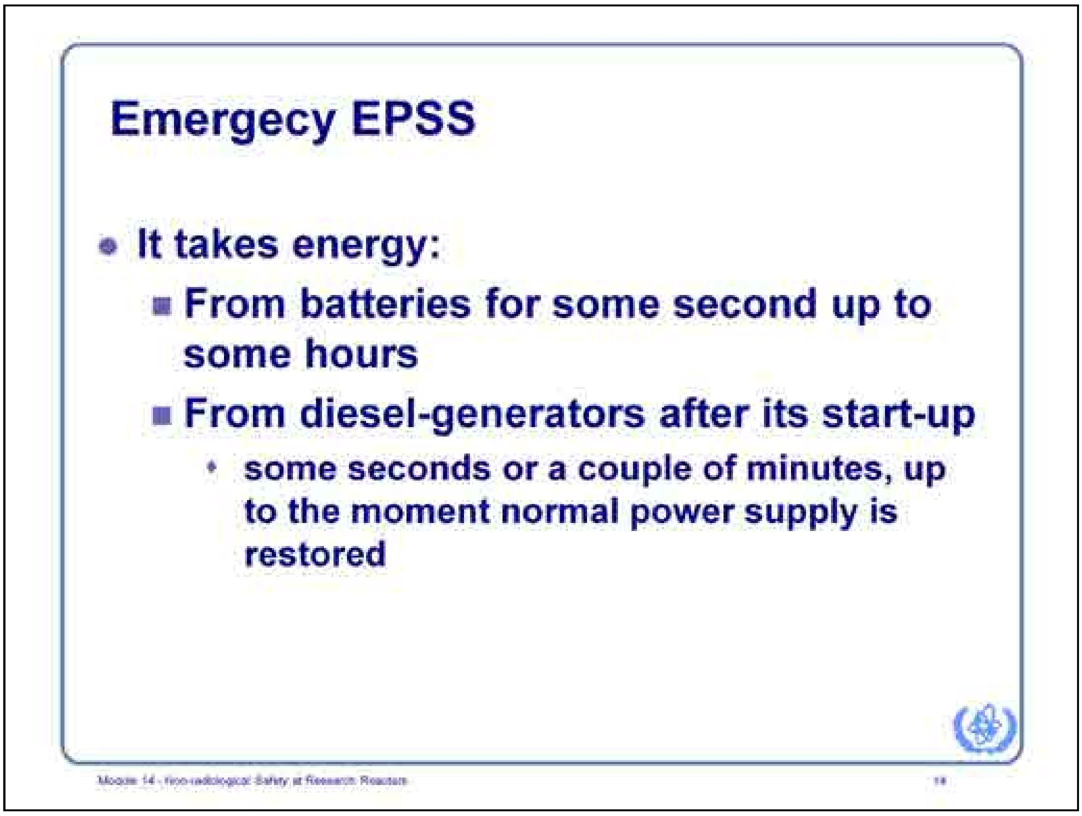
Lecture notes:

Diversity of a research reactor systems needs different electric power supply sources.

The main is a regular but specially reliable electric power grid, as a rule national electro-energy network from which, after the transformations, the reactor facility is fed. It means that the grid electrical energy from standard low voltage 220/380 V is transformed into lower or higher voltage and from alternating current (AC) into direct current (DC) needed voltages. First of all the DC is needed to charge batteries as emergency sources of energy for the time when the grid is cut-off. Then the facility auxiliary installations fit to the voltages and power limits to the facility needs. But this energy source is available when the grid is efficient.

Otherwise, an emergency electrical power system must operate fed by energy from the batteries until their discharge.

Before this the diesel-generators are put into operation. Sometimes the diesel-generators start automatically using energy from a flywheels, turned by electrometers fed by the grid. Kinetic energy of the flywheel put the diesel-motor into operation and the electric generator turned by the diesel-motor feeds the electric emergency system.



Lecture notes:

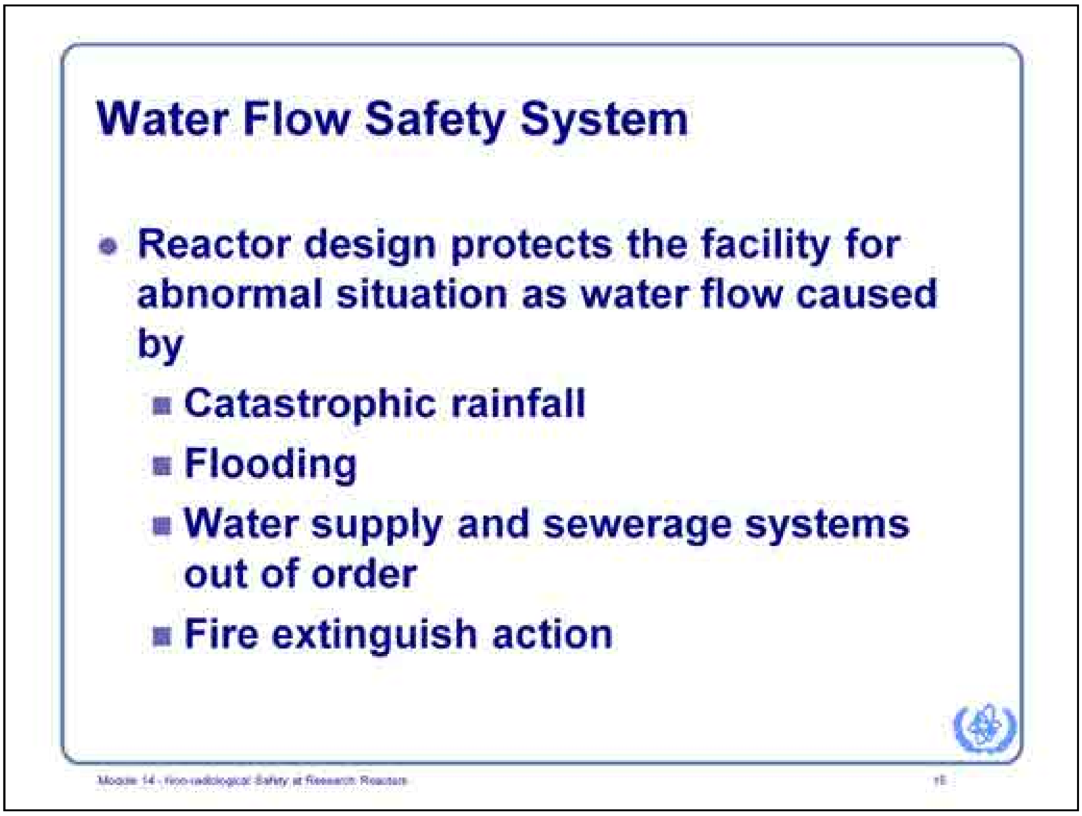
Reliable operation of the research reactor electric emergency system which guaranties the nuclear safety on the facility needs the strict harmonization between the normal and emergency systems.

The problem can be difficult. For instance the running light diesel-generator do not wont to take charge and electric emergency system is left non fed. What to do ? Switch-on the the generator charge again but on lower power, e.g. light only, and after that increase the charge. When the emergency system fed by batteries is put into use automatically at the moment of the grid cut-off it can not take the charge because of the batteries state which were not maintained properly. In that case the second battery should be put into use, if it is not possible, the diesel-generator should be quickly put into operation.

The time in which the reactor systems can be left without electric supply depends the thermal and hydraulic parameters analysis result of the reactor core. If it is excluded to leave the core without the cooling circulation some circulating pumps should be fed always in uninterruptible system (UPS), from batteries charged continuously by the grid energy in buffering system.

The emergency electric power supply system is a safety sensitive auxiliary installation, then it should be regularly tested, i.e. before every reactor start-up.

Nuclear safety requirements, expressed in national rules and international recommendation, named limits and conditions, impose to the reactor operator obligation to have the possibility the reactor shut-down an kept subcritical and controlled in every condition normal, abnormal even catastrophic. To fulfill the requirement there is needed an electric supply in any condition. It is needed an emergency electrical power system.

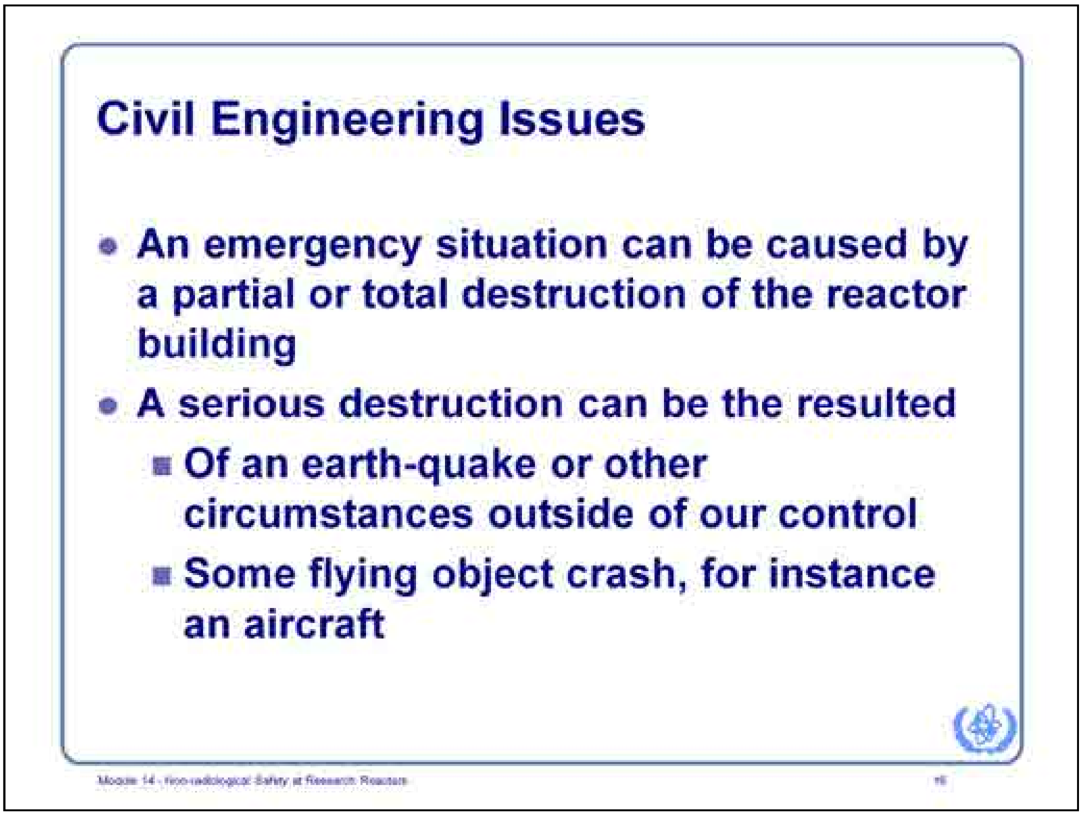


Lecture notes:

The main safety objective in the siting of a research reactor is the protection of the public and environment against the radiological impact of normal and accidental releases of radioactive material. The safety analysis based on collected site information demonstrate that the research reactor facility can be safely operated at the chosen site.

For many low power reactors, which present very limited hazard potential (e.g. critical assemblies and low power research reactors), the amount of detail considered in safety analysis report (SAR) can be substantially reduced below that which is required for a medium or high power reactor. In the evaluation of the suitability of a particular site for a research reactor, the characteristics which may affect the safety aspects of the research reactor are investigated and assessed.These characteristics include those related to the natural environment as well as those related to human activities at the site and its vicinity. It include geology and seismology, hydrology, meteorology, present and projected. The site related phenomena and their characteristics include external events of both natural and man induced origin. The severity of external events with more than negligible probability of occurrence were be used to determine the design basis events for important natural phenomena and man induced induced events. The location characteristics considered to the research reactor include dams, diversion channels and any flood control measures. Consequences of a possible rupture of dams or dikes in the area are also considered.

It is essential to know the mitigation program for the water flow accident developed in the emergency plan for the research reactor.



Lecture notes:

Any destruction of a research reactor building is classified as a beyond design basis accident, because of low probability to take place. Then the facility is not technically protected against that accident. The accidents with reactor building damage are then taken into account in the emergency plans for the reactor facility. The reactor buildings are designed and constructed having in mind the local requirements applied to the specially important edifice, with consideration of tectonic and climatic circumstances. The geographic siting of the reactor facility is also important to the building damage treat. If the reactor site is away of a sea coat a tsunami should not be considered. The same remark considers to the reactor siting if it is away to the rivers and dams.

Some flying object crash treat, in fact concerns aircrafts. It is essential to make the strict interdiction of aircrafts flight over the reactor siting. It should concern a circle of about 1500 m in radius and about 1500 m in altitude. Any violation of the interdiction should be recorded and the authority of air traffic control and surveillance should be notified. For that purpose some person turning duty on site where a reactor is located should be responsible to record the possible violation of the flight interdiction over the reactor site.

Lecture notes:

The research reactor building structures are, as a rule, sufficiently strong and design terms consider the normal climatic phenomena characteristic for the region of the reactor siting. In the design of any reactor building a reserve of the building structure resistance is taken into account. It would be too expensive to construct the buildings resistant to the atmospheric phenomena which can cause with very low probability. The accidents resulted by a hurricane winds or by a tornado, if the geographic region indicates on such a necessity, are analyzed in the emergency plans for the reactor facility. Those are the external events, "*vis major'*, on which the reactor operator can do nothing.

To carry the normal research reactor maintenance, the reactor operator has the workshop with the instruments to weld in which there are the the explosive gas cylinder fulfilled with flammable and explosive gas as hydrogen or acetylene on high pressure. If the the sufficient safety measure are not undertaken in the procedure of the welding using the gases, it can be caused an extraordinary event with an explosion of the pressurized gas cylinder. For this reason the gas welding workshop should be located outside of the reactor building, on the fresh air, never inside of the building.

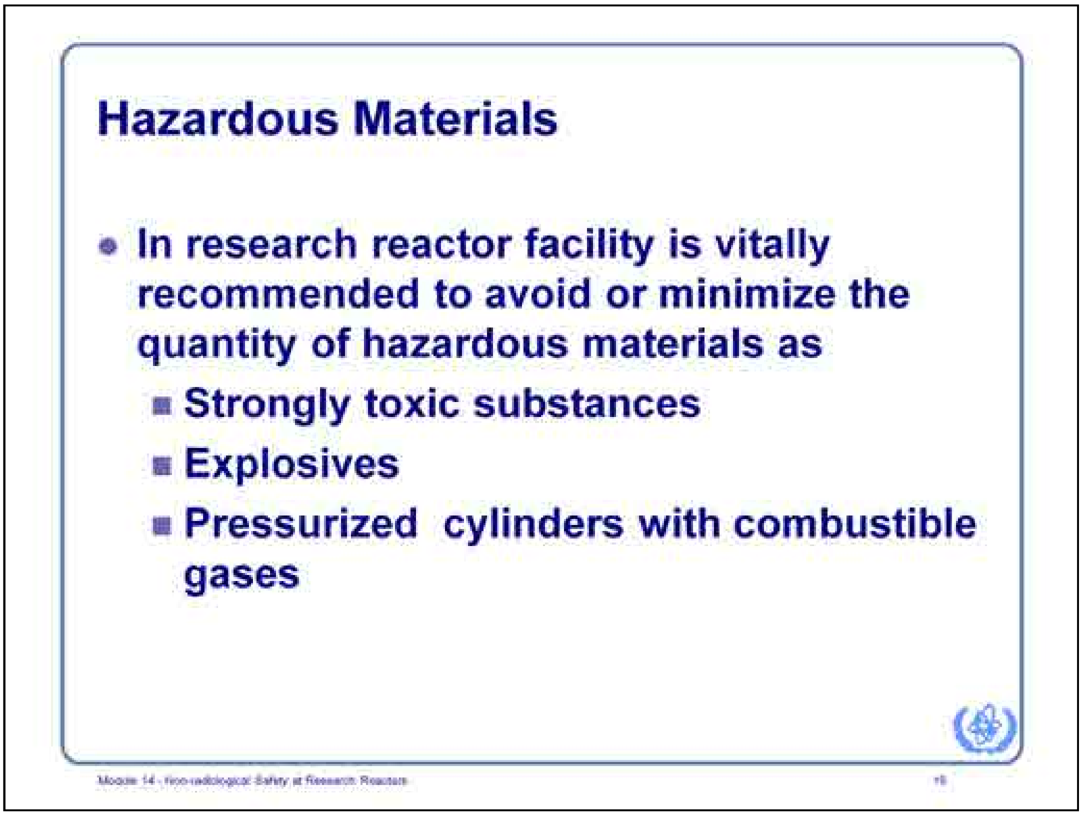
To protect the reactor facility against a missile attack the reactor operator can only believe that the national security forces are able to protect the reactor facility to such an attack and accident.

Lecture notes:

In the protection measure against the emergency event witch can have the place with such a low probability, the reactor owner can not put themselves into exaggeration, because it is very expensive.

That is why, if the reactor building structure has the sufficiently solid construction the reactor operator should obviously systematically check the possibility of the reactor safely shut-down in every situation even if the reactor building structure is damaged in result of a catastrophic destruction.

In the emergency plan for the reactor facility it should be foreseen, step by step, what to do if the reactor building is damaged as a result of some nature catastrophic phenomena.



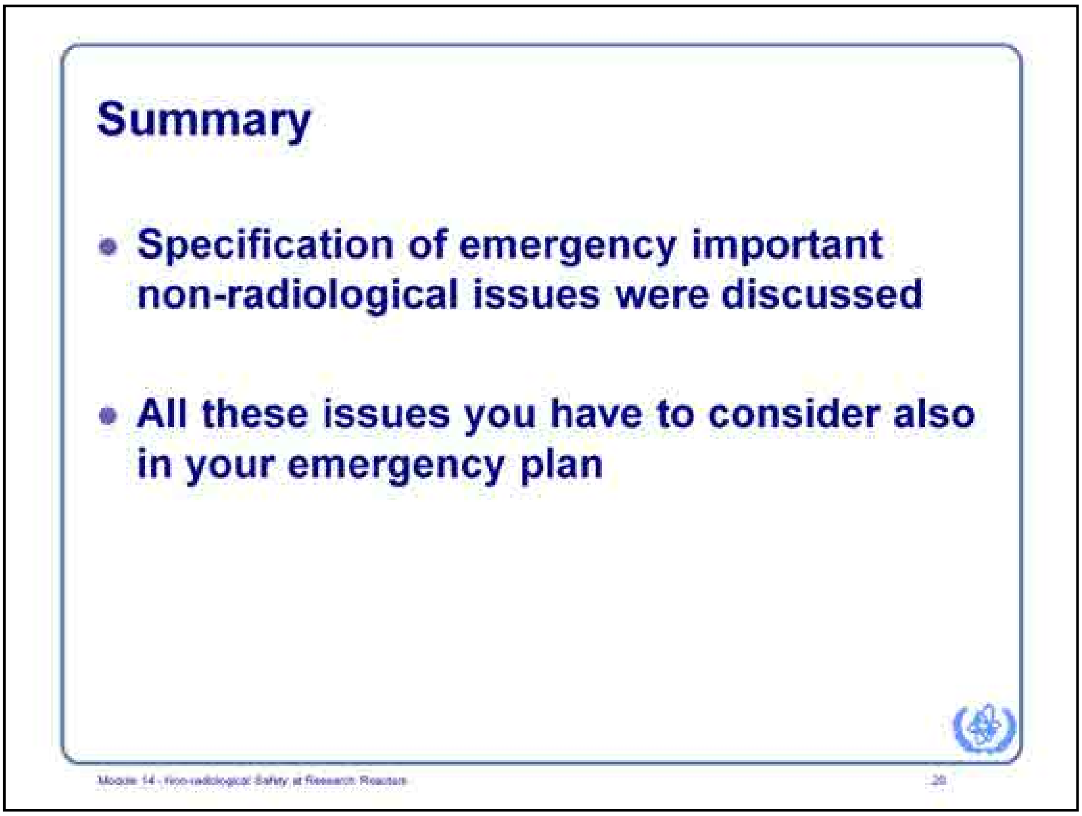
Lecture notes:

To minimize the probability of the unhappy events on a reactor facility it should be minimize the chance of the events of release to the interiors of the reactor building toxic substances as chlorine, ammonia, nitric oxide. The mentioned gases, after release, can be easily propagate in the reactor building rooms, and the reactor operators and users can be paralyzed with dangerous consequences. In this case a medical intervention and treatment is indispensable. The reactor can be take away the operators which ca safely shut-down the reactor.

To avoid such an unhappy event it is strongly advised to avoid the toxic substances keeping and processing in the reactor building laboratory rooms. If it is necessary it should by done outdoor.

Explosives are prohibited in the reactor areas. If it was smuggled by a malefactor it meant that the physical protection system and procedures were insufficient and the fact is a transgression and should be prosecutes.

The pressurized gas cylinders can expose only in case of a fire or if they are on insufficient technical state. For that reason the flammable gas cylinders should be obviously located in outdoor.

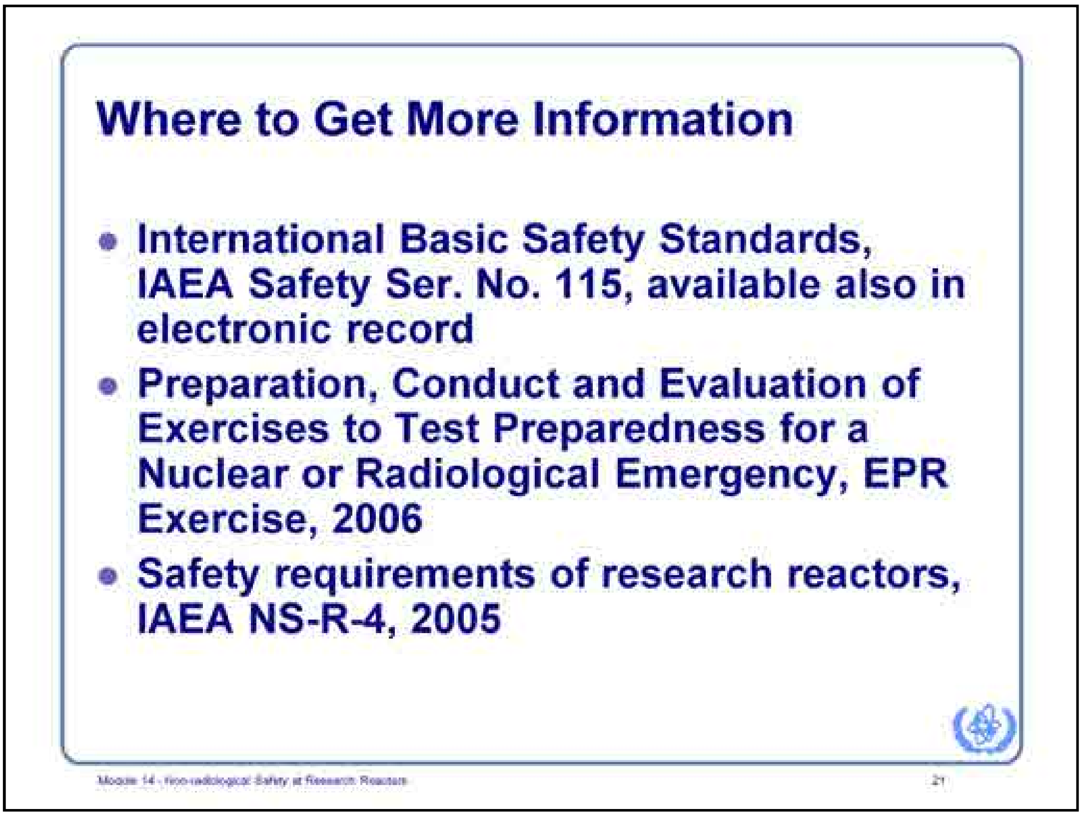


Lecture notes:

Let's summarize the main subjects we did cover in this session.

We have got in touch the main subject of the non-radiological issues in which an improper operation can lead to a radiological emergencies:

- Physical protection systems which concern the security of the special nuclear material and the facility as wee as the reactor personnel
- Fire protection systems part describes the protection against the fire on the research reactor facility; The fire protection system effectiveness should be systematically checked by drills
- Electric power supply systems have the essential significance to the reactor safety; Particular significance, from the emergency preparedness of the reactor have the the uninterruptible electric supply and the emergency supply systems
- Water flow safety system importance depends strongly the site of the reactor; It should be more sophisticated if on the reactor site is more risk to a flood
- In civil engineering emergency events are scare, but its importance for the nuclear safety makes indispensable not to forget them in the reactor facility emergency planning
- The same concerns the hazardous materials which can be, sometimes, dangerous to the research reactor and can disturb the research reactor safety.



Questions:

1. What the physical protection system is to protect ?
2. What are the physical protection systems fundamentals ?
3. Name the targets to be protected on a research reactor facility.
4. What was happened if the special nuclear material has been stolen ?
5. What is the standard composition of a research reactor fire protection systems ?
6. What are the most sensitive issues during the fire extinguish action on a research reactor facility ?
7. What any nuclear reactor should be equipped with an emergency electric supply system for ?
8. How the structure of the electric supply systems of the research reactor depend of the reactor nominal thermal power ?
9. How the research reactor safety sensitive areas are prepared to possible water flood ?
10. How the water flood preparedness of the reactor facility depends of the facility site ?

Block 4: Development of a Response Capability

Module 15: Developing Emergency Response Capability – Step-by-step Process

Learning objectives: Upon completion of this module, the participants will:

- know that developing a national capability requires a systematic approach
- become aware that EPR-METHOD 2003 recommends a ten-step process
- know that this process is modular, requires extensive consultation with all relevant organizations and that it is iterative
- understand the main elements of the ten-step process and considerations in their implementation
- know the objective of writing a plan
- know the importance of structuring the plan for future revisions
- know the principal components of a national plan

Activity: Seminar, questions and discussion

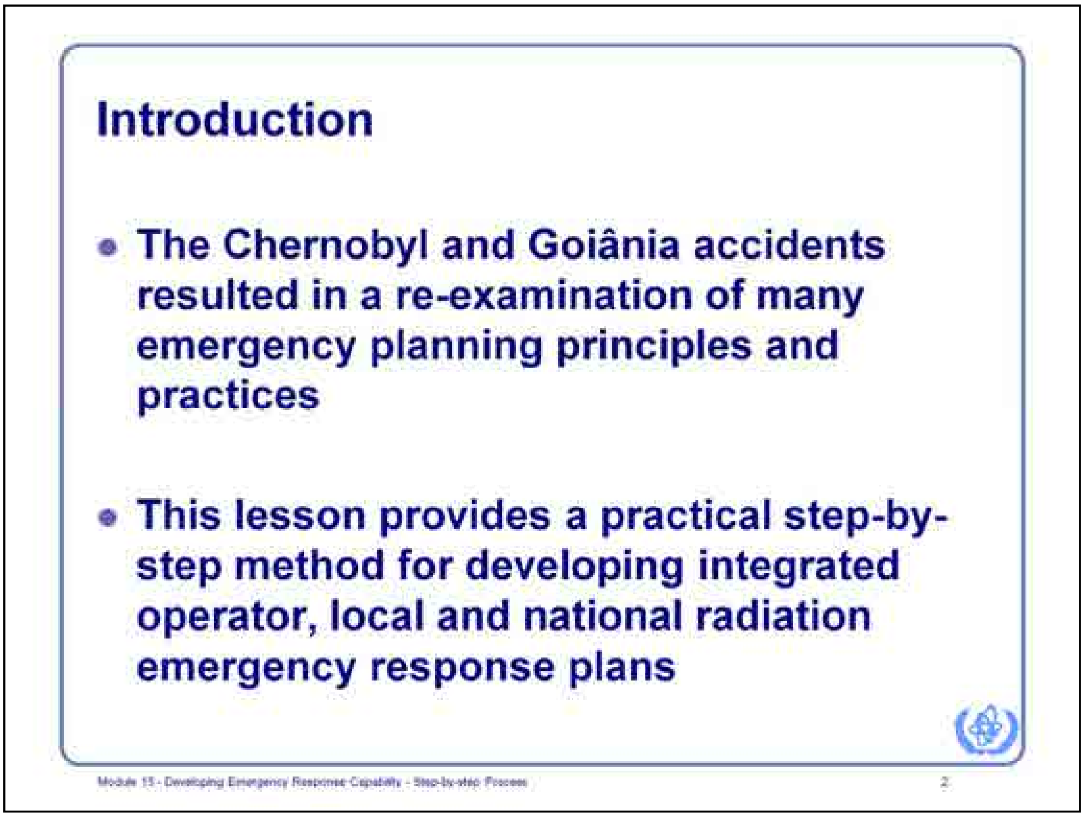
Duration: 1 hr

Materials and equipment needed: none

References:

1. INTERNATIONAL ATOMIC ENERGY AGENCY, Preparedness and Response for a Nuclear or Radiological Emergency, Safety Standards Series No. GS-R-2, IAEA, Vienna (2003)
2. INTERNATIONAL ATOMIC ENERGY AGENCY, Arrangements for Preparedness for a Nuclear or Radiological Emergency, Safety Standards Series No. GS-G-2.1, IAEA, Vienna (2003)
3. INTERNATIONAL ATOMIC ENERGY AGENCY, Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency, EPR-METHOD 2003, IAEA, Vienna (2003)
4. INTERNATIONAL ATOMIC ENERGY AGENCY, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency, Safety Standards Series

No. GSG-2, IAEA, Vienna (in preparation)



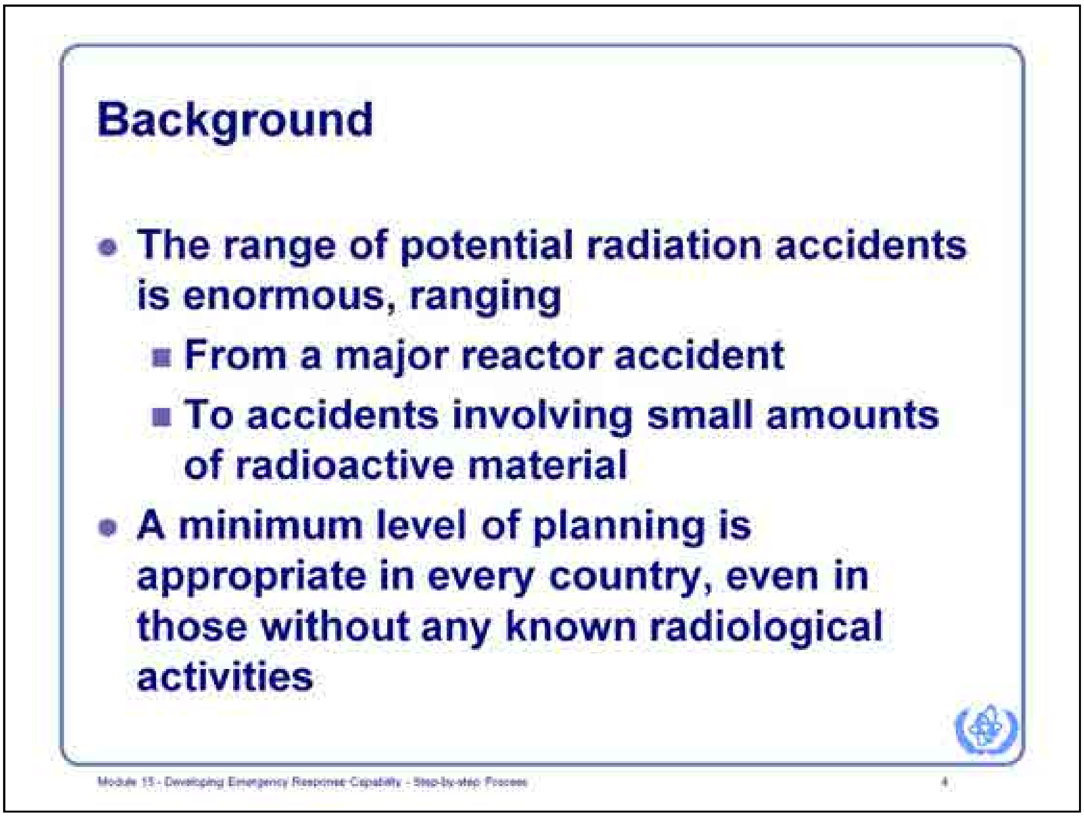
Lecture notes:

The Chernobyl and Goiânia accidents resulted in a re-examination of many emergency planning principles and practices. The basic obligations, responsibilities and requirements for emergency situations are established in the "International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Draft Safety Requirements DS379, January 2010”. Guidance on the radiation protection criteria for use in planning for response to radiation emergencies is provided in "DS-44, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency, (DRAFT)”

This lesson concerns emergency planning for radiation emergencies. It provides a practical step-by-step method for developing integrated operator, local and national radiation emergency response plans.We will use the term “radiation emergency” as a common term for nuclear and/or radiological emergency.

Lecture notes:

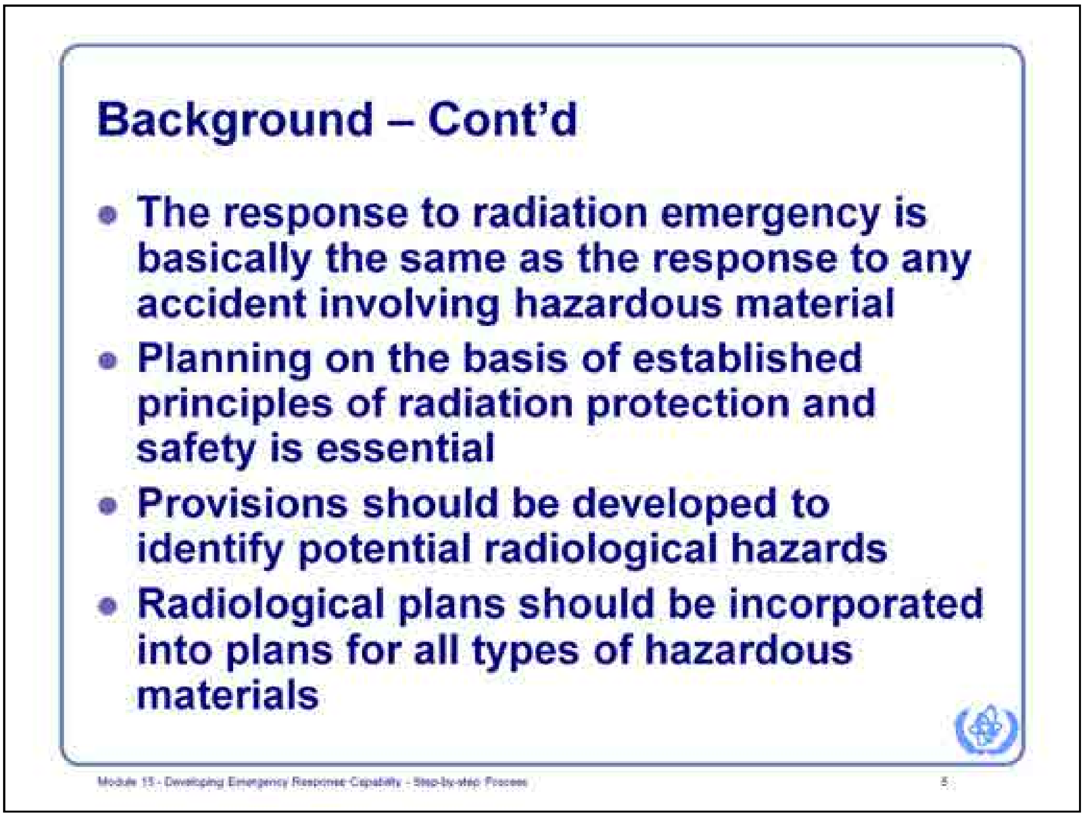
We will start the lesson with basic concepts and information we need before the planning process can begin: threat categories and threat assessment, planning areas and zones, planning levels and responsibilities, and emergency classes and conditions. After discussing integrated planning concept we will introduce planning methodology, a practical step-by-step approach for developing integrated radiation emergency response capability. There are ten tasks to develop and implement emergency response plans and all ten will be explained. At the end we will summarize the key points.



Lecture notes:

Planning for radiation emergencies has often been performed in isolation without the full involvement of the other organisations within the country responsible for response to conventional emergencies such as fires, floods, or storms. However, these organisations will play a crucial role during a radiation emergency. In addition the emergency may involve criminal activity such as terrorism. In this case the emergency response must be coordinated with the criminal investigation and possible response if the criminal activity is ongoing. Many emergency plans do not consider this possibility. This lack of prior planning with the law enforcement and other response organisation has caused confusion and reduced the effectiveness of responses. Consequently, it is assumed that the radiological and non-radiological planning will be fully integrated.

In the past many responses to emergencies have been directed by many different organisations and individuals (at the same time) located throughout the country. Obviously this resulted in confusion, conflicting information and instructions, and ultimately in an ineffective response and loss of trust amongst the public. Consequently it is assumed that each country will develop an integrated response system with responsibilities and authorities both clearly assigned and coordinated. It is also assumed that the response will be directed from a central location near the scene as soon as possible.



Lecture notes:

The response to a radiation emergency is basically the same as the response to any accident involving hazardous material. The major difference is that in many hazardous material accidents, but not all, the hazard can be smelled, seen or heard. This is not the case with radiation accidents. In addition in most cases responders will have no experience with radiation emergencies (radiation emergencies are very rare), very small amounts of radioactive material and radiation (unlike many chemicals) can be immediately detected with simple – commonly available instruments, and the medical symptoms of radiation exposure (expect in extreme cases) will not appear for days, weeks or even years. Finally, there are many misconceptions prevalent concerning the health effects of radiation and radiation emergencies, which can lead to response actions that do more harm than good. Consequently, preplanning on the basis of established principles of radiation protection and safety is essential. Such preplanning is only achieved through a co-ordinated effort. Therefore provisions should be developed to identify potential radiological hazards and inform the public and emergency workers of the actions they should take. Radiological plans should be incorporated into plans for all types of hazardous materials.

Before any planning can begin the practices and activities for which emergency response planning is necessary must be identified. Next slide briefly explains how to do that in a simplified way.

Threat Categories

Threat Category	Radiological Threat
I	Severe deterministic health effects off-site
II	Warranting urgent protective actions off-site, deterministic health effects on-site
III	No urgent protective actions off-site are warranted, severe deterministic health effects on-site
IV	Minimum level of threat – all countries
V	Food contamination due to transboundary contamination necessitating food restrictions

Lecture notes:

Emergency planning could be different for each practice. However, this can be simplified by grouping practices into five threat categories, each presenting common features in terms of the magnitude and timing of the hazard. The slide shows the five emergency threat categories. Threat categories I through IV represent decreasing levels of threat and therefore decreasing emergency preparedness and response requirements. Threat category IV is the minimum level of threat assumed to exist everywhere and thus *always applies* possibly along with other categories. Threat category V is a special category and *may apply* along with other categories. Note that these threat categories are only used as a convenient way to provide guidance on planning and are not used during an emergency. These threat categories apply to both facilities or uses and governmental jurisdiction for which various levels of planning is warranted.

Emergency planning for threat category I facilities is the most demanding. For the national agency, planning and implementing the capabilities to handle emergencies at threat category I facilities will ensure that the capability exists to handle emergencies of the other categories. Threat category IV applies everywhere because these emergencies can occur anywhere. Thus guidance for the threat category IV represents the minimum level needed for all jurisdictions.

Lecture notes:

For most accident types, emergency response takes place over two distinct areas:

On-site area

The area surrounding the facility within the security perimeter, fence or other designed property marker. It can also be the controlled area around a radiography source or contaminated area. This is the area under the immediate control of the facility or operator. For transportation accidents on public roads or territories, there is in effect no on-site area.

Off-site area

The area beyond that under the control of the facility or operator.

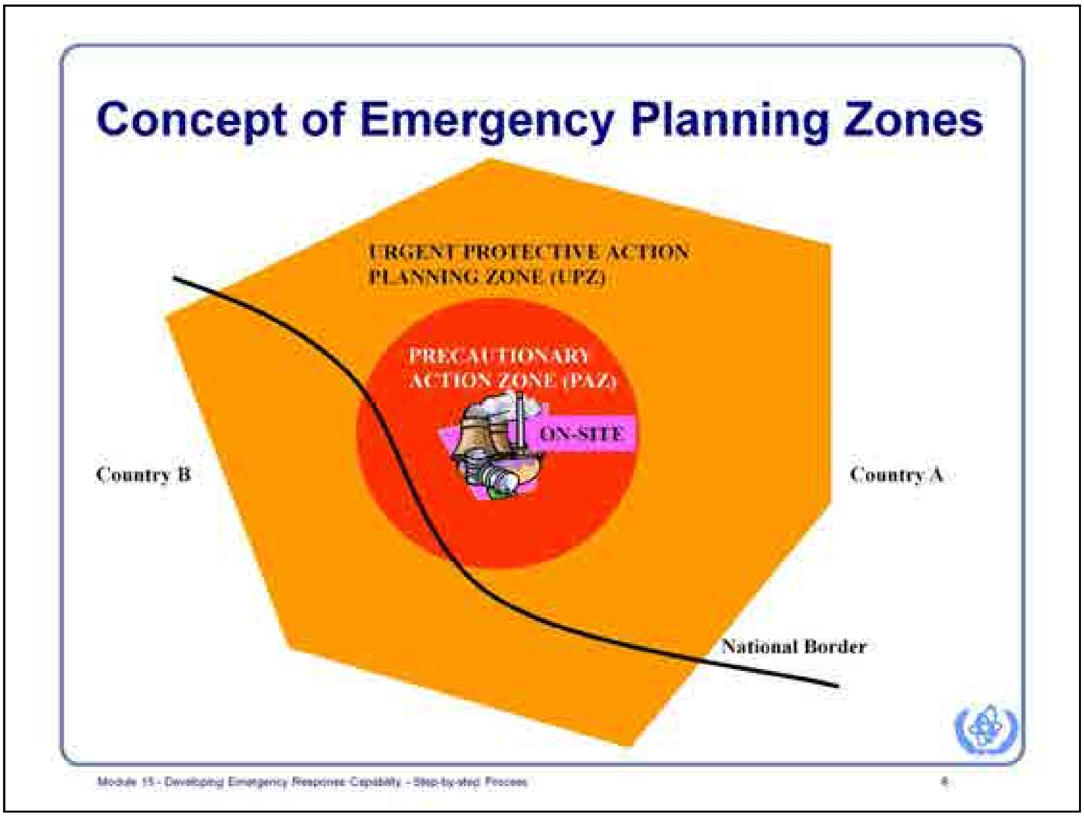
For facilities with the potential for accidents resulting in major off-site releases (threat categories I and II), the level of planning will vary depending on the distance from the facility. For these facilities, planning can be discussed for two emergency planning zones, as shown in next slide.

Precautionary action zone (PAZ)

Pre-designated area around a facility where urgent protective actions have been pre-planned and will be implemented immediately upon declaration of a general emergency. The goal is to substantially reduce the risk of serious deterministic health effects by taking protective actions within this zone *before* or shortly after a release. This zone is within the site boundary for research reactors with power levels less than 100 MW.

Urgent protective action planning zone (UPZ)

Pre-designated area around a facility where preparations are made to promptly implement urgent protective actions based on environmental monitoring and facility conditions. The goal is to make provisions to effectively implement urgent protective actions to avert the doses specified in international standards. This zone is within the site boundary for research reactors with power levels below 2 Mw.



Lecture notes:

These zones should be roughly circular areas around the facility. However, the boundaries of the zones should be defined by local landmarks (e.g., roads or rivers) to allow easy identification during a response. It is important to note that the zones do not stop at national borders. The size of the zones can be determined by an analysis of the potential consequences. However, previous studies of a full range of radiation accidents provide a basis for generic zone sizes, as summarized in next slide.

Response and Planning Zones Sizes

Facility	PAZ	UPZ	FRPD
Category I	3 – 5 km	5 – 30 km	500 – 1000 km
Category II	On-site	0.5 – 5 km	10 – 50 km
Category III	On-site	Not required	Not required

PAZ – Precautionary Action Zone
UPZ – Urgent Protective Planning Zone
FRPD – Food Restrictions Planning Distance

Lecture notes:

This slide provides generic ranges for the size of the various response and planning zones for different threat categories and facility types. Ranges are provided in recognition of the great uncertainties involved. The actual boundary of the zones should be established to conform to geographical features such as roads, rivers, or political boundaries. This is required to allow practical application of the zones in the event of an emergency. The size used should be scaled to the corresponding potential threat. That is the higher end of the suggestion range should be used for facilities at higher end of the applicable facilities. Site-specific studies could also be used to determine boundaries.

Category I and II Food Restrictions Planning Distance (Category V distance)

It is the area where preparations for effective implementation of protective actions to reduce the risk of deterministic and stochastic health effects from and ingestion of locally grown food should be developed in advance. More time will be available to take effective actions within this zone. In general, protective actions such as relocation, food restrictions and agricultural countermeasures will be based on environmental monitoring and food sampling.

Lecture notes:

Operator

The staff at the facility or the personnel using the material at the time of the accident. They are responsible for the immediate actions to mitigate the emergency; protecting people on-site; notifying off-site officials and providing them with recommendations on protective actions and technical assistance, and providing initial radiological monitoring.

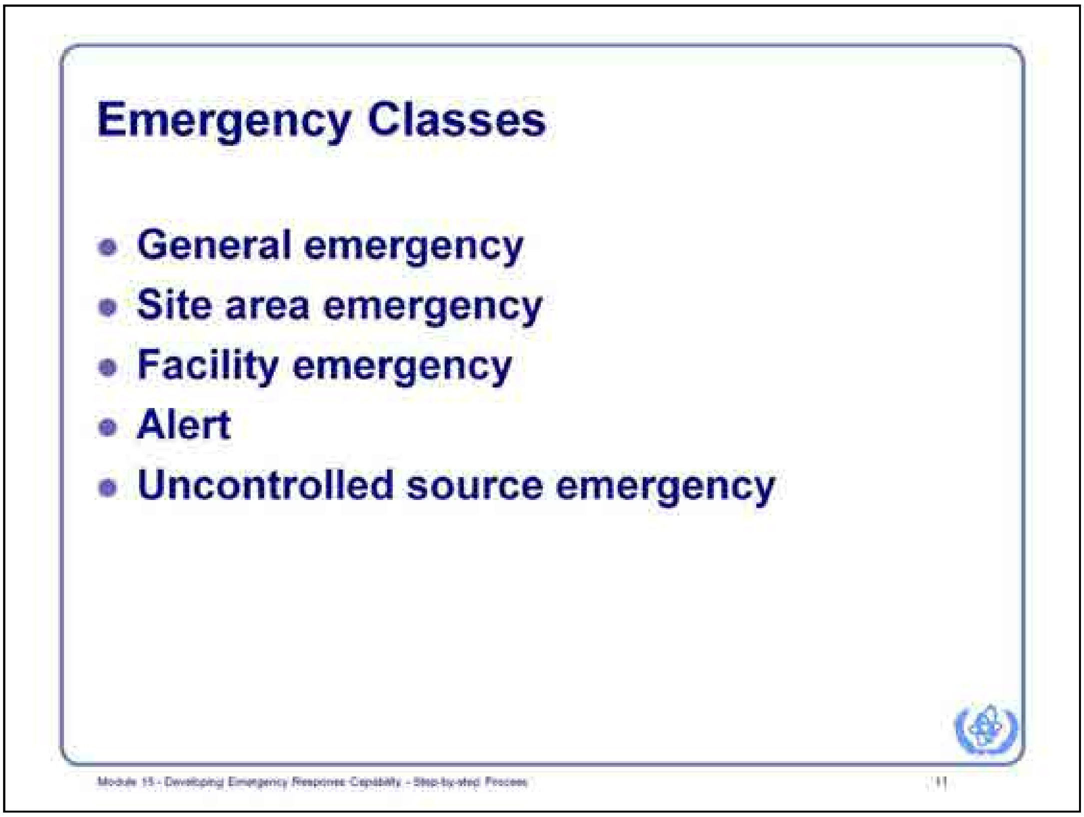
Off-site

Organisations responsible for the protection of the public. This includes:

- Local officials: the government and support agencies responsible for providing immediate support to the operator and prompt protection of the public in the vicinity. This also includes the police, fire fighting and civil emergency services or medical personnel who may be the first to learn of an accident. This may include officials from different countries if the facility is near a border.
- National and regional (province or State) officials: the governmental agencies responsible for planning and response on the national (or regional and State) level. These agencies are typically responsible for tasks that do not need to be implemented urgently to be effective. This includes longer-term protective actions, and support of local officials in the event their capabilities are exceeded.

International

Organisations responsible for providing international assistance. This includes IAEA (under the Assistance Convention countries have committed to facilitate prompt assistance in the event of an accident) and organisations such as UNDHA or WHO that can provide technical, humanitarian or medical assistance in the event of an accident.

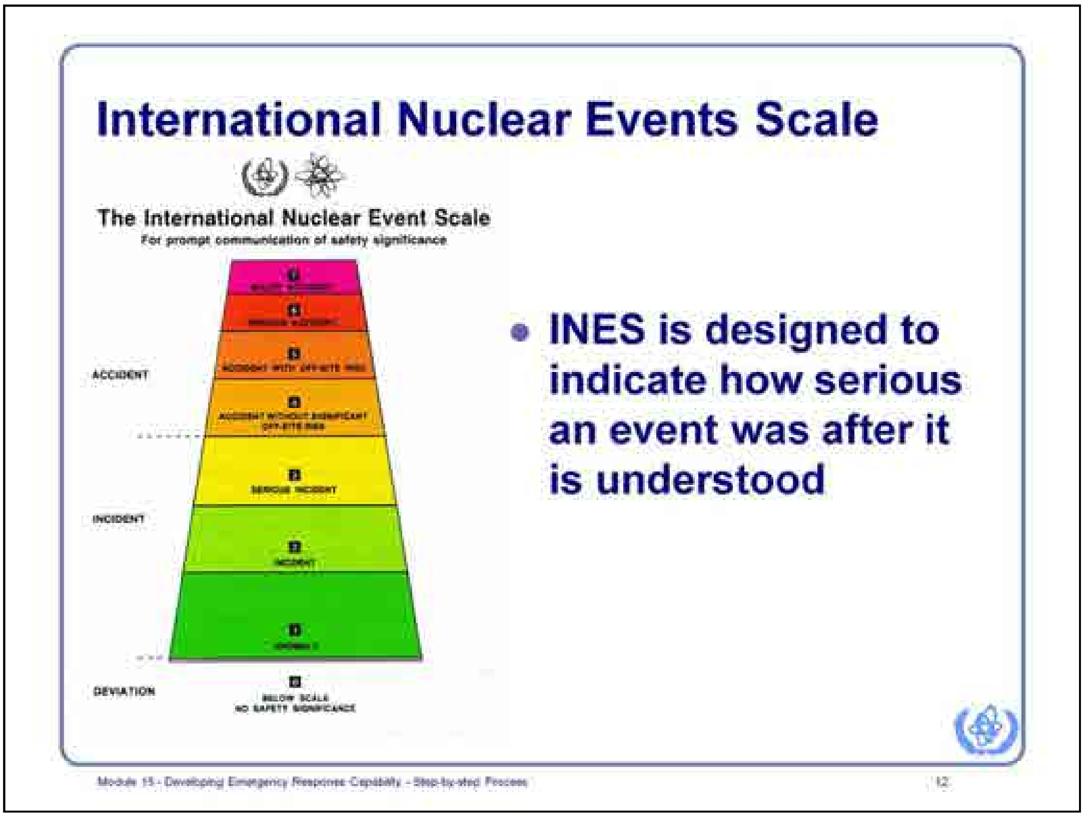


Lecture notes:

Threat category I, II, III and IV operators should have the capability for prompt recognition and response to emergencies. The following five classes of emergency that address different types of emergencies are defined:

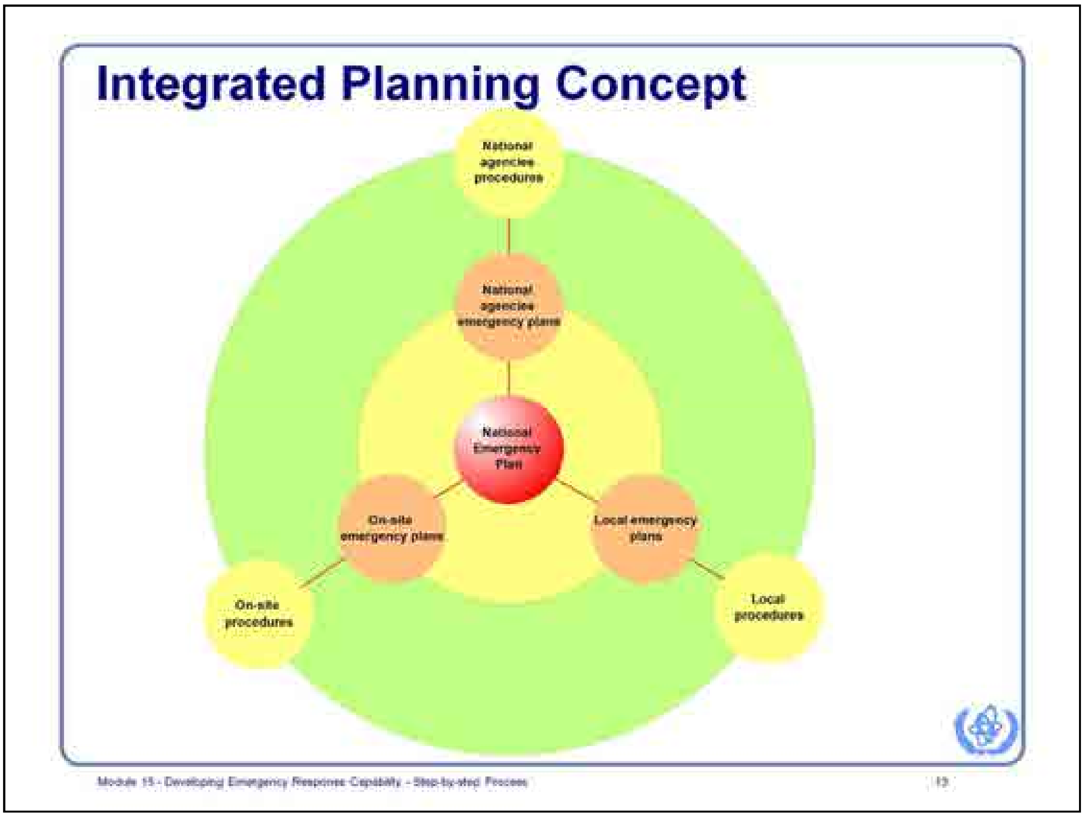
- *general emergencies* at threat category I and II facility involving an actual or substantial risk of a release of radioactive material or irradiation warranting immediate implementation of urgent protective actions off-site. Upon declaration of this level of emergency, actions should be promptly taken to mitigate the event and to protect the people on-site and within the precautionary action zone and urgent protective action planning zone as appropriate.
- *site area emergencies* at threat category I and II facility involving a major decrease in the level of protection for those on-site and near the facility. Upon declaration of this level of emergency, actions should be promptly taken to mitigate the event, protect people on-site and to make preparations to implement protective actions off-site if that should become necessary.
- *facility emergencies* at threat category I, II or III facilities involving a major decrease in the level of protection for people on-site. Upon declaration of this level of emergency, actions should be promptly taken to mitigate the event and to protect the people on-site. This class of emergency does not represent an off-site threat.
- *alerts* at category I, II and III facility involving an uncertain or significant decrease in the level of protection for the public or on-site personnel. Upon declaration of this level of emergency, actions should be promptly taken to assess and mitigate the event and to increase the readiness of the on- and off-site response organisations as appropriate.
- *uncontrolled source emergencies* involving loss, theft or loss of control of a threat category IV dangerous source or practice to include re-entry of a satellite with significant amounts of radioactive material.

The titles of the emergency classes may be different than those specified provided that these types of emergencies are addressed. The actions to be taken for each class should be coordinated in advance and be initiated upon declaration of the emergency. For threat category IV and V the immediate actions to be taken should also be pre-planned; however, this may be accomplished without the use of a classification system.



Lecture notes:

The emergency classification should not be confused with the International Nuclear Events Scale (INES). INES is designed to indicate how serious an event was *after it is understood* and **is not the basis for the response**. Determining the INES rating is impossible early in an emergency, does not form part of the initial response, nor should determining the rating delay any response actions.



Lecture notes:

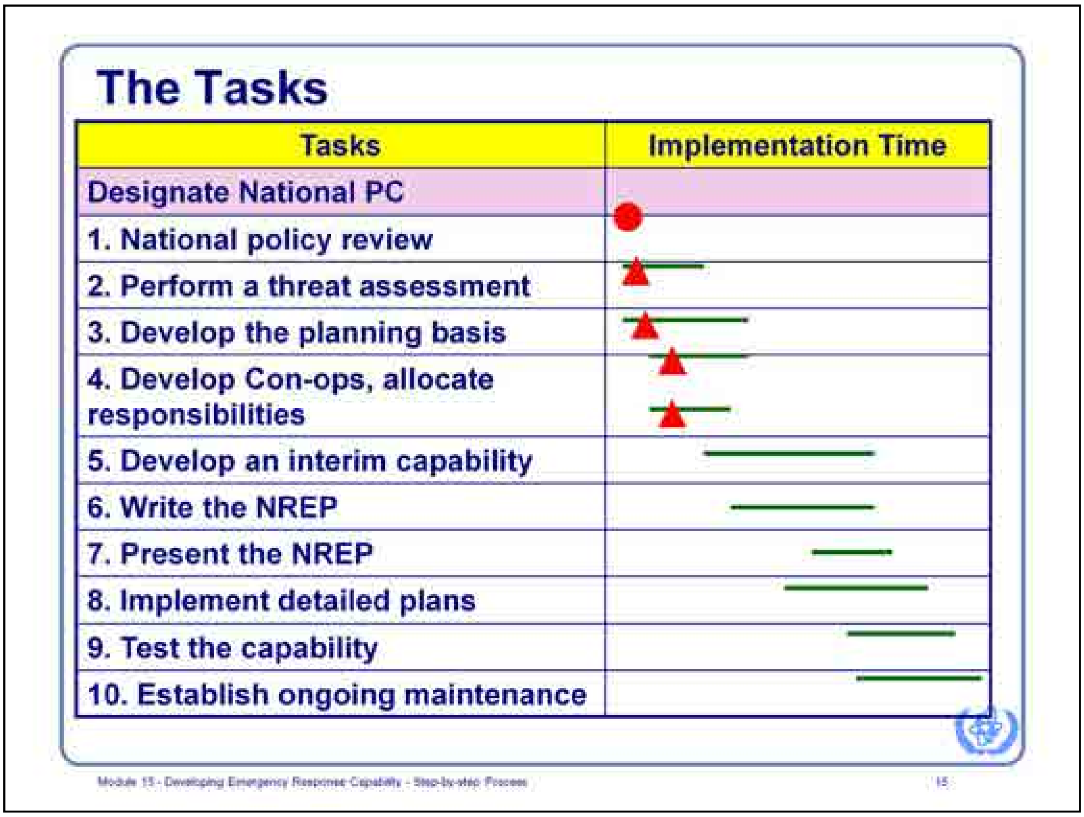
Capabilities, plans and procedures should be structured into a coherent and interlocking system, as shown in this slide. The National Radiation Emergency Plan (NREP) is a general description of the roles and responsibilities of all the responding organisations and their relationships. It is a summary of the more detailed plans and assures that all the other planning is integrated and compatible. At the next level there are the plans developed by individual agencies, governmental jurisdictions, and facilities or operators. The final level represents the procedures (e.g., implementing instructions and operational procedures) and resources that will be used during an emergency to carry out the plans.

In order to optimise the use of resources and the response effectiveness, it is recommended that response plans be highly coordinated and consolidated. In other words, planning should not be done in isolation between the organisations and agencies involved. Assignment of responsibilities should be done jointly with all interested parties represented. However, an existing governmental body must be identified to act as a national co-ordinating authority, whose function, among others, is to assure that responsibilities are assigned and resolve differences and incompatible arrangements between the various participating parties.

Lecture notes:

The main features of the planning methodology are:

- it is modular, i.e. the overall methodology is divided into self-contained tasks that can be planned, developed and executed independently;
- it is based on extensive consultation with all relevant organisations (*plans that have been developed in isolation have been consistently shown to be ineffective*); and
- it is iterative, i.e., plans and procedures are dynamic documents, may need to be revised throughout the process.



Lecture notes:

There are ten tasks to develop and implement emergency response plans and procedures:

Task 1 – National policy review

Task 2 – Perform a threat assessment

Task 3 – Develop the planning basis

Task 4 – Develop Concept of Operations and allocate responsibilities

Task 5 – Develop an *interim* capability

Task 6 – Write the National Emergency Plan

Task 7 – Present the National Emergency Plan

Task 8 – Implement detailed plans

Task 9 – Test the capability

Task 10 – Establish ongoing maintenance.

The tasks are listed in the order that they would logically be started. Furthermore as shown in this slide, many of the tasks will be performed in parallel over time. The development process can be roughly divided into two phases. Phase 1 includes the tasks 1 through 5. One of the aims of this phase is to identify serious deficiencies in the capability to respond to emergencies and immediately develop an interim capability to address them. During phase 2, all the tasks are completed resulting in a fully developed and formalized emergency response capability.

Lecture notes:

A single overall National Emergency Planning (EP) Coordinator should be designated before planning can begin to:

- develop an integrated National Emergency Plan;
- coordinate the development of plans and procedures within each level (national, local and operator);
- guide the planning process outlined in the following sections;
- ensure the functions and responsibilities of operators and response organisations are clearly assigned and understood by all response organisations;
- ensure that the responsibilities for preparedness and response for a radiation emergency are clearly allocated;
- resolve differences and incompatible arrangements between the various participating parties;
- ensure that a review is conducted periodically in order to identify any practice or event that could necessitate an emergency intervention;
- make all responsible efforts in accordance with international law and obligations to foster the implementation by other States of measures designed to fulfil the relevant obligations in accordance with these; and
- act as the contact point for international cooperation to include the international notification and assistance conventions and IAEA assistance projects.

The EP Coordinator in the writing process should involve all parties who have an interest in the development and implementation of the emergency plan(s) at the early stage. Coordination “after the fact” may actually be counterproductive by creating opposition to requirements being imposed on those who had no part in assigning those obligations.

Lecture notes:

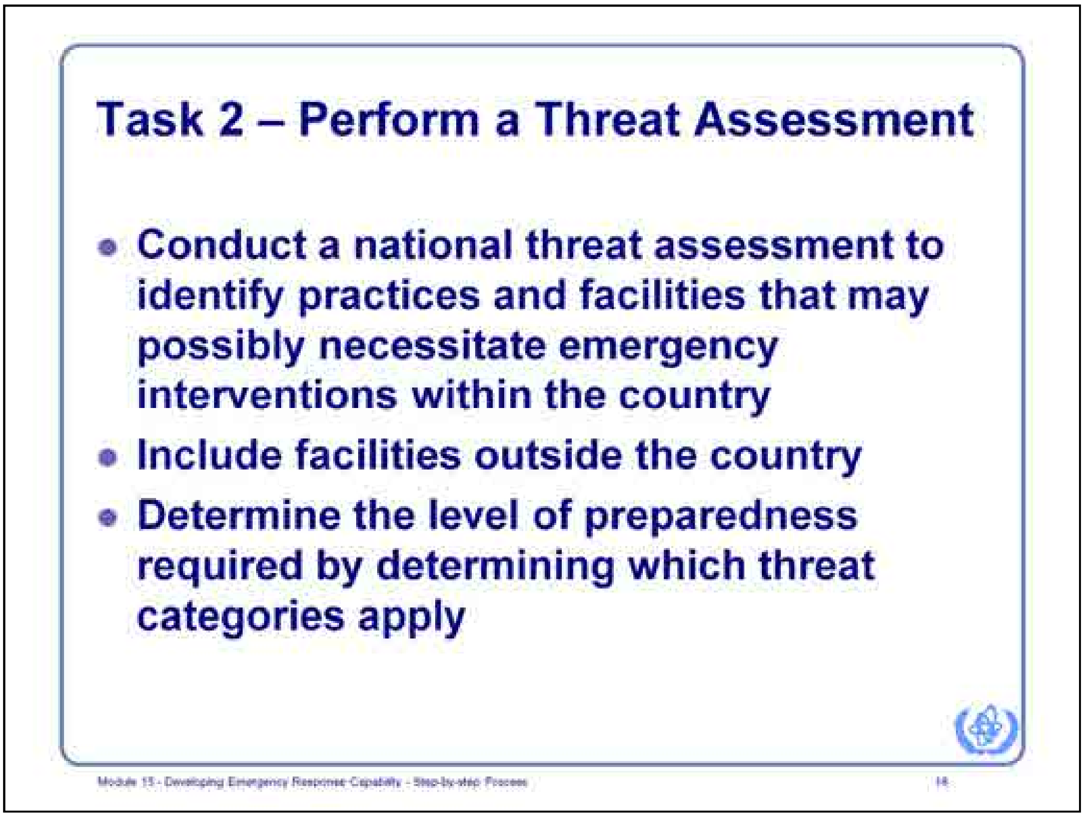
Review and document the legal infrastructure and policies to ensure there is agreement on planning responsibilities at the national level. This is a crucial step, and without such an agreement it will be impossible to achieve effective plans.

The results must be documented and agreed by all the major ministries that may have a role in the response to an emergency. This documentation will be incorporated in the National Radiation Emergency Plan and should include:

- a list of the national laws or Acts for natural or man-made accidents or emergencies (e.g., dealing with transportation of hazardous materials), which define who is responsible for planning, decisions and actions;
- a brief description of the roles, responsibilities and capabilities of the major national ministries;
- a brief description of the responsibilities of the local governments and the operators; and
- a brief description of how response to radiation accidents is integrated into the planning for other types of emergencies.

Ensure that responsibility for all types of potential radiation emergencies are addressed to include those involving licensed uses, military uses, unlicensed sources, transboundary releases, transportation or terrorist acts. Ensure the roles of police, military and other non-technical agencies are clearly defined and agreed. It should be clear how responsibilities might change as the emergency progresses.

If the legal and regulatory infrastructure is not complete, *it is not necessary* to enact new laws before the emergency planning process can start. In fact, doing so would most likely delay the implementation of an effective emergency response capability by several months or years. If needed, government policy statements can be issued in the interim. In addition the planning may identify revisions that are necessary to the roles and responsibilities.



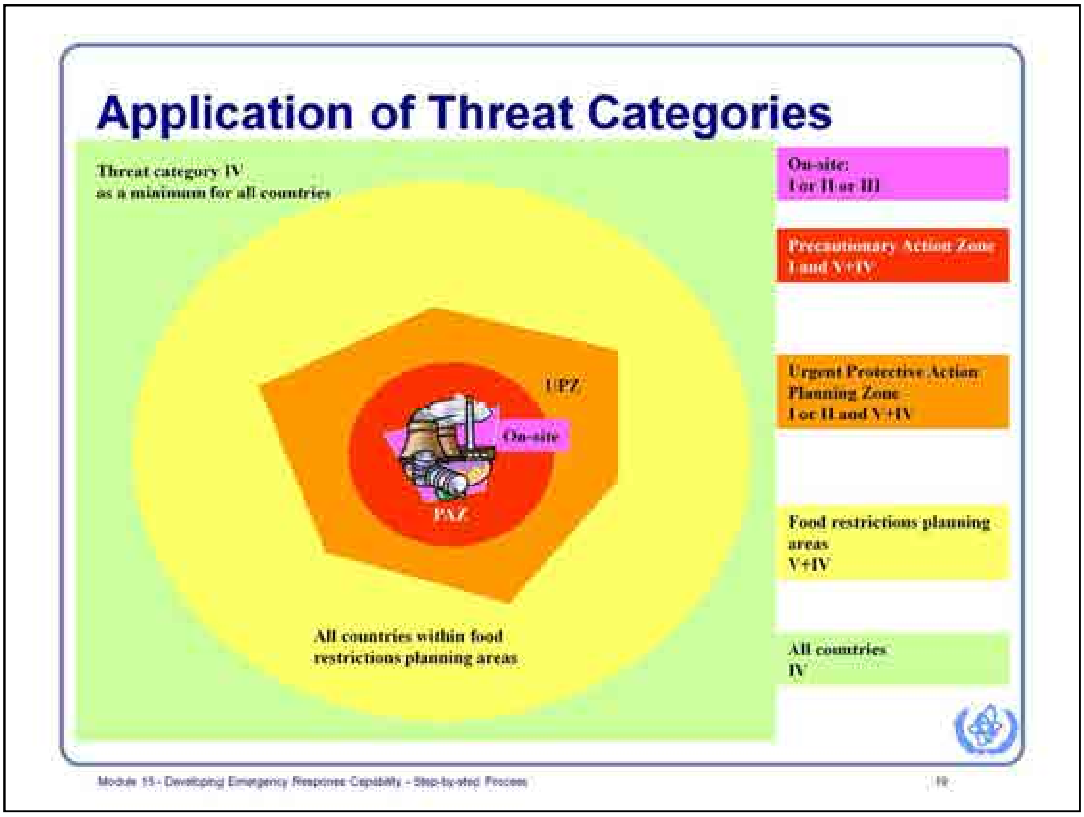
Lecture notes:

Determine the level of preparedness required by determining which threat categories apply. A national threat assessment should be conducted to identify practices and facilities that may possibly necessitate emergency interventions within the State. This includes facilities outside the country.

The threat assessment shall identify installations, sources, practices, on-site areas, off-site areas or locations for which radiation emergencies could warrant:

- precautionary urgent protective actions to prevent severe deterministic health effects by keeping doses below those for which intervention is expected to be undertaken under any circumstances;
- urgent protective actions to reduce stochastic effects by averting doses, consistent with international standards;
- food restrictions consistent with international standards; and
- protection for the workers responding (undertaking an intervention) consistent with international standards.

The threat assessment should also identify locations at which there is a significant probability of encountering a dangerous source that has been lost, abandoned, stolen or illicitly transported. This should include consideration of large scrap metal processing facilities, national border crossings, or abandoned military or other facilities that may have used large sources.



Lecture notes:

A minimal threat assessment could be accomplished by identifying:

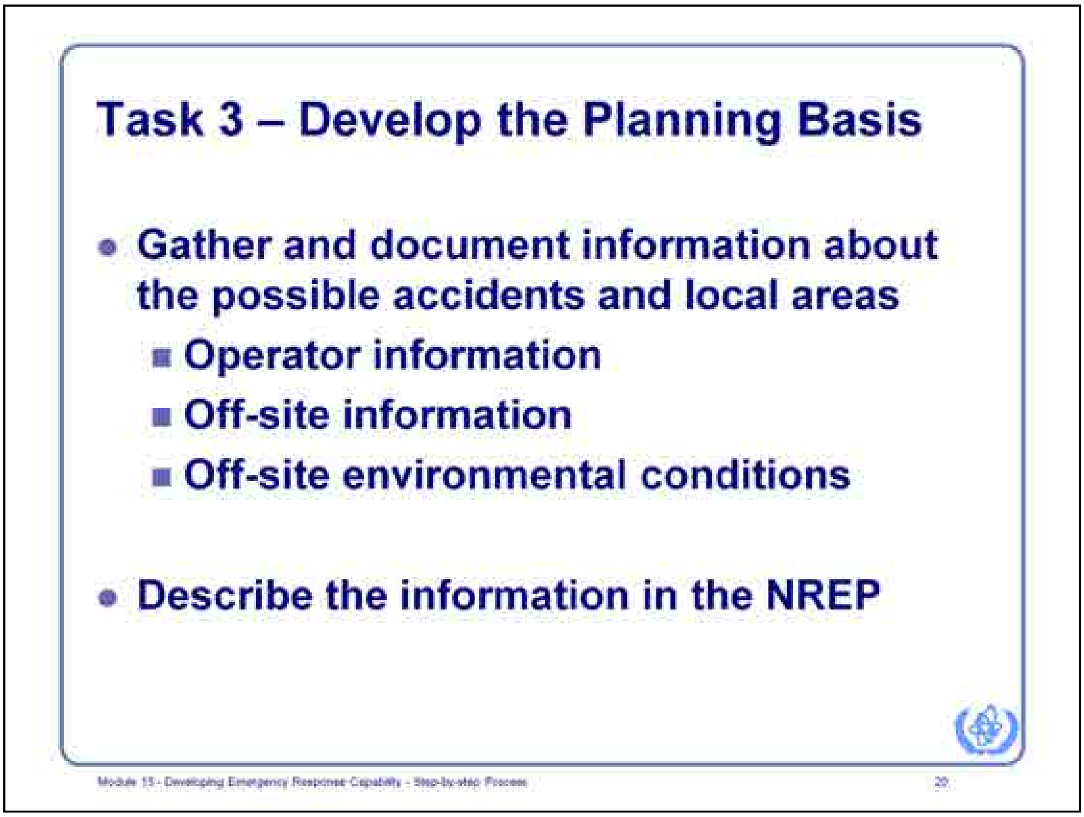
- the threat category of facilities within the country,
- the threat category I and II facilities outside the country in nearby States that are within food restriction distances,
- the threat category of the jurisdictions within the country,
- assume a minimum level of threat to exist for all jurisdictions.

This threat assessment is based on the results of generic accident studies. This is generally sufficient to initiate the emergency planning process. If a detailed analysis is to be performed, it should consider a range of potential accidents and not be limited to the “design basis” accidents.

The most complex part of this process is determining the threat category that should be assumed for off-site jurisdictions. This slide illustrates the application of threat categories to off-site jurisdictions. Several different categories may be applicable for a governmental jurisdiction (local or national); while only one category can apply to a facility. All jurisdictions as a minimum fall within threat category IV. The effectiveness of various protective actions must also be evaluated to determine up to which distance from a facility detailed preparations are needed.

The results of this analysis should be documented and be included in the National Radiation Emergency Plan. This should include a list and map showing threat categories of the facilities and local jurisdictions.

The results of the threat analysis will be used to implement the graded approach to emergency preparedness arrangements that are commensurate with the potential magnitude and nature of the hazard.



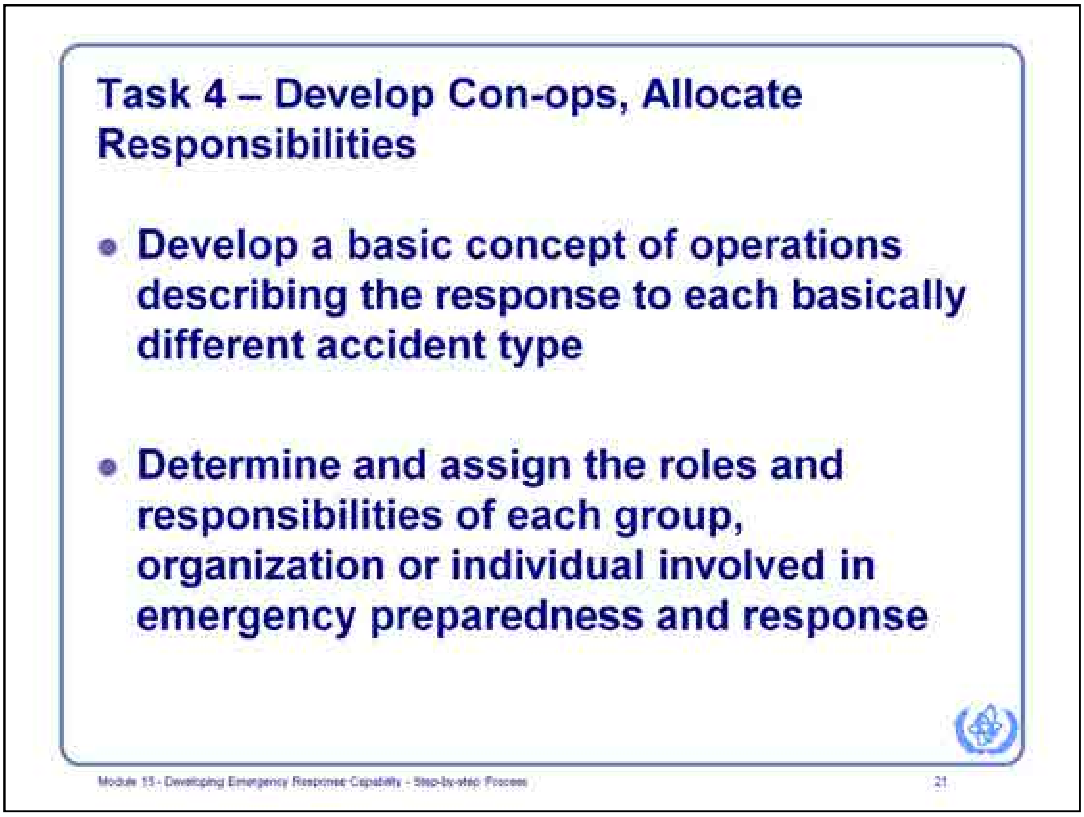
Lecture notes:

Once the emergency threat category of the facilities and jurisdictions have been established, it is necessary to gather and document information about the possible accidents and local areas that must be considered before plans can be developed. This information should be documented and briefly described in the National Emergency Plan. It should include a general description of the nature of the possible emergencies addressed by the plan.

Operator information: emergencies that could result in on-site exposures or off-site release warranting protective action; information in facility that can give prior warning of release or potential exposure; typical radiological composition and timing of a release; radiological and other environmental conditions in the facility during a response; and actions in facility that could be taken to mitigate the accident or reduce a release.

Off-site information: medical, police and fire fighting support available; typical sheltering available in the UPZ; typical transportation available for evacuation within the UPZ; communication available for decision makers; communications available to alert and inform the public; food and milk that is locally produced that may be directly contaminated; information on agriculture product collection and distribution system; drinking water supply systems; population distribution; special populations (e.g., hospitals) and transients within UPZ; special facilities (e.g., factories that can not be evacuated) that may be affected by an emergency; transportation systems that may be affected by an accident (e.g., road, rail, air, sea, canals); points of import and export of food.

Off-site environmental conditions: range of weather conditions under which protective actions and monitoring may be conducted; severe conditions that may result in an accident.



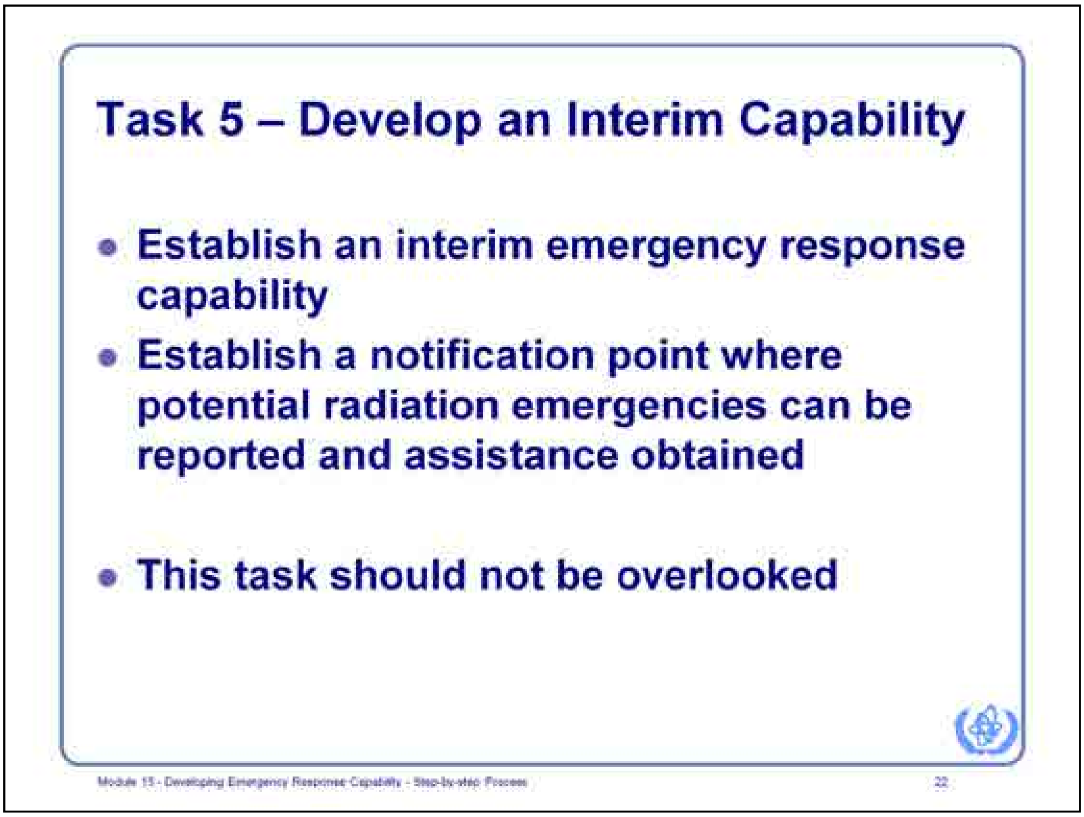
Lecture notes:

Develop a basic concept of operations describing the response to each basically different accident type (see Lesson X.2.1).

Based on the concept-of-operations, determine and assign the roles and responsibilities of each group, organisation or individual involved in emergency preparedness and response.

Coordinators should be designated for each operator (facility), group, organisation, department and ministry that may have a role to play in emergency response.

Allocation of responsibilities is an interactive process. Responsibilities should be attributed in consultation with pertinent groups and must be based on realistic capabilities of that group. The individual groups to which roles and responsibilities are assigned should agree with the assignments and make a commitment to develop the necessary response capability.



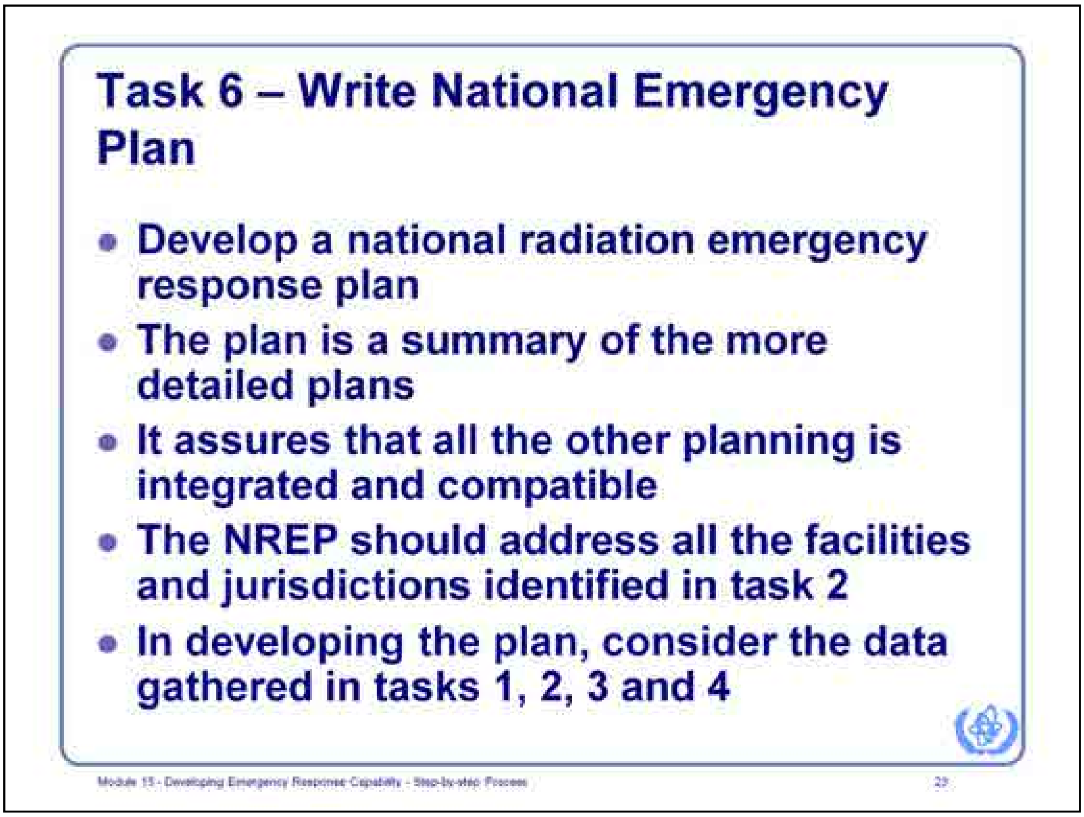
Lecture notes:

The full implementation of the plan can be a long process, which involves writing procedures, training staff and holding drills and exercises. In order to ensure that a response capability is in place before the National Radiation Emergency Plan can be fully implemented, an *interim* emergency response capability should be established. The purpose is to provide the response to emergencies until the full plan can be implemented. This interim capability does not need to be optimal. This means that, in the interest of quickly implementing this interim capability, it will probably be necessary to "make do" with available means and resources, and with only minimal additional training.

Concentrate on using existing capabilities effectively. This involves assuring that decisions can be made quickly and that existing capabilities are identified and provisions are made for quickly accessing them. An interim means for coordination of a large response involving several ministries and or jurisdictions should also be established.

At this step in the process, establish a notification point where potential radiation emergencies can be reported and assistance obtained. The means of contacting the notification point and other basic information should be provided to first responders (e.g., fire brigades and police) concerning recognition and immediate response to a radiation emergency. This information should address transport emergencies, lost sources, and reports of potential exposures or contamination. Basic information should also be sent to physicians and hospitals on the recognition and reporting of radiation induced injuries. Finally the warning point for receipt of IAEA notifications should be established.

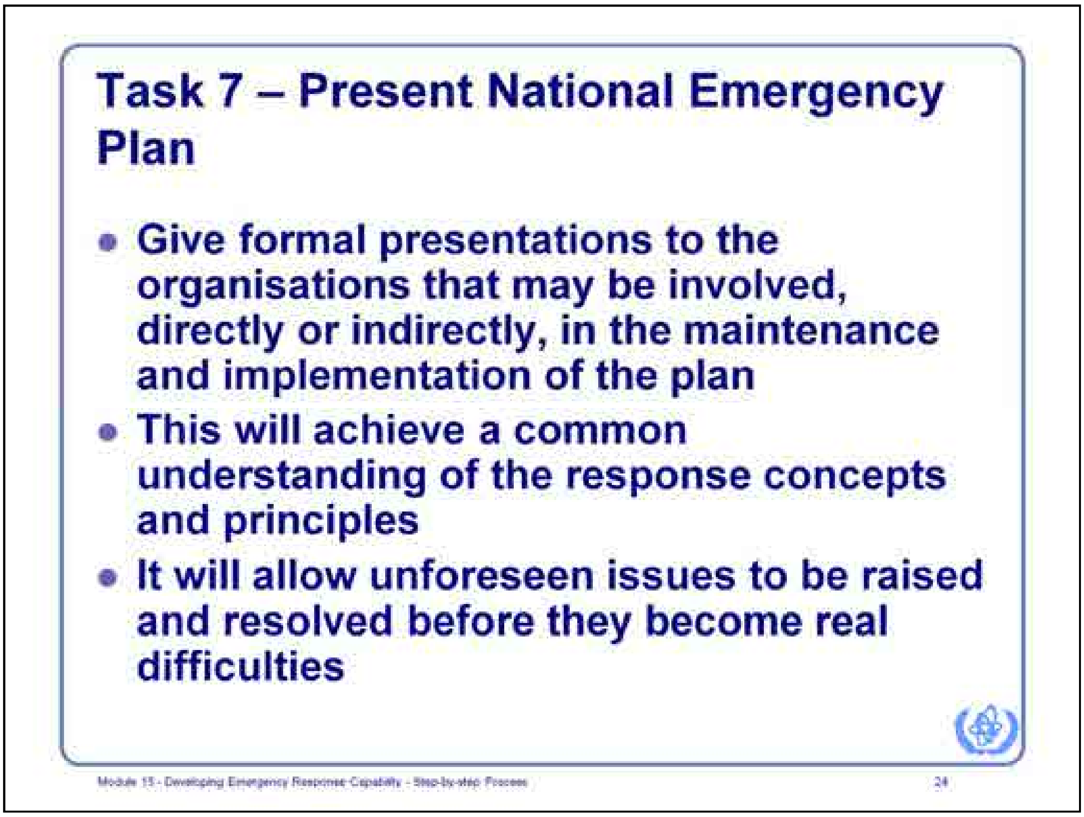
This task should not be overlooked. A serious emergency can occur at any time and the time and efforts invested in developing an interim organisation and capability will provide significant savings during the implementation of the full emergency response capability.



Lecture notes:

Develop a national radiation emergency response plan. The National Emergency Plan should be a *general* description of the possible emergencies, concept of operations for responding to each type of emergency. In addition the plan should describe the roles and responsibilities of the ministries, governments and facilities involved in a response and should include all the countries within the UPZ. It is a summary of the more detailed plans and assures that all the other planning is integrated and compatible. All countries, jurisdictions, ministries and organisations addressed in the National Radiation Emergency Plan should be given an opportunity to review the plan. Module 19 contains a suggested outline for the plan.

The National Emergency Plan should address all the facilities and jurisdictions identified in task 2. The planning should consider the emergency threat categories of the facilities and jurisdictions. In developing the plan, consider the data gathered in tasks 1, 2, 3 and 4.



Lecture notes:

Once the National Emergency Plan has been developed and approved, give formal presentations to the organisations that may be involved, directly or indirectly, in the maintenance and implementation of the plan. This will achieve a common understanding of the response concepts and principles and will allow unforeseen issues to be raised and resolved before they become real difficulties. It will also facilitate the implementation of the National Radiation Emergency Plan by maximising staff participation and common ownership.

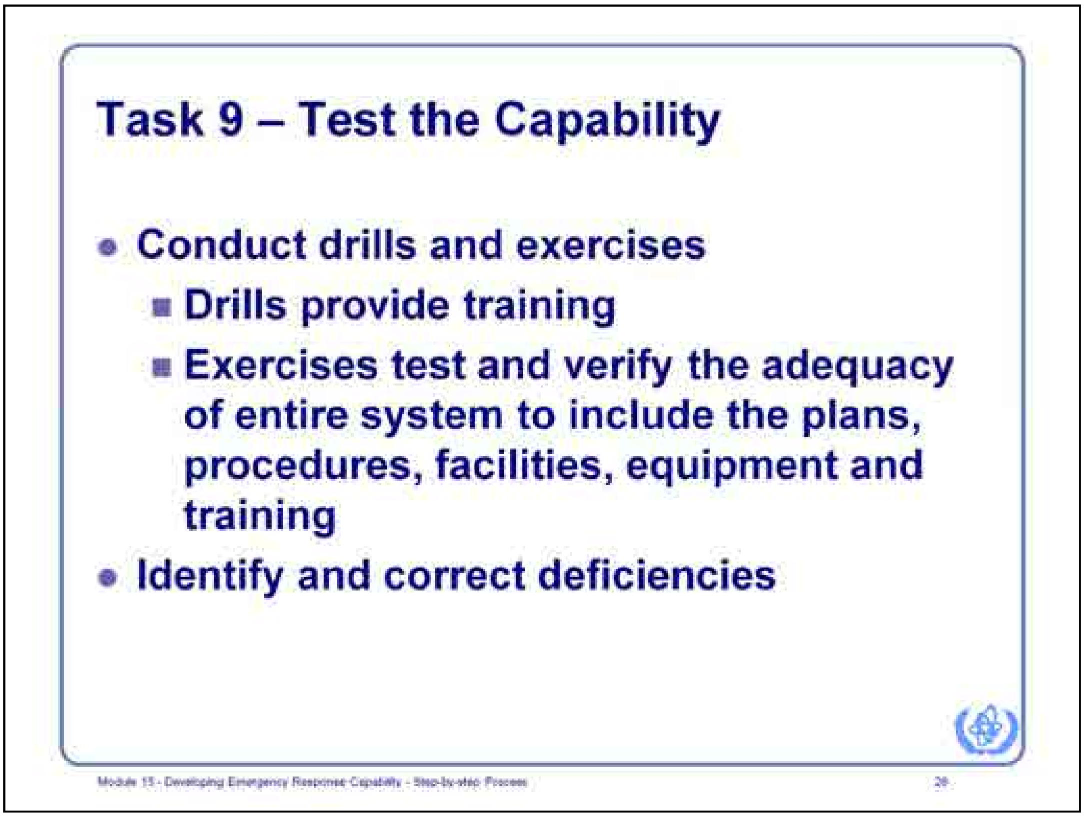
This process should begin with workshops on the plan and its basis. Meetings should also be held for the public near threat category I and II facilities to explain the plan and obtain public comments.

Lecture notes:

Develop the infrastructure and functional capabilities needed to implement the National Radiation Emergency Plan for each facility and jurisdiction identified in task 2. Capabilities should be developed to address all planning elements appropriate for the emergency threat category of the facility or jurisdiction. This will include plans, procedures, staff, organisation, facilities, equipment and training. Remember that more than one threat category and therefore checklist may apply to a jurisdiction. For example the jurisdiction containing a nuclear power plant will fall within threat category I and IV. Threat category IV is applicable because it applies to ***all*** jurisdictions.

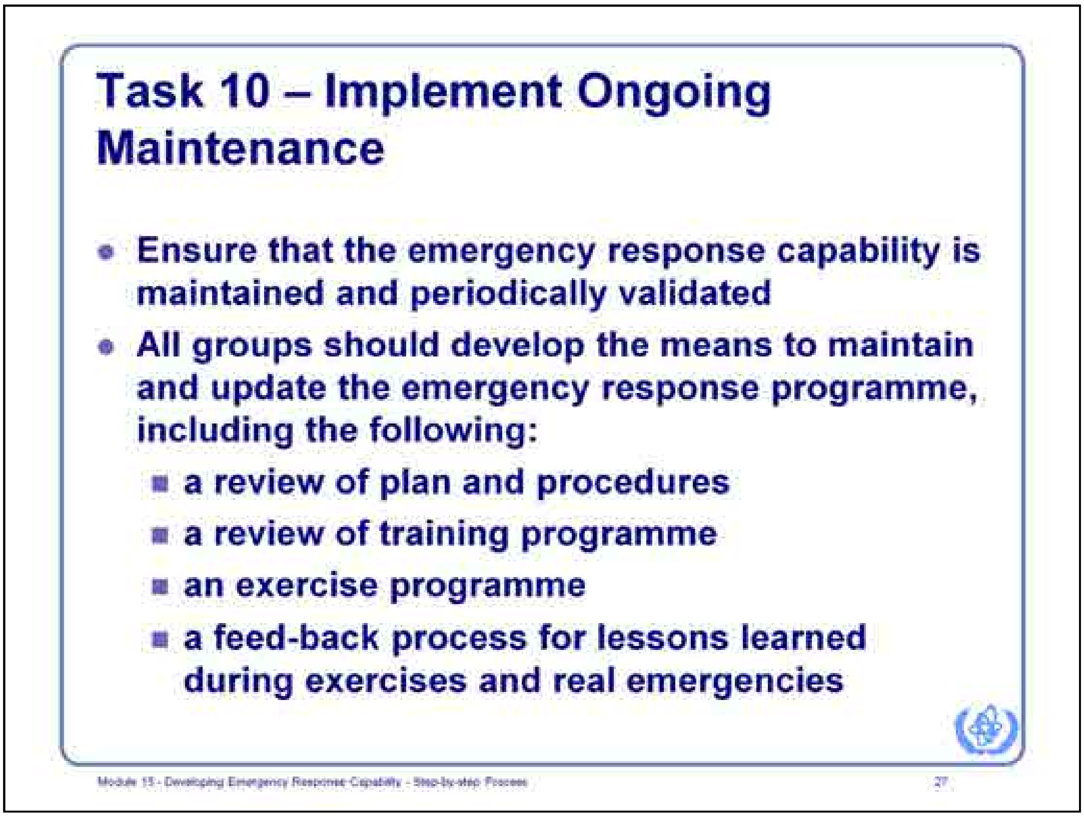
A group should be assigned the responsibility to assist and help in this effort. EP Coordinator may chair the group. This coordinating group will:

- develop a schedule and requirements for the development of individual facility, group, department, ministry (etc.) plans and procedures;
- provide assistance to individual groups in the development of plan and procedures to ensure compatibility and completeness of the planning process;
- organise periodic meetings between key representatives to encourage coordination; and
- ensure compliance with the schedule.



Lecture notes:

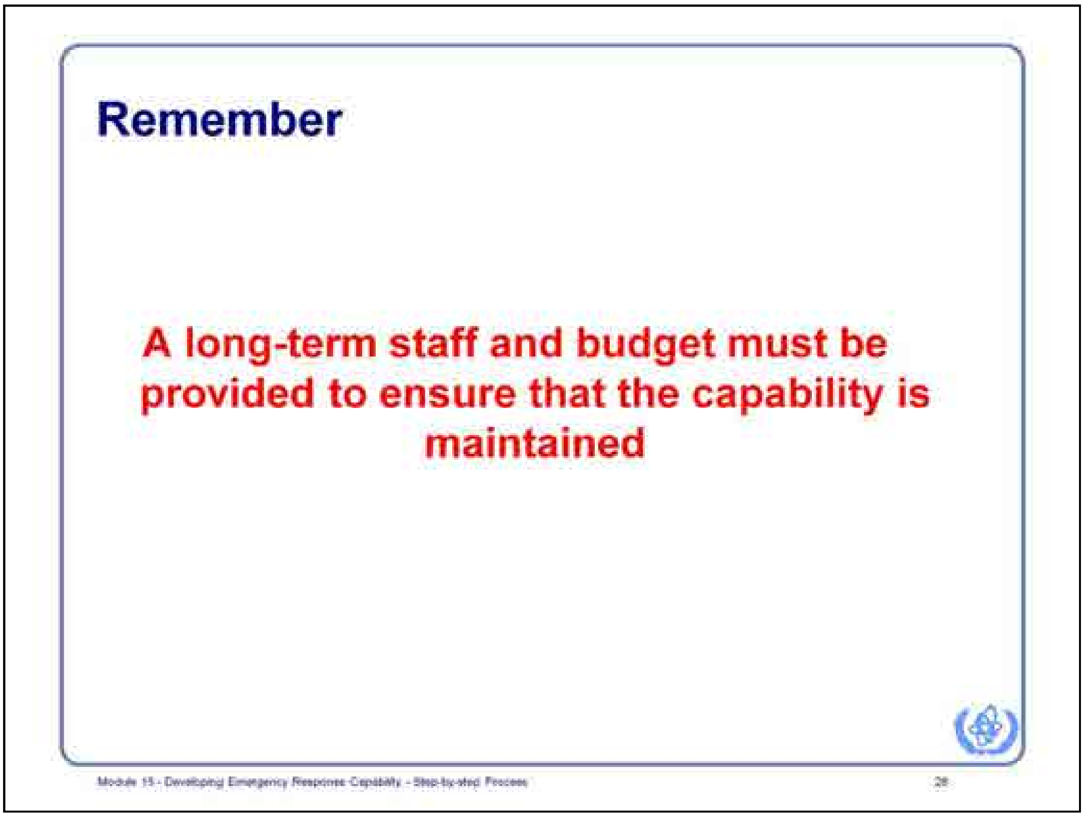
Once a response capability has been developed drills and exercises should be conducted. These drills will provide training and the exercises will test and verify the adequacy of entire system to include the plans, procedures, facilities, equipment and training. Following the drills and exercises deficiencies should be identified and corrected. The drills and exercises should be conducted in a sequence starting with the smallest organisational elements (e.g., monitoring teams) and culminate in a national level exercise.



Lecture notes:

The final task is to ensure that the emergency response capability is maintained and periodically validated. All groups should develop the means to maintain and update the emergency response programme, including the following:

- a review of plan and procedures;
- a review of training programme;
- an exercise programme; and
- a feed-back process for lessons learned during exercises and real emergencies.



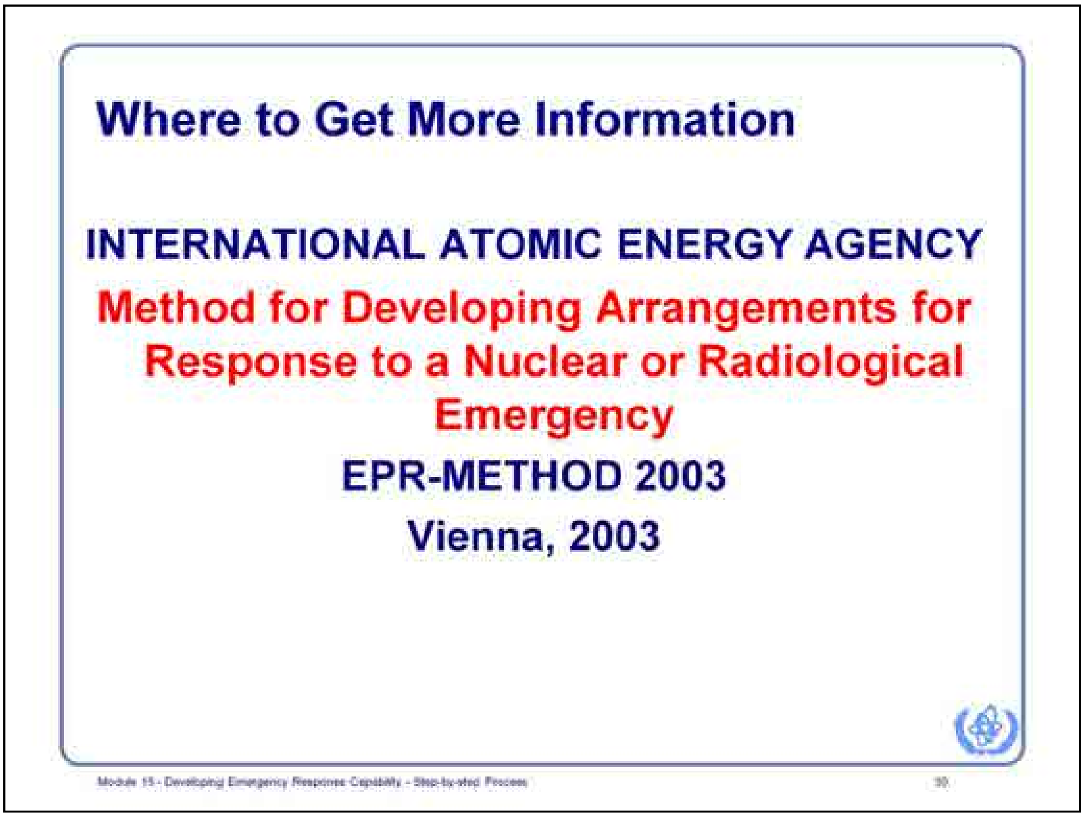
Lecture notes:

Ultimately the State should adopt legislation to clearly allocate responsibilities for preparedness and response for a radiation emergency. This should ensure the functions and responsibilities of operators and response organisations are clearly assigned and understood by all response organisations. In addition regulatory body should require that emergency plans be prepared the on-site area for any practice or source, which could necessitate an emergency response.The regulatory body should ensure that these plans are integrated with those of other response organisations as appropriate before the commencement of operation. The regulatory body should also ensure that these plans provide reasonable assurance of effective response in a radiation emergency.

Lecture notes:

This lesson concerned emergency planning for radiation emergencies. It provided a practical step-by-step method for developing integrated operator, local and national radiation emergency response capability.

The main two subjects we did cover were basic concepts – threat categories, planning areas and zones, planning levels and responsibilities, emergency classes and conditions, and integrated planning concept – and planning methodology consisting of ten tasks that can be planned, developed and executed independently. And remember, plans are dynamic documents.


Where to Get More Information
INTERNATIONAL ATOMIC ENERGY AGENCY
Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency
EPR-METHOD 2003
Vienna, 2003
Module 15 - Developing Emergency Response Capability - Step-by-step Process
30

Block 4: Development of a Response Capability

Module 16: Outlines of Emergency Plans and Procedures

Learning objectives: Upon completion of this module, the participants will:

- understand the requirements for writing an emergency response plan
- be aware of QA elements for emergency plan
- be acquainted with the off-site an on-site emergency plan's outline
- understand the process of developing and writing an implementing procedure
- be aware of quality assurance requirements in developing procedures
- be able to list parts and elements of a generic procedure
- be able to write an implementing procedure

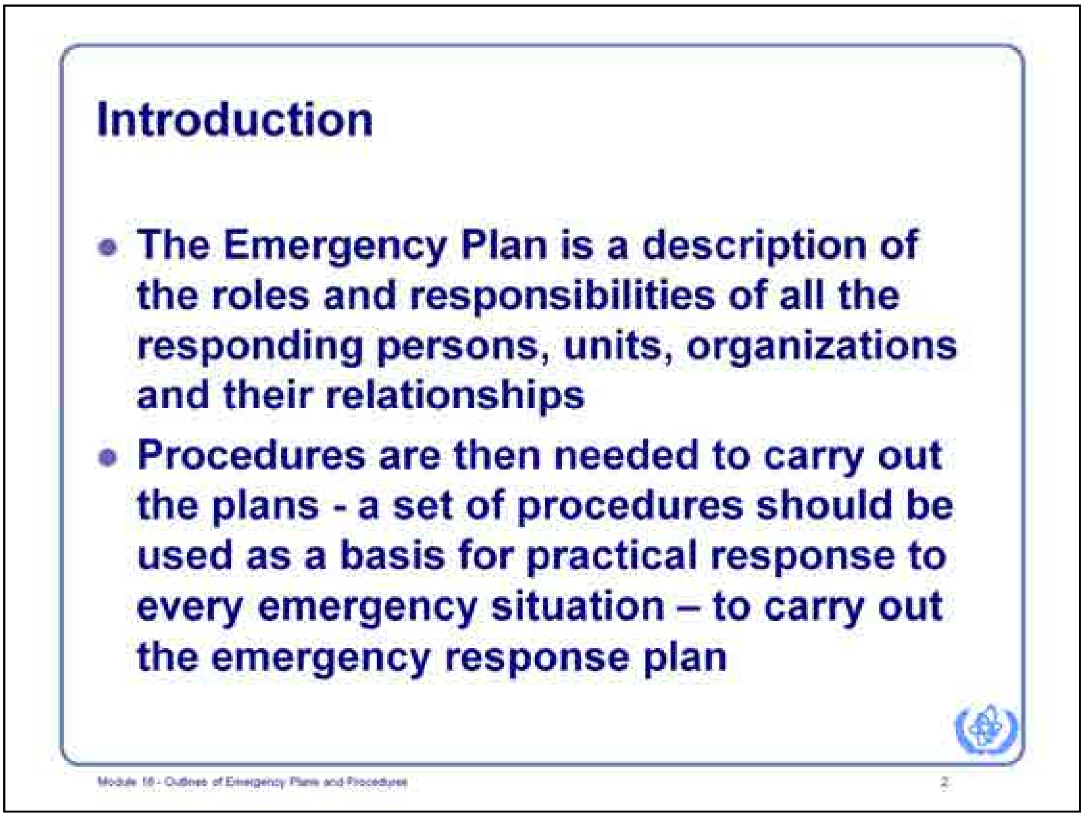
Activity: Seminar, questions and discussion

Duration: 1 hr

Materials and equipment needed: none

References:

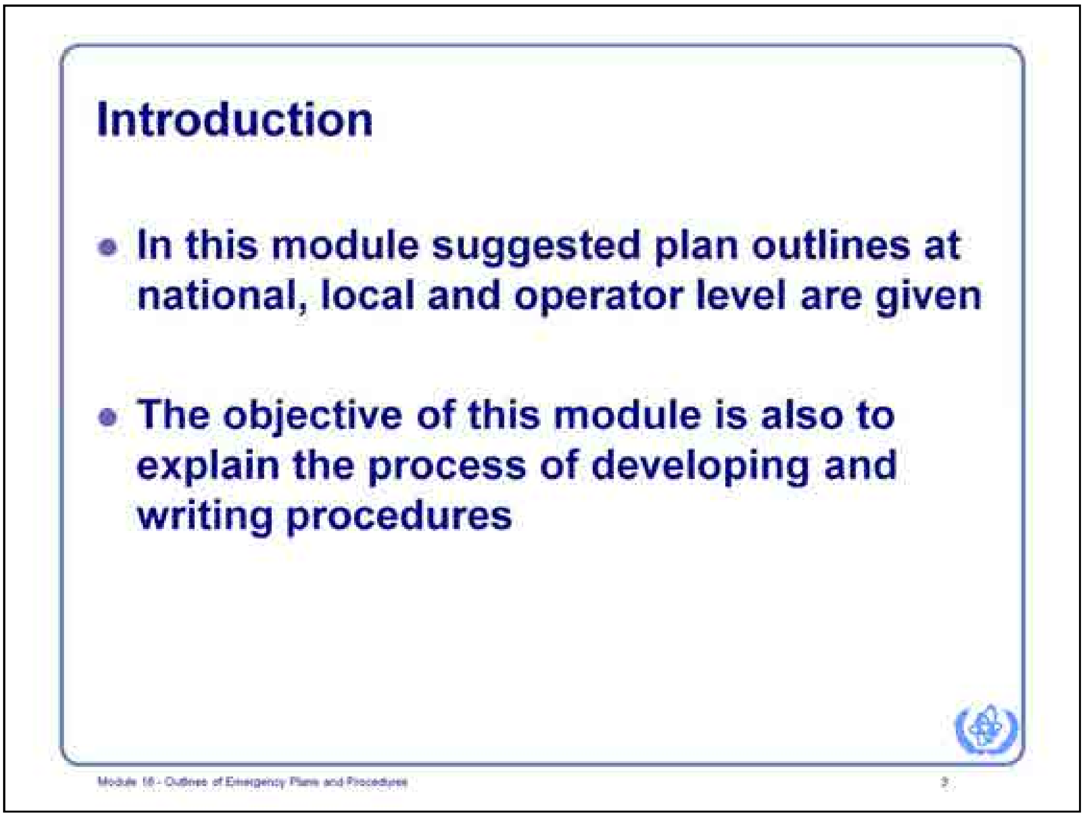
1. INTERNATIONAL ATOMIC ENERGY AGENCY, Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency, EPR-METHOD 2003, IAEA, Vienna (2003)
2. INTERNATIONAL ATOMIC ENERGY AGENCY, Preparedness and Response for a Nuclear or Radiological Emergency, Safety Standards Series No. GS-R-2, IAEA, Vienna (2002)
3. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Response to a Nuclear or Radiological Emergency at Research Reactors, EPR-RESEARCH REACTOR, IAEA, Vienna (2011)



Lecture notes:

Radiation emergency plans should be developed as a part of the overall emergency response system. Radiation emergency plan is a description of the roles and responsibilities of all the responding persons, units, organisations and their relationships. Procedures are then needed to carry out the plans.

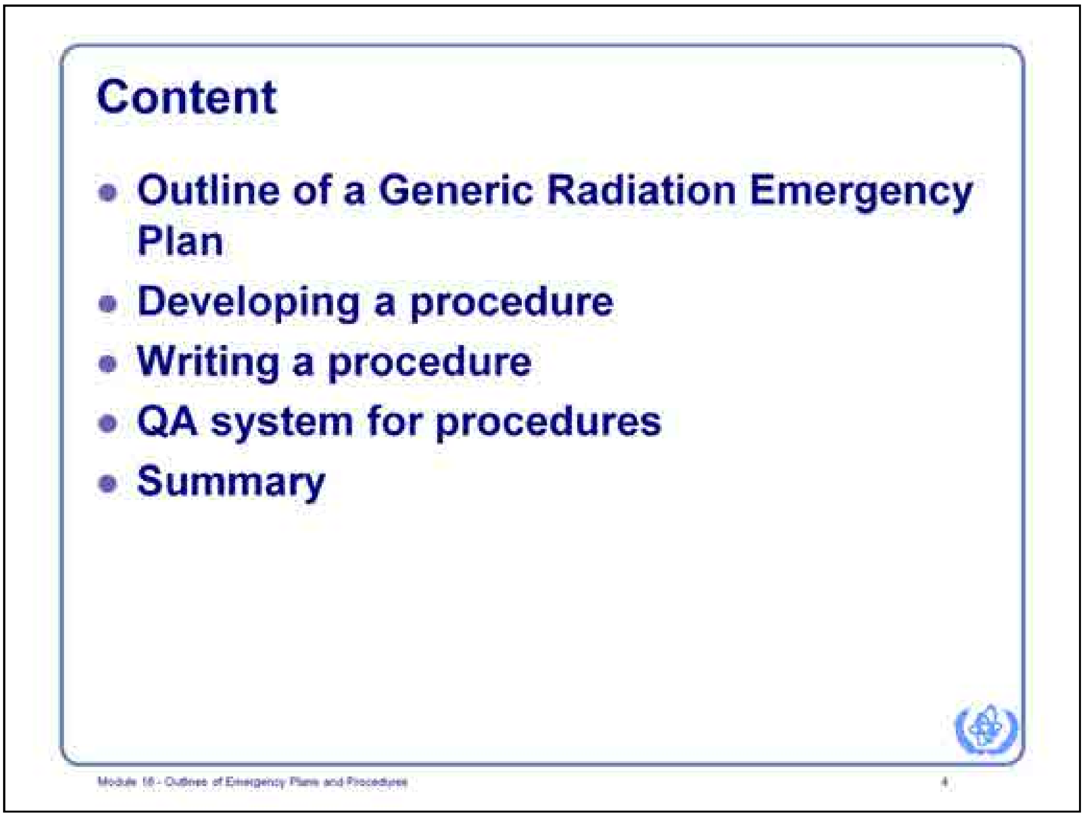
In this lesson we will present suggested plan outlines at the national, local and participating organisations level at the facility level (on-site plan).



Lecture notes:

Emergency response plans and procedures form an obvious part of emergency response preparedness capability. They represent one of the seven infrastructure elements to achieve a sound emergency preparedness. The other being authority, organization, co-ordination, logistical support and facilities, training, drill and exercises, and quality assurance and programme maintenance.

A set of procedures should be used in any emergency situation to carry out the emergency response plan. In this lesson we will explain, therefore, basic requirements, rules and steps in developing and writing an implementing procedure or operational instructions.

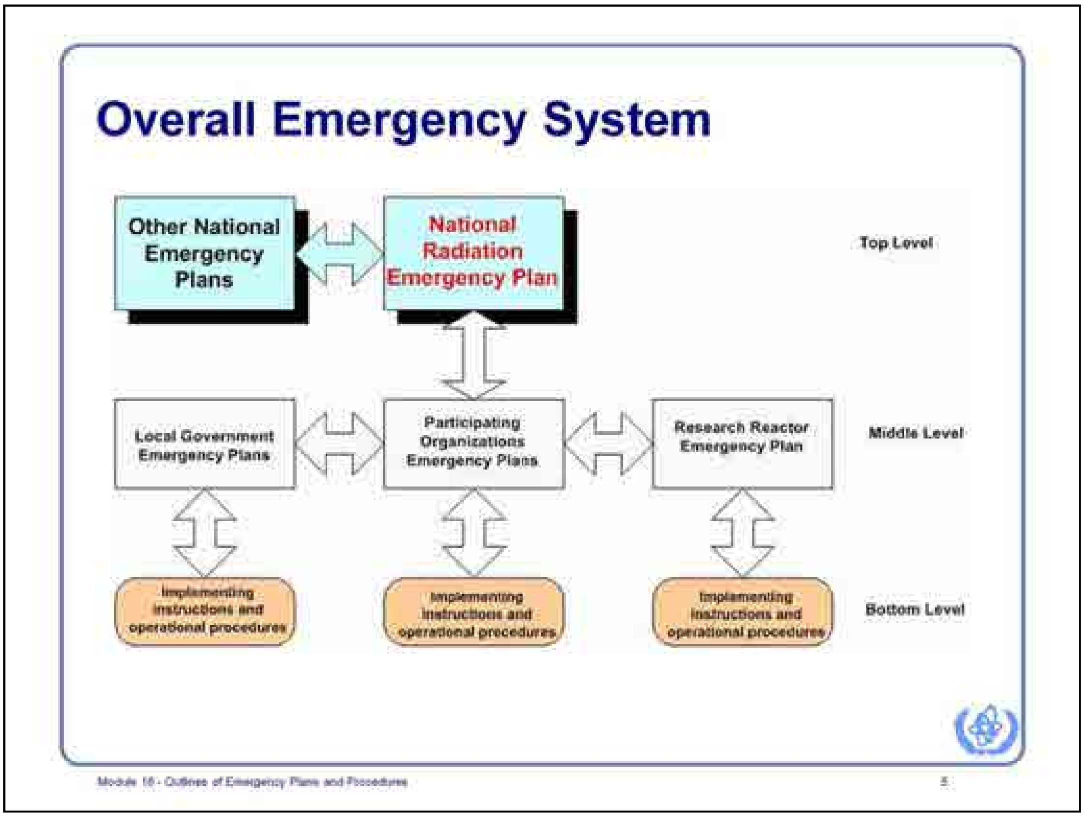


Lecture notes:

We will start this lesson by explaining a suggested, generic outline of a Radiation Emergency Plan.

Then we will explain why implementing procedures or operational instructions are needed and where is their place in an overall emergency system. Finally we will discuss a process of developing, writing and maintaining a procedure.

We will conclude the presentation with a short summary of main module’s points.



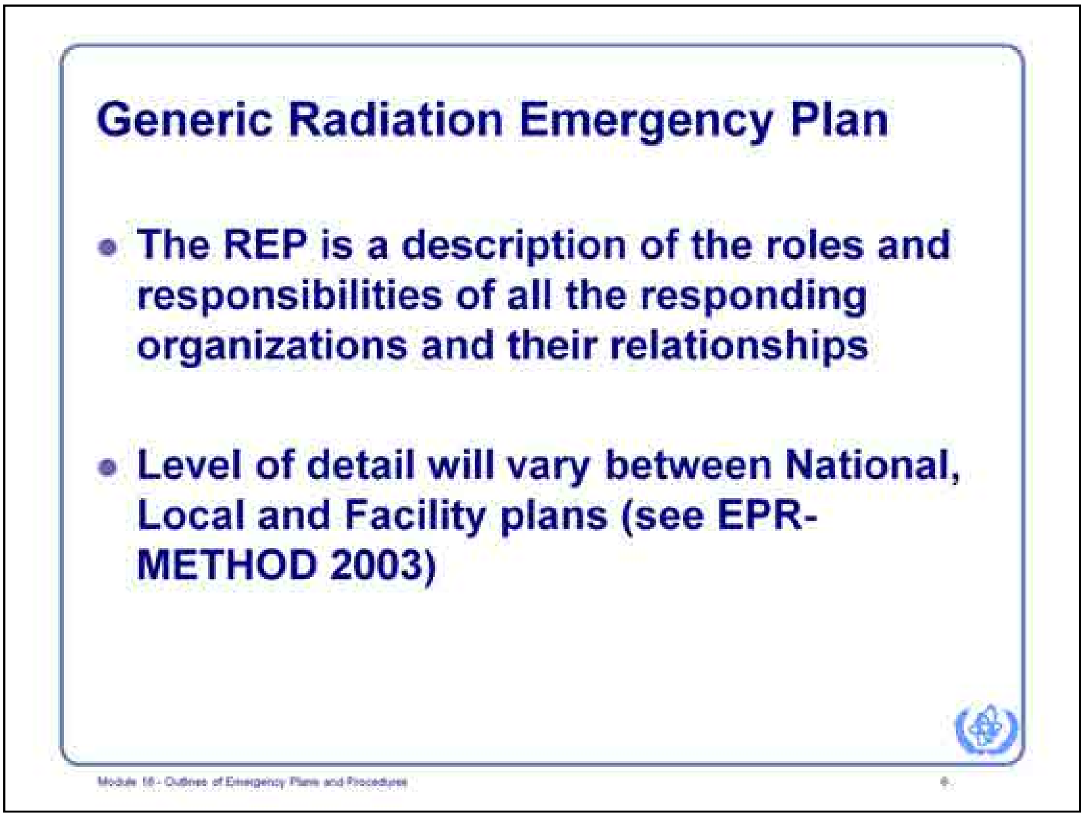
Lecture notes:

Emergency response plans and procedures in a country should be structured into a coherent and interlocking system as shown on this slide.

At the top level is the National Radiation Emergency Plan (NREP).

In the middle level there are the emergency response plans developed by ministries, individual agencies, governmental jurisdictions, and facilities or operators.

The bottom level represents the procedures (e.g., operational procedures and implementing instructions) that will be used during an emergency to carry out the plans.

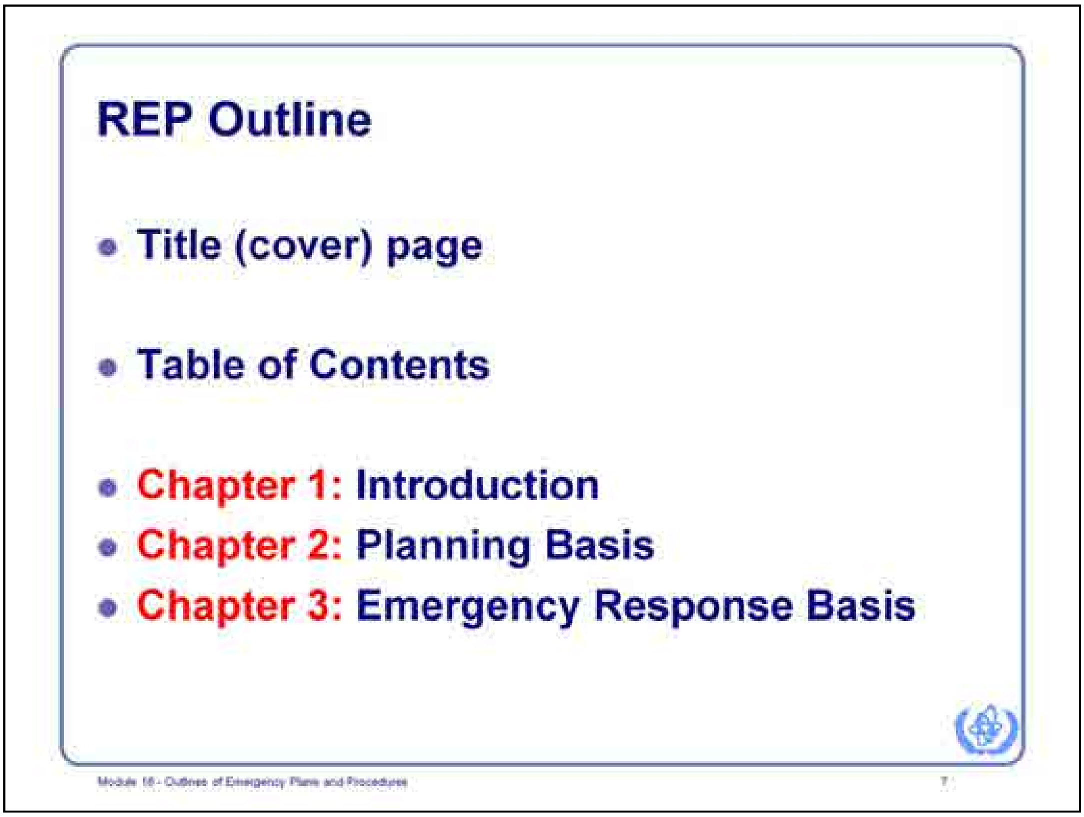


Lecture notes:

The EP should be developed as part of the overall emergency response system for the country. The NREP should be integrated with the other national and local plans used to response to conventional emergencies. The NREP should deal principally with the unique aspects of a response to a radiation emergency at the national level. The aspects of the response that are not unique to a radiation emergency should be addressed by the plans for conventional emergencies. Obviously the plans for radiation and conventional emergencies must be integrated. This must include a mechanism for directing the overall response carried out under both plans; and resolving conflict over priorities and resources.

Plans at the National, Local, and then facility level will all be similar in format, but content will be slightly different. Generally the detail of activities such as the expected concept of operations, how organizations provide support, and so on, increases from the National plan to the facility plan. The outlines in EPR-METHOD 2003 provide sample plans that fully comply with, and are organized around the requirements of IAEA GS-R-2

The following is an example of suggested plan outline. Other formats or structures can be entirely adequate, provided that they are comprehensive. Preferably, the structure of the radiation emergency plan should be consistent with that of other existing national emergency response plans.



Lecture notes:

A Radiation Emergency Plan should contain, but not necessarily be limited to:

- background information explaining purpose, scope and legal authorities,
- planning basis, and
- emergency organisation, authorities and responsibilities within the emergency organisation.

(See next slide for continuation)

REP Outline – Cont'd

- Chapter 4: Emergency Preparedness Process
- References
- List of Abbreviations
- Distribution List
- Appendices

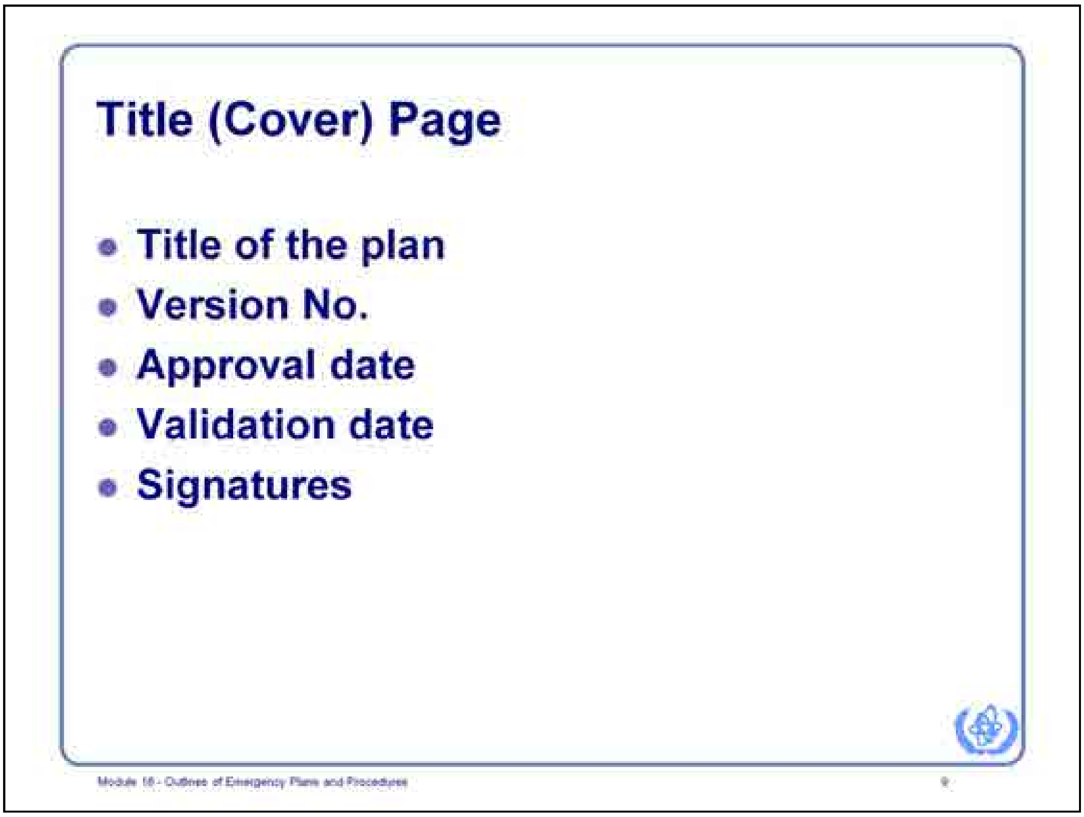
Module 16 - Outlines of Emergency Plans and Procedures 8

Lecture notes:

The REP should also contain emergency response mechanism e.g., concept of operations, and emergency preparedness elements such as plan maintenance, training and public education.

References, list of abbreviations and distribution list conclude this part of the plan outline.

A number of appendences are also suggested such as a comprehensive list of authorities, responsibilities and capabilities of national agencies, ministries and organisations, table of international legal authorities and agreements, national intervention levels, facilities and specialized radiological resources in the country, list of operational procedures to carry out the plan and list of supporting documentation.

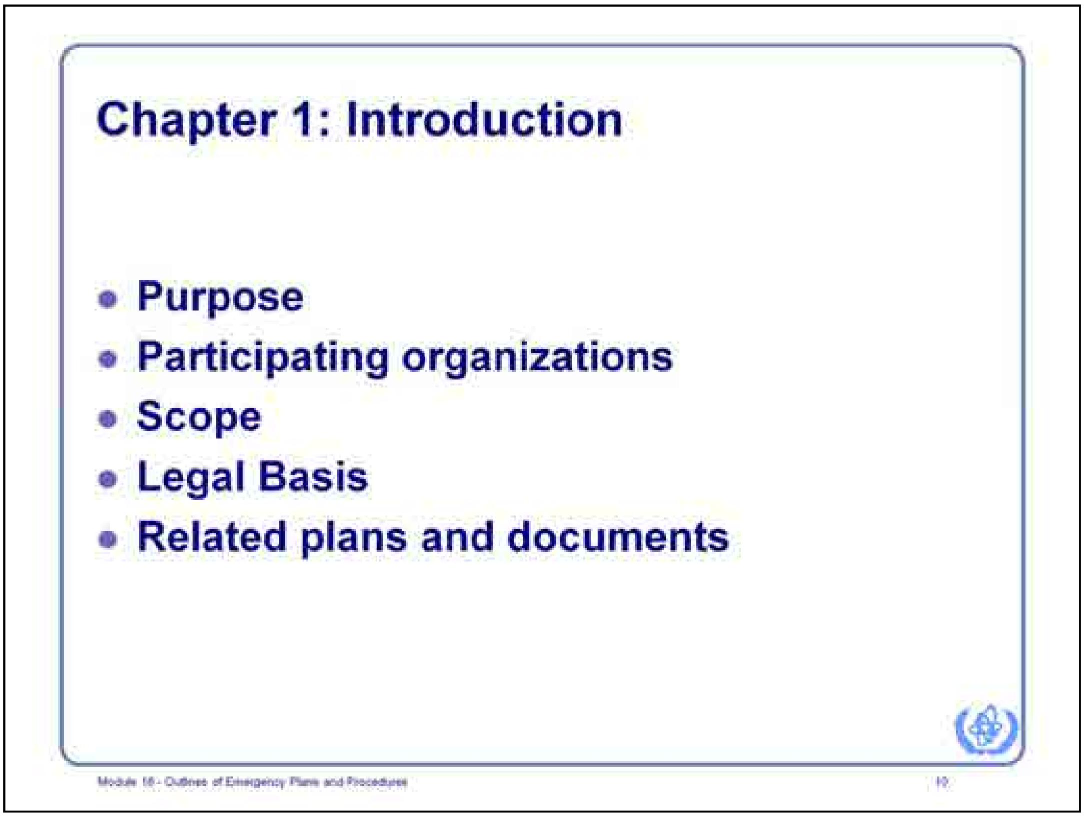


Lecture notes:

On the title (cover) page write the title of the plan, approval date, version No., and validation date (if different from approval date), and concurrence/signatures. Signatures of the heads of all the agencies and organisations with a role during the response to a radiation emergency you may wish to put on the inner (second) page.

The Plan should be viewed as a controlled document. That implies a formal identification and copy tracking system to verify that each organization with a copy of the plan, and actions to follow as described in the plan has a current copy, and invalid copies are destroyed.

Ensure that every organization with a defined role in the plan agrees and signs.



Lecture notes:

1. INTRODUCTION AND BACKGROUND

Introductory material, but important because it describes the participating organizations and the legal basis for the plan.

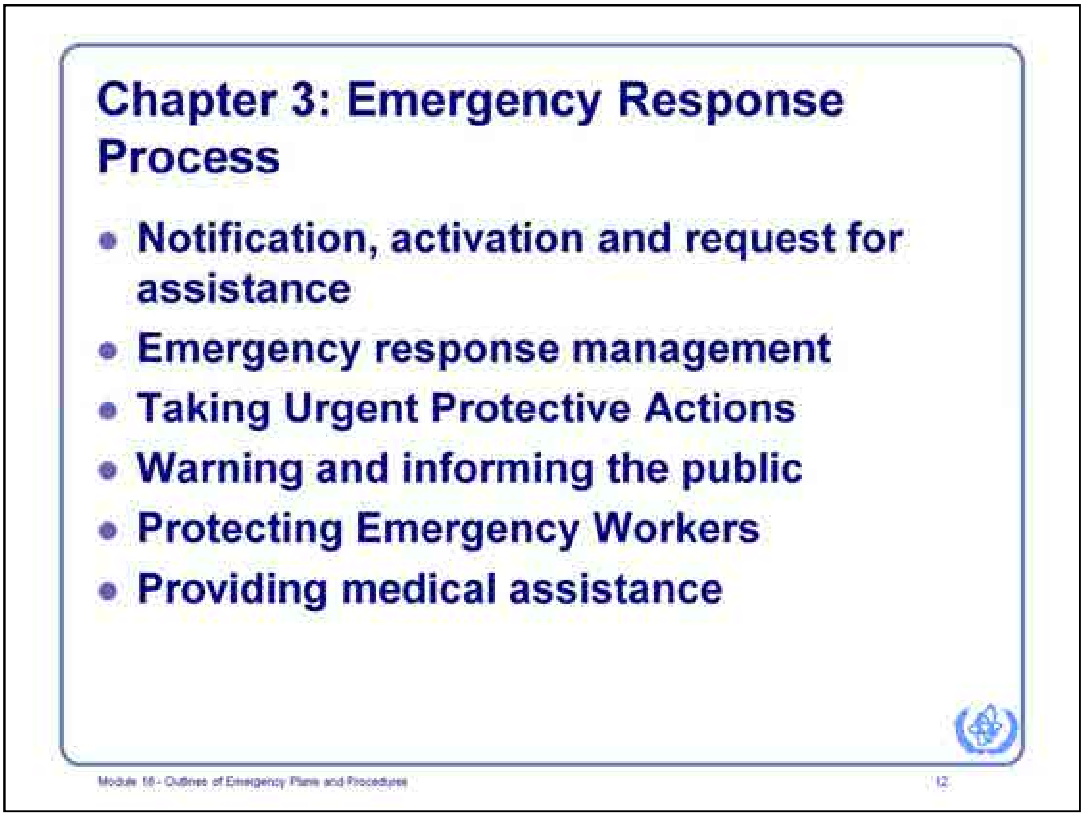
Lecture notes:

2. PLANNING BASIS

What were the assumptions regarding threats, one should be able to review those and judge the adequacy of what follows in the plan.

The response facilities would describe location of supplies, perhaps evacuation routes in the local level plan. National plans may show additional information.

Some facilities will be unique to each plan, such as the expected, and perhaps, alternate Emergency Response Centers.



Lecture notes:

3. EMERGENCY ORGANIZATION AND RESPONSIBILITIES

This chapter, on this and the next slide, describes how the response is expected to work, from notification of an emergency to recovery operations. Again, the details will differ between the plans, with focus on the organization described in the particular plan. For example, at the local level, explain how a particular Urgent Protective Action will be implemented, including how it will be determined to be necessary. A corresponding procedure may need to be developed to give a step-by-step set of actions for the implementation. However, some of these actions may already exist in other Emergency Plans. If the local area already knows how an evacuation would be implemented, those actions are usually adequate for a radiation emergency and only the affected area needs to be determined and the route for the evacuation since that will be dependent on the affected area.

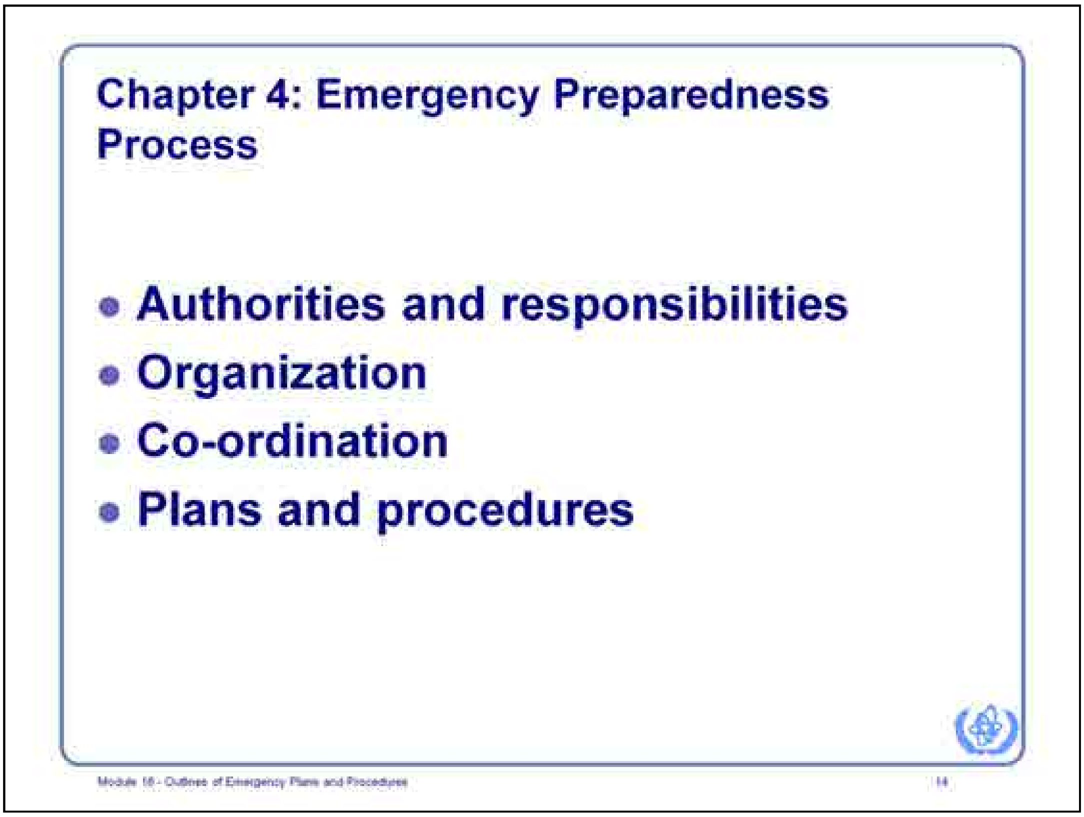
Lecture notes:

3. EMERGENCY ORGANIZATION AND RESPONSIBILITIES (cont)

Conducting recovery operations doesn’t include any details on the recovery operations themselves, but would discuss how the transition from emergency operations transitions to recovery operations where it is assumed that everyone goes back to their normal jobs. Still, it might provide for some longer term actions such as getting relocated people back home or settled elsewhere while their home is decontaminated, for example. The assumption for recovery operations is that it is no longer an emergency and doesn’t require an unusual and extraordinary level of response. For example, even now there are still recovery operations, new home building is one such activity, going on in New Orleans as a result of hurricane Katrina in 2005.

Financing may include a method to reimburse supporting organizations, or reimbursing for supplies and equipment consumed during the emergency. Clearly this will be a complicated section and may merely refer to some other documentation, such as detailed financial agreements.

The records and data are important for several reasons. They will assist a better understanding of how well, or not, the emergency response served its purpose. There may also be legal need for such records.

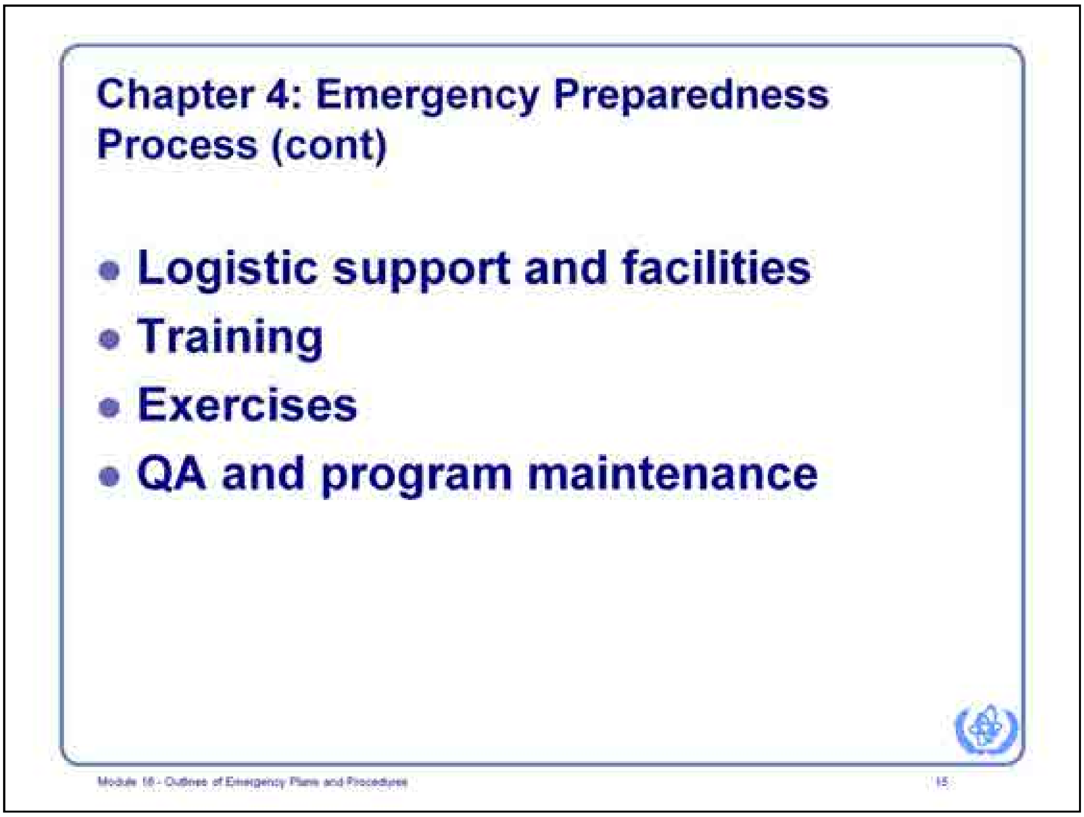


Lecture notes:

4. EMERGENCY PREPAREDNESS PROCESS

This chapter is devoted to the arrangements made to prepare and maintain the emergency plan and the supporting infrastructure. It includes arrangements for selecting the individuals who form the emergency response teams at all levels, how the plans are assured to be co-ordinated and so on.

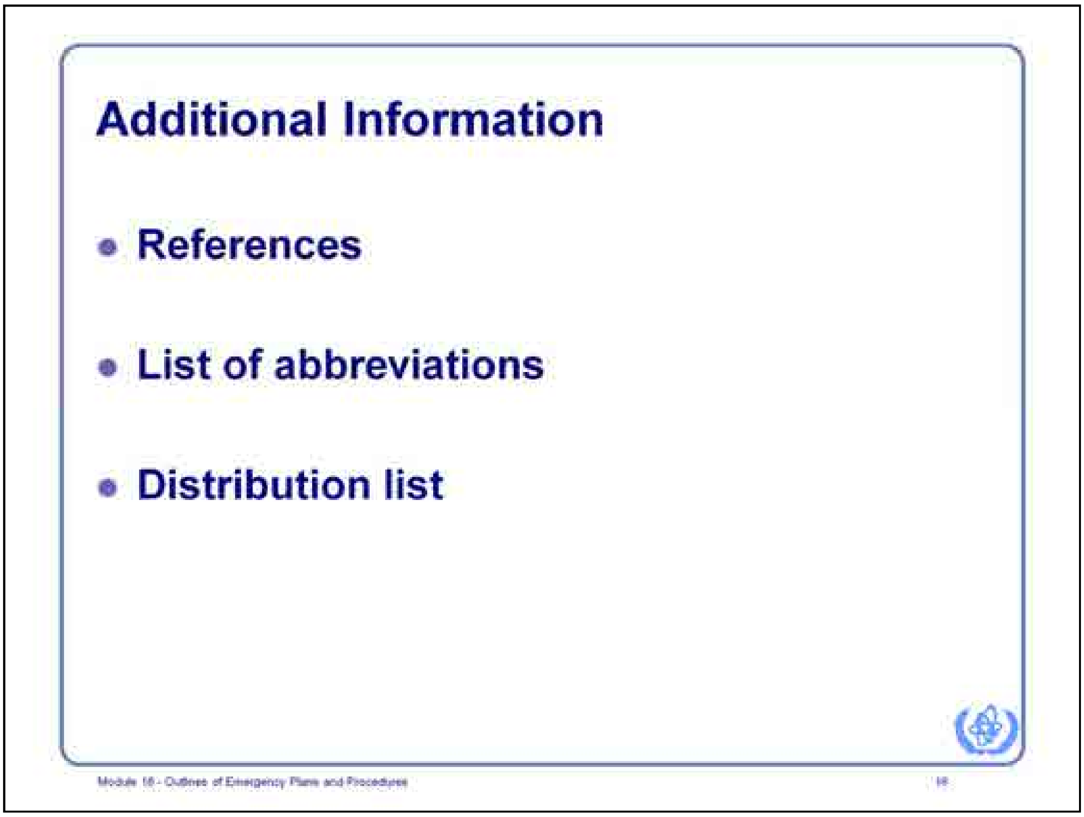
So rather than describing what the plan does, this chapter describes how the plan was prepared.



Lecture notes:

4. EMERGENCY PREPAREDNESS PROCESS

Continuing the descriptions of the arrangements to prepare and maintain the plan. The individual or position responsible for maintaining the emergency plan should be identified in the emergency plan to avoid uncertainty of who owns that responsibility.



Lecture notes:

REFERENCES

LIST OF ABBREVIATIONS

List all abbreviations used in the plan and give corresponding explanations.

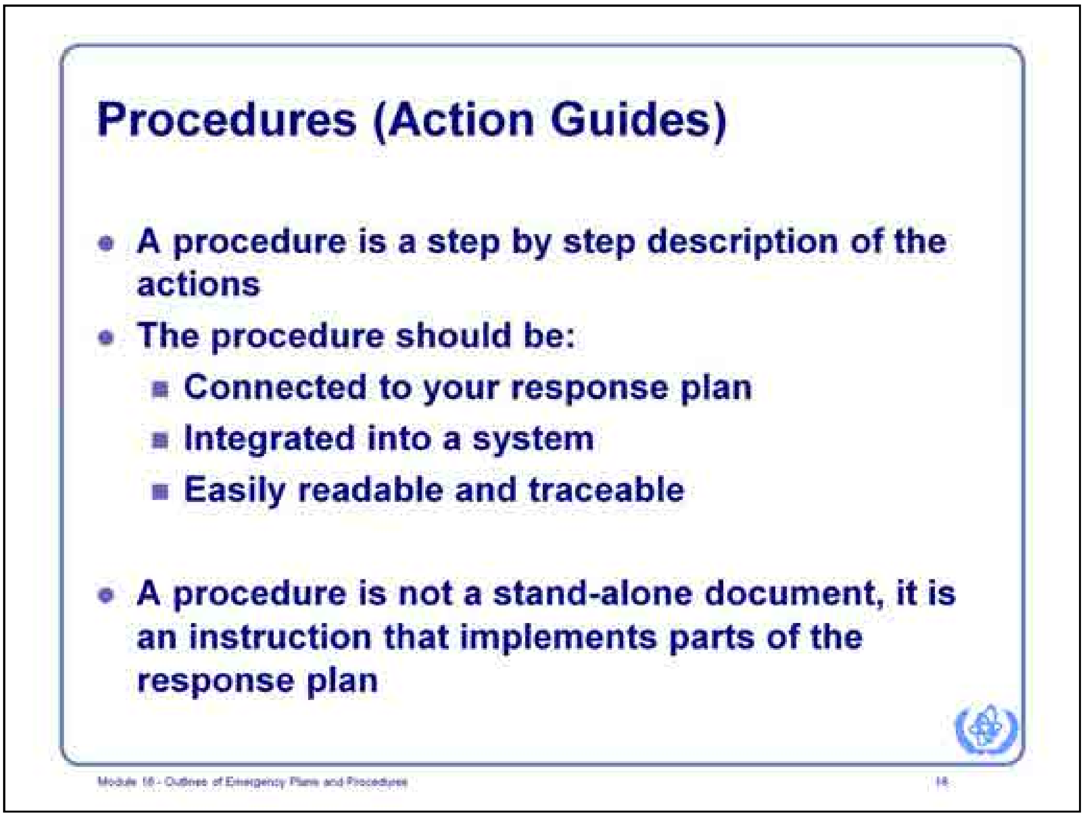
DISTRIBUTION LIST

Give a list of all individuals and/ or organisations that must receive the plan. Mechanisms for confirmation of receipt of a plan should be provided.

Lecture notes:

Here are some of the topics that may be provided in appendices, depending on the which level plan is prepared.

The Implementation Procedures are what we will discuss next. They could be in a separate document rather than an Appendix to the response plan. However, the procedures remain an integral part of the response plan.

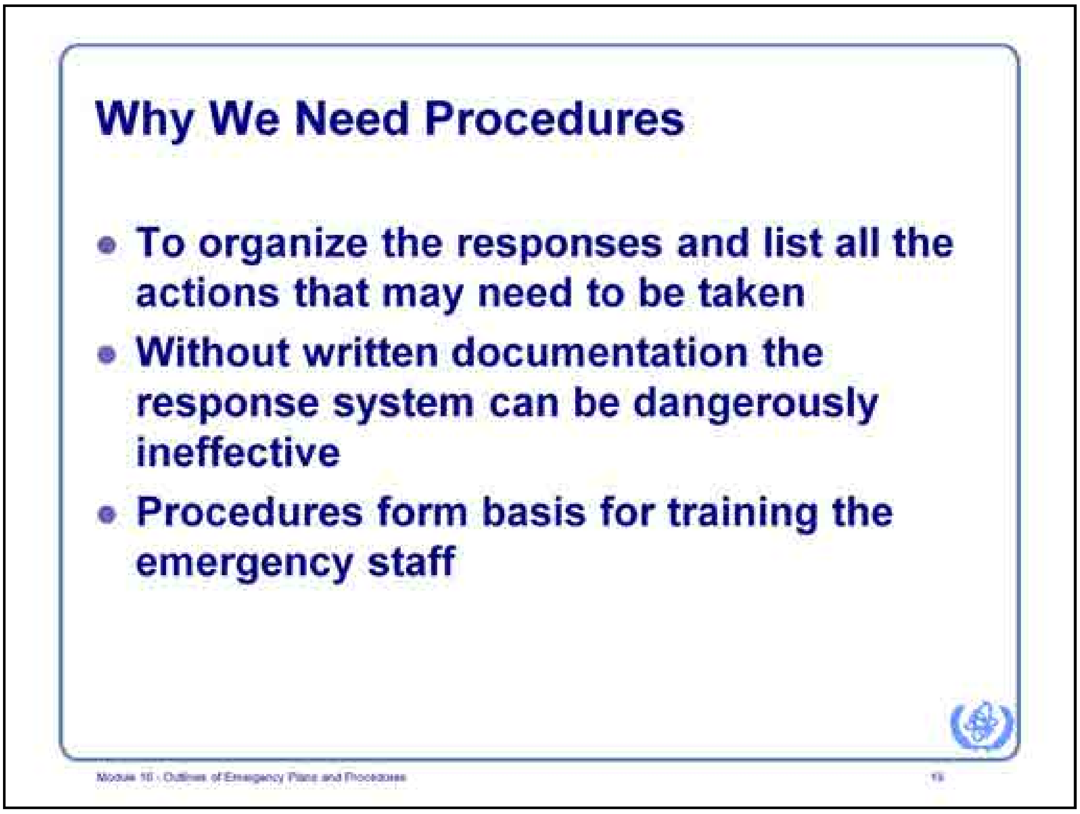


Lecture notes:

The response procedures in EPR-RESEARCH REACTOR are called Action Guides for consistency with other publications in the EPR-series. The name is not important, but the purpose and content is very important.

The set of procedures should be used as a basis for response to every emergency situation that you might be involved in. Responders need to be trained in their use. The procedures should not be developed for a specific exercise or drill. The procedures in EPR-RESEARCH REACTOR are only examples of a procedure. The reactor facility needs to carefully modify them to conform to the planned responses the facility must perform.

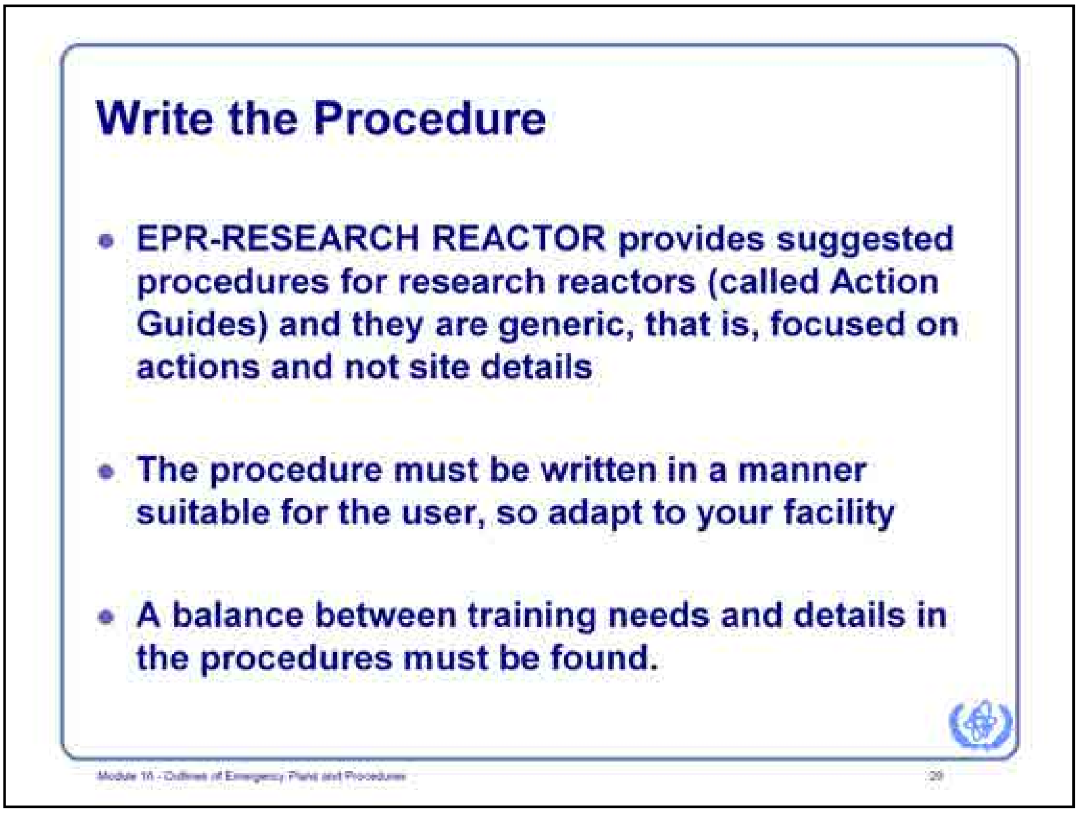
As an example of an implementation instruction, one Action Guide in EPR-RESEARCH REACTOR says to request off-site support. Now the Action Guide doesn't give names of the off-site support organizations. That should be arranged during the development of the response plan. EPR-RESEARCH REACTOR does provide a Worksheet on which the contact information can be listed for the off-site organizations that have agreed to provide support during an emergency.



Lecture notes:

Procedures are important because they can be carefully thought through and tested before an emergency occurs. The lessons from this learning process are then transferred to a written procedure to organize the response, and set the desired priorities,. Moreover accidents can happen at any time, including when the most experienced staff are on leave, sick etc. Procedures form the basis for training staff who can provide backups.

Each level of emergency response plan should define who is responsible for ensuring that emergency response procedures are developed and maintained. This person has to make sure that procedures are developed that are consistent with the relevant emergency plans. He/she should be in charge to control the process of preparing, approving, releasing and distributing of the procedures.



Lecture notes:

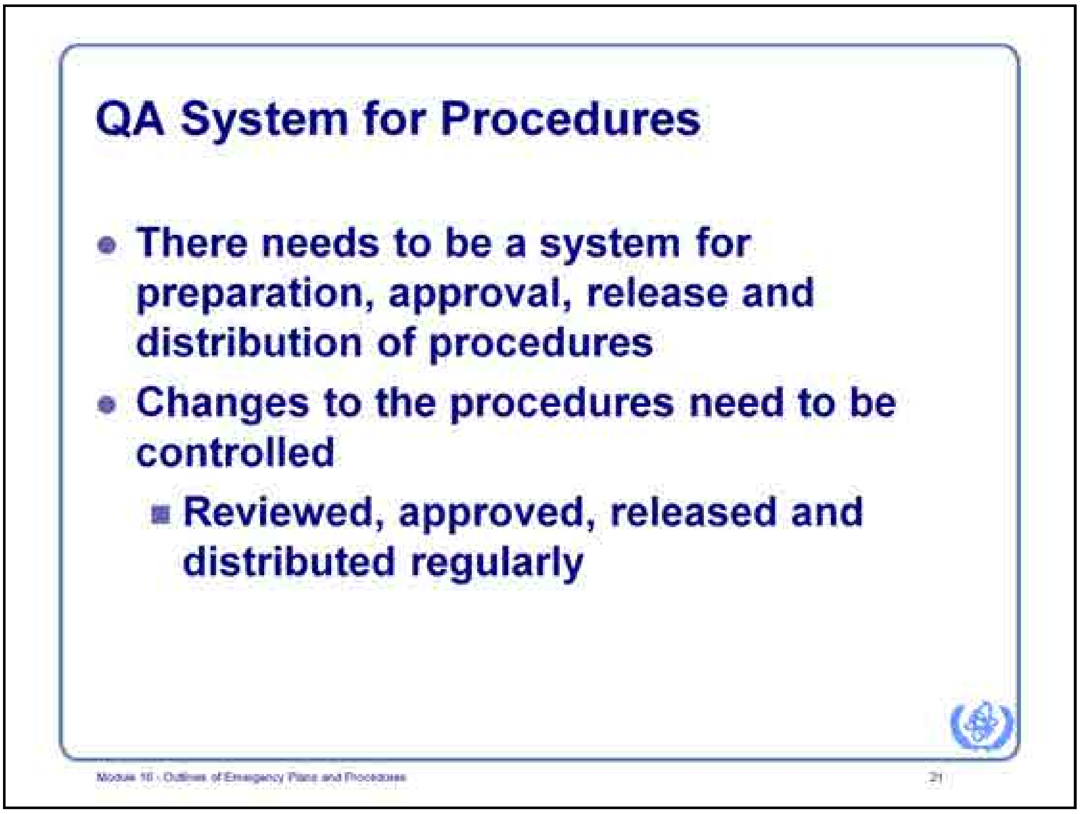
Before you start writing the procedure make sure that you have all the information that should be in the procedure. This covers all the tasks for a position from all the processes and also all the information that is needed for the system of the procedures (i.e., information on the preparation, review, approval, release and distribution of the document). For the electronic formatting it is recommended to define a template that will by default set-up the correct styles and structure. Generic structure of a procedure is explained in the following slides.

When writing the procedure always think of the user. The procedure should be easy to use and allow some flexibility. Nevertheless, all the important information should be given in the procedure. Take into account of how intensive the training will be for the persons performing a certain position. In general a good guideline is that you should write the procedure from the point of view of a person that does **not** know your system. This can be too extreme since a lot of detail on actions for specific emergencies complicates the use of the procedure, especially if an emergency develops that is not exactly like the one for which the procedures were developed.

Make sure that actions that involve two positions (like the transmission of information or the transfer of an action) are reflected in both procedures and that an appropriate protocol for their interaction is defined.

At the national and local level, procedures will also be necessary. A part of the development of procedures is to verify that the procedures are consistent with the other plans.

Other IAEA publications provide procedures that may be useful at local level. For example INTERNATIONAL ATOMIC ENERGY AGENCY TECDOC-1162, Generic procedures for assessment and response during a radiological emergency, Vienna 2000, provides procedures for police, fire fighters and medical responders that could be easily adapted to the local organization plan.



Lecture notes:

Controlling the changes means that you keep a record of all proposed changes, that the responsible person reviews the proposals, approves proposed changes to be implemented, ensures a plan is made for developing the changes and also ensures the new procedures are checked and approved before releasing updated procedures.

Distribution lists and mechanisms for confirmation of receipt of procedures should be provided.

In general, it is a good approach to develop a procedure how to develop and write a procedure.

The procedures need to have a document control system, just like the response plan.

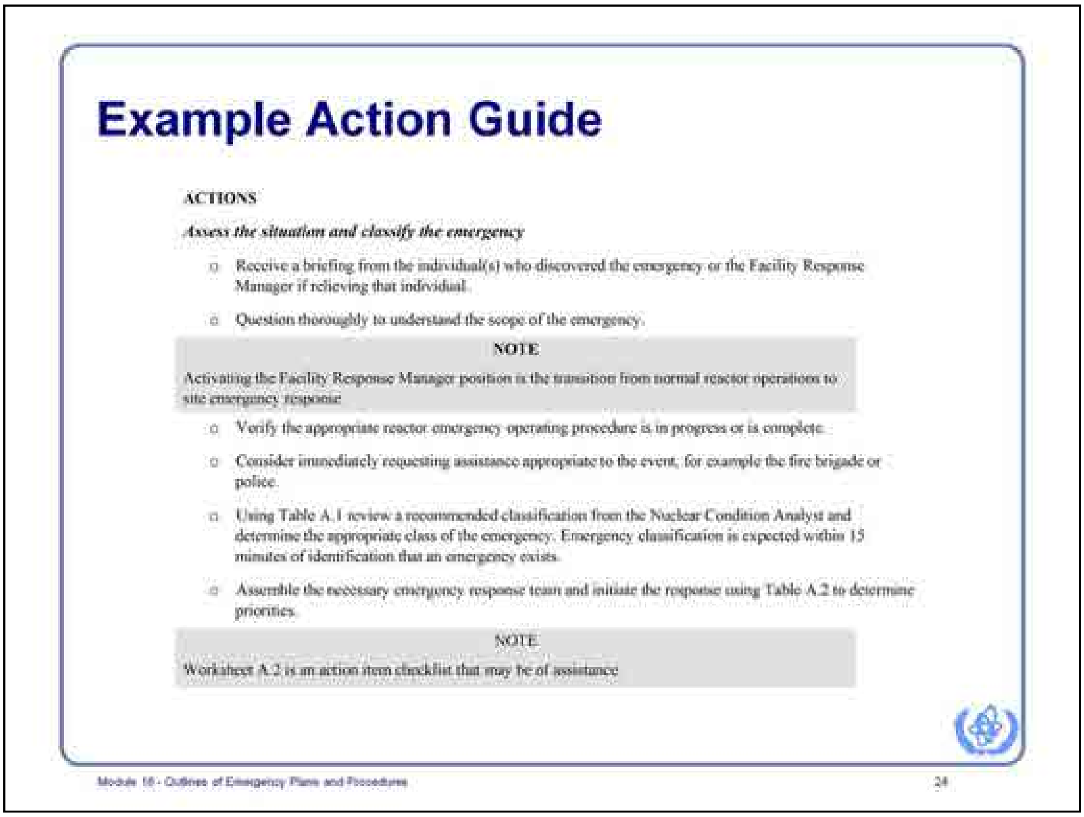
Lecture notes:

Remember that an approved procedure should not be implemented immediately. Before the procedures should become effective (be released), the response system might need to be adapted and staff will need to be trained on the new procedures.

Lecture notes:

Exercises, drills, new equipment, etc. might create a need to change your plan/procedures. Changes to the higher level plan will usually lead to changes in the procedures. Some changes will only affect the procedures. In any case you need to control the changes to the plan/procedures.

Measures (distribution lists and mechanisms for confirmation of receipt and for destroying old procedures) should be provided for ensuring those performing a procedure are aware of and use the appropriate, correct procedure.



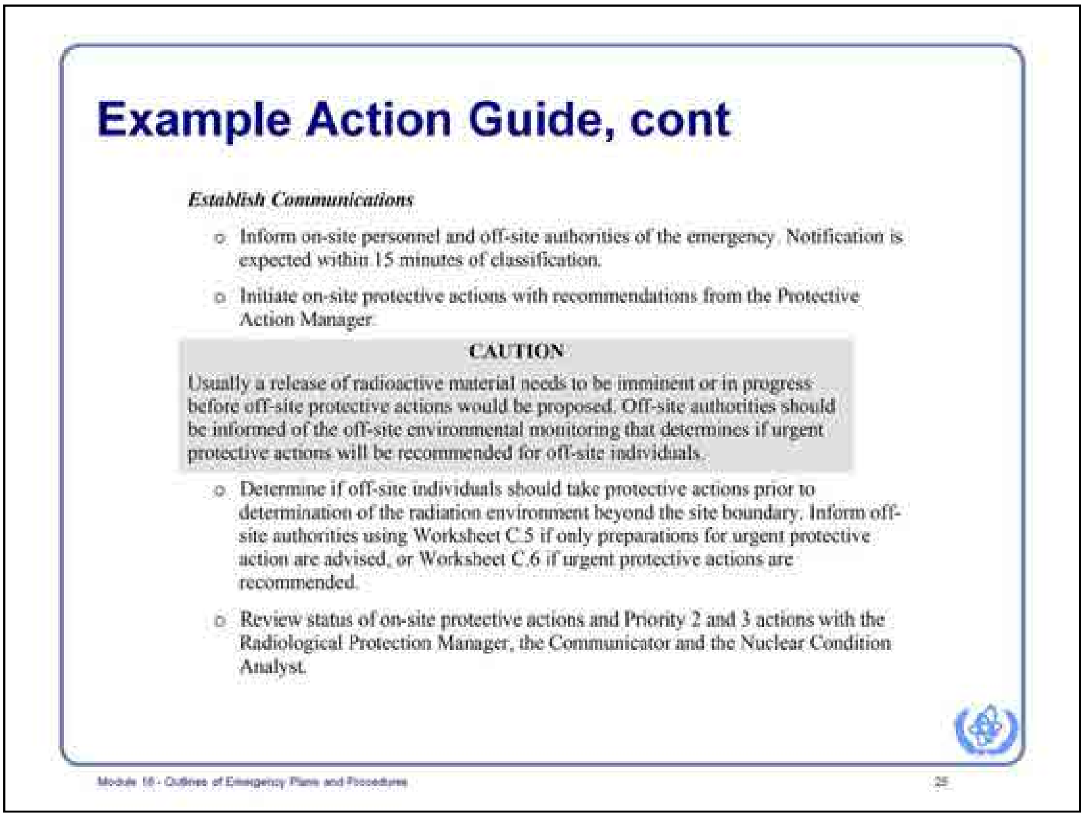
Lecture notes:

Here is the first part of one of the Action Guides from EPR-RESEARCH REACTOR. Several items to notice.

Assess the situation and classify the emergency – this is one of the four sections of the procedure

Receive a briefing from the individual(s) who discovered the emergency or the Facility Response Manager if relieving that individual. – This is a specific step, in this case, the first response step by the individual filling the role of Facility Response Manager. It also would be the first step for a second individual coming in to replace the original Facility Response Manager.

NOTES are shown after the step to which they apply, and are used to add information that is not an action. The action steps are specific actions to take.

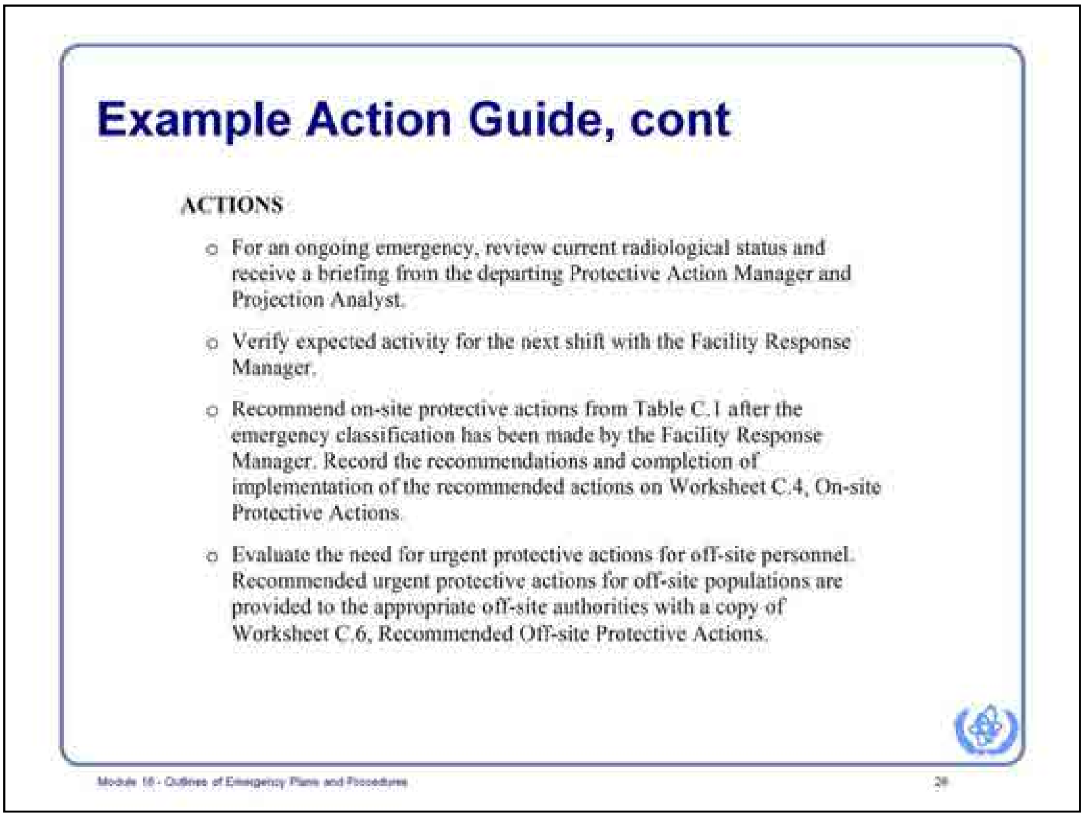


Lecture notes:

Here is the second part of the same Action Guide

Establish Communications – *is* the next set of actions for this position.

Unlike NOTES which follow the action to which they apply, CAUTION precedes the applicable step to alert the user to consider information or other actions that may influence how or to what extent the step is implemented.



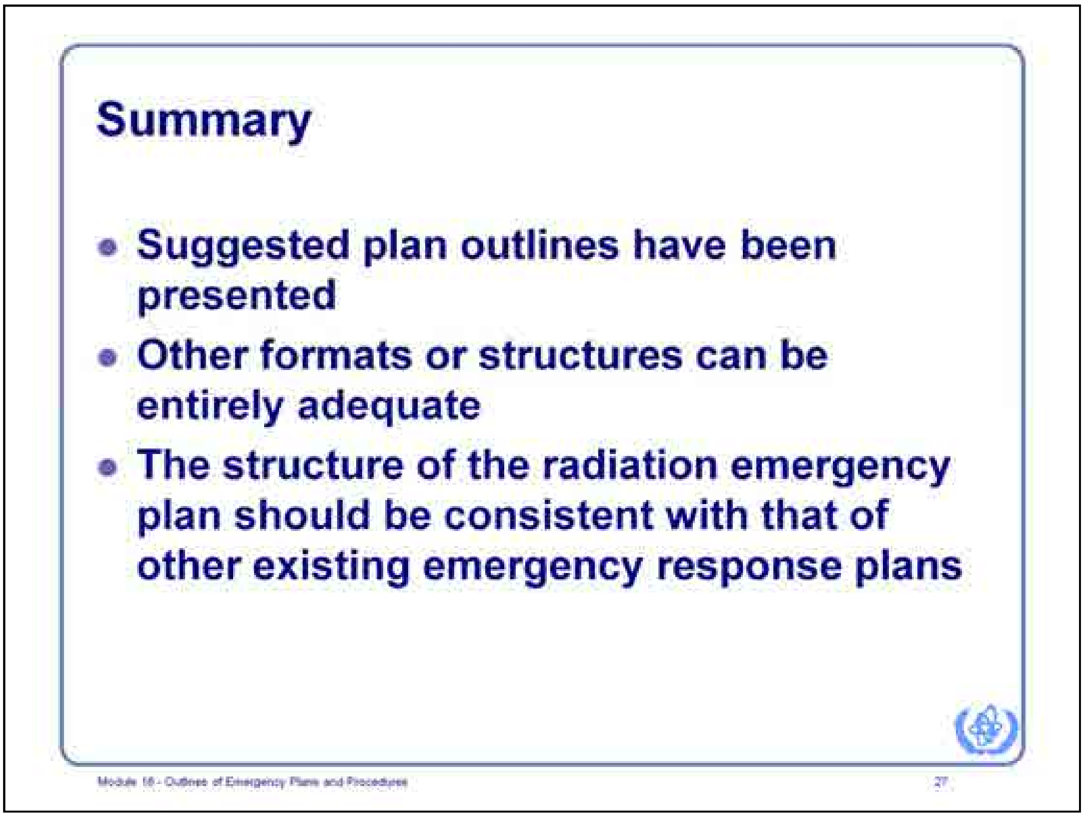
Lecture notes:

Here is another example from EPR-RESEARCH REACTOR.

The first step is present in all the Action Guides as a first action that should be taken at the start of each individual's time of duty in the position.

The second step is present in most of the Action Guides to coordinate the response actions, especially when positions are being changed from one person to another. Similarly, the Action Guides end with a step to document decisions and other actions so the record of what was done is thorough.

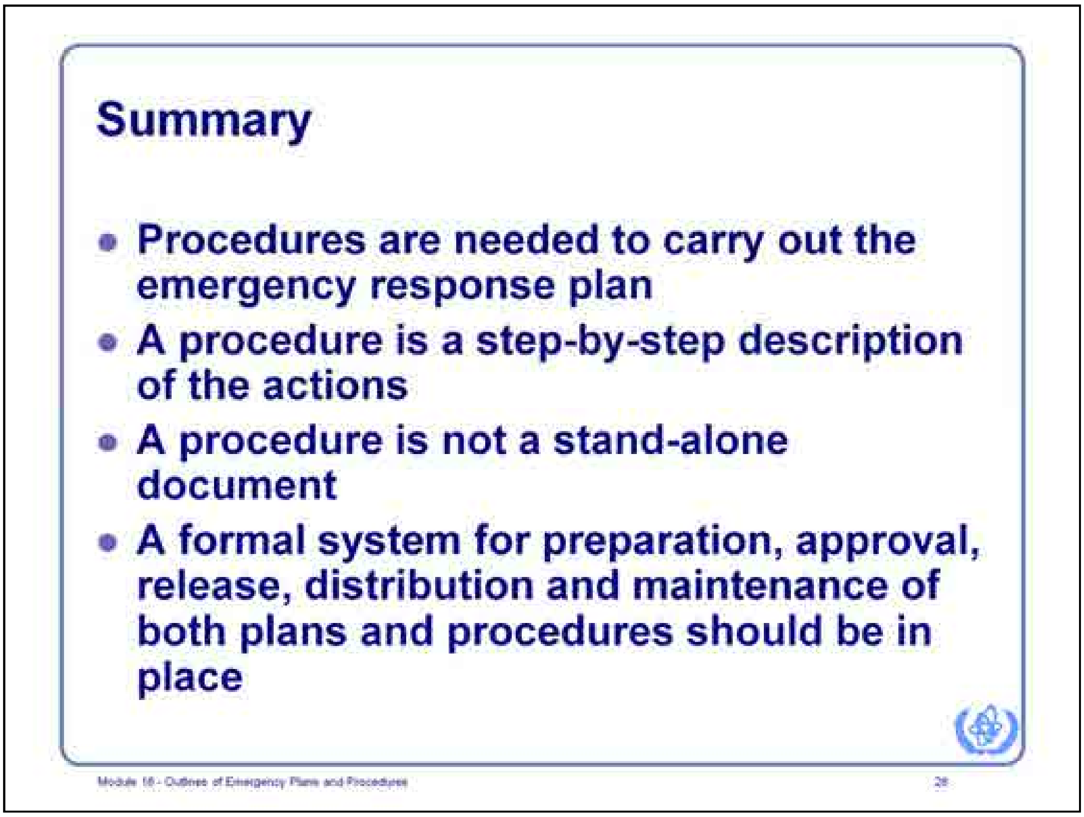
Probably worth repeating that. One reviewer of the publication noted that keeping records during an emergency meant someone at each position to record what was done by the response team individual at that position. Perhaps that is needed, but I think not in every case. Each facility needs to make their own determination of the necessity of a separate record keeper.



Lecture notes:

Let’s summarize the main subjects we did cover in this module.

We have started this module by explaining a suggested, generic outline of a National Radiation Emergency Plan. Then we continued with the outlines of local government an participating organisations’ emergency response plans. Then we have presented facility’s emergency plan outline and operator's contingency plan outline. But remember, other format or structures can be entirely adequate, provided that they are comprehensive.



Lecture notes:

We also explained why procedures are needed and where they fit in an overall emergency response system. Then we went through the process of developing, writing and maintaining a procedure. QA requirements in developing procedures were also given. At the end we presented examples of the Action Guides from EPR-RESEARCH REACTOR..

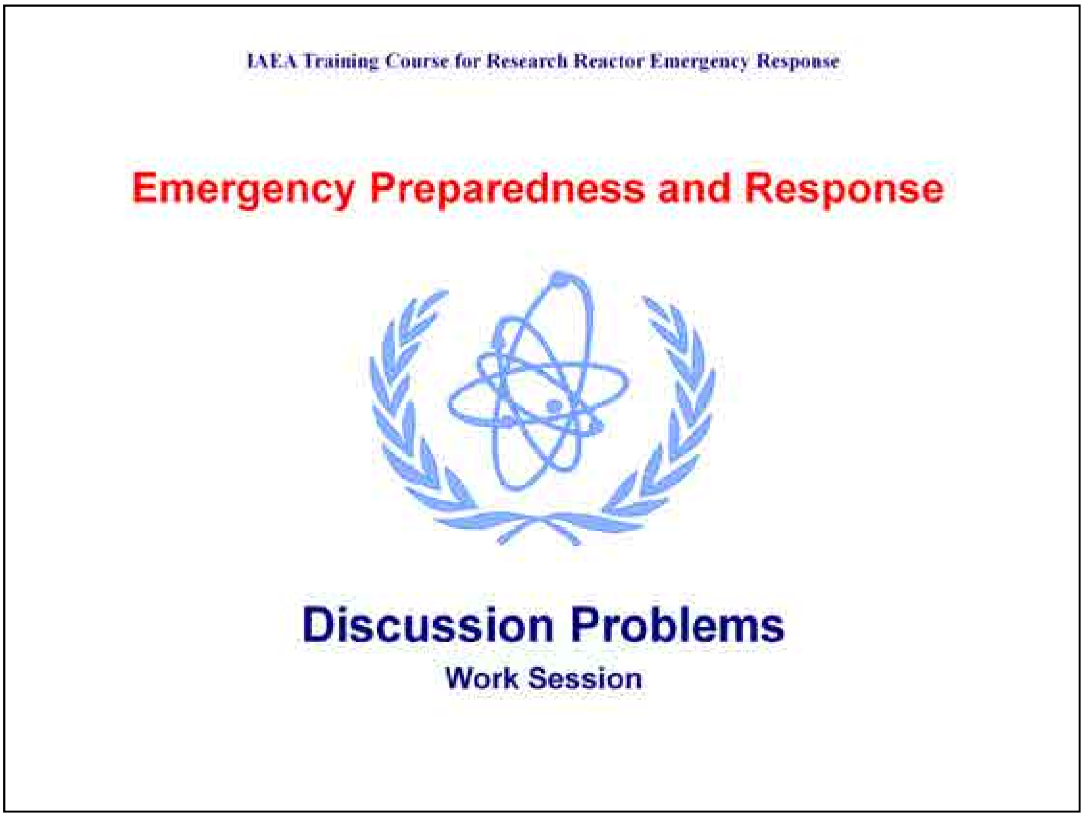
Where to Get More Information

IAEA EPR-METHOD 2003

IAEA EPR-RESEARCH REACTOR

IAEA TECDOC-1162

IAEA GS-R-2 AND GS-G-2.1



Block 3: Emergency Response and Preparedness

Module 17: Discussion Problems

Learning objectives: Upon completion of this module, the participants will have demonstrated their level of understanding of the material presented in the training course.

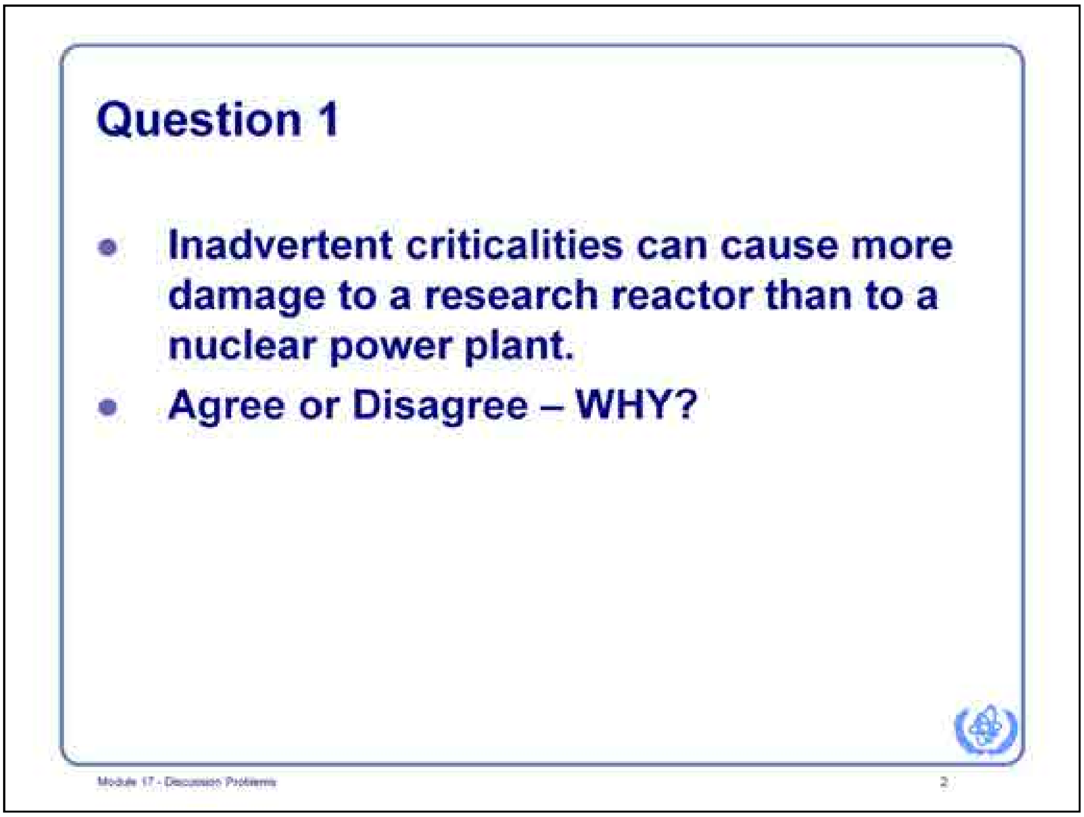
Activity: Work session

Duration: 1 hr

Materials and equipment needed: none

References:

1. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Response to a Nuclear or Radiological Emergency at Research Reactors, EPR-RESEARCH REACTOR, IAEA, Vienna (2011).



Note for this question that the TRIGA reactors are essentially immune to damage from inadvertent criticality.

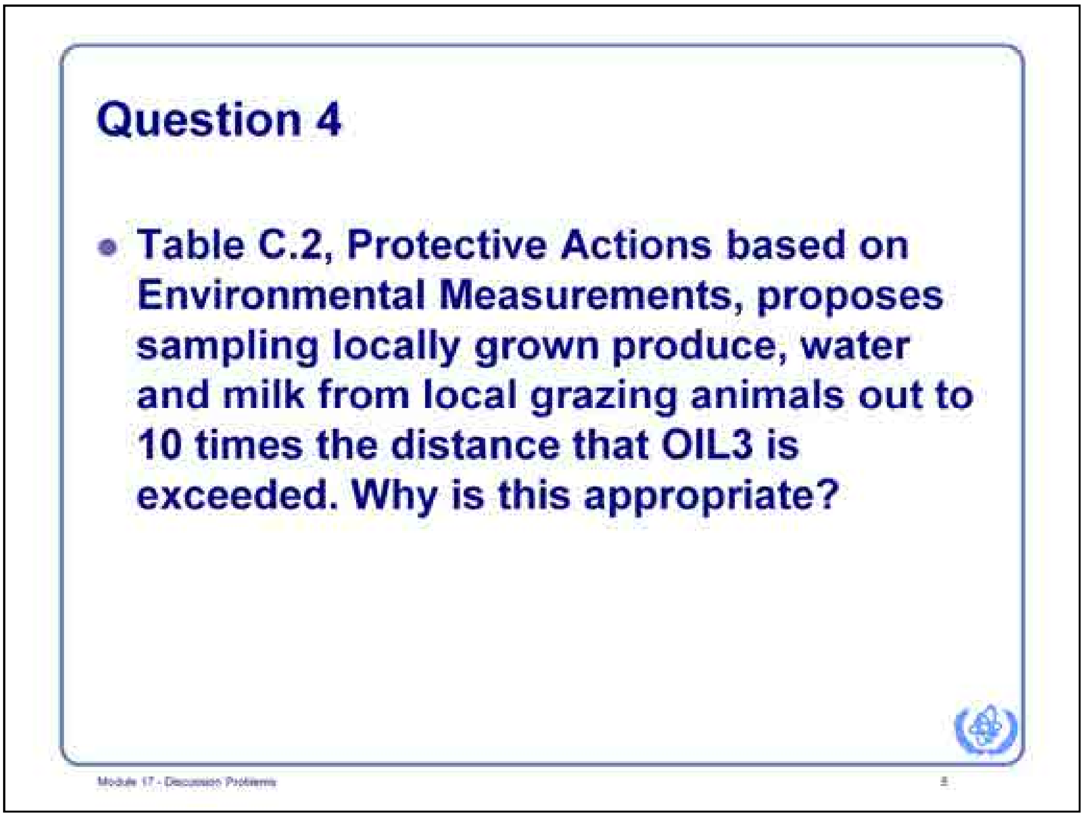
Question 2

- Research reactors are less susceptible to loss of flow accidents than a nuclear power plant.
- Agree or disagree – WHY?

Module 17 - Discussion Problems 3

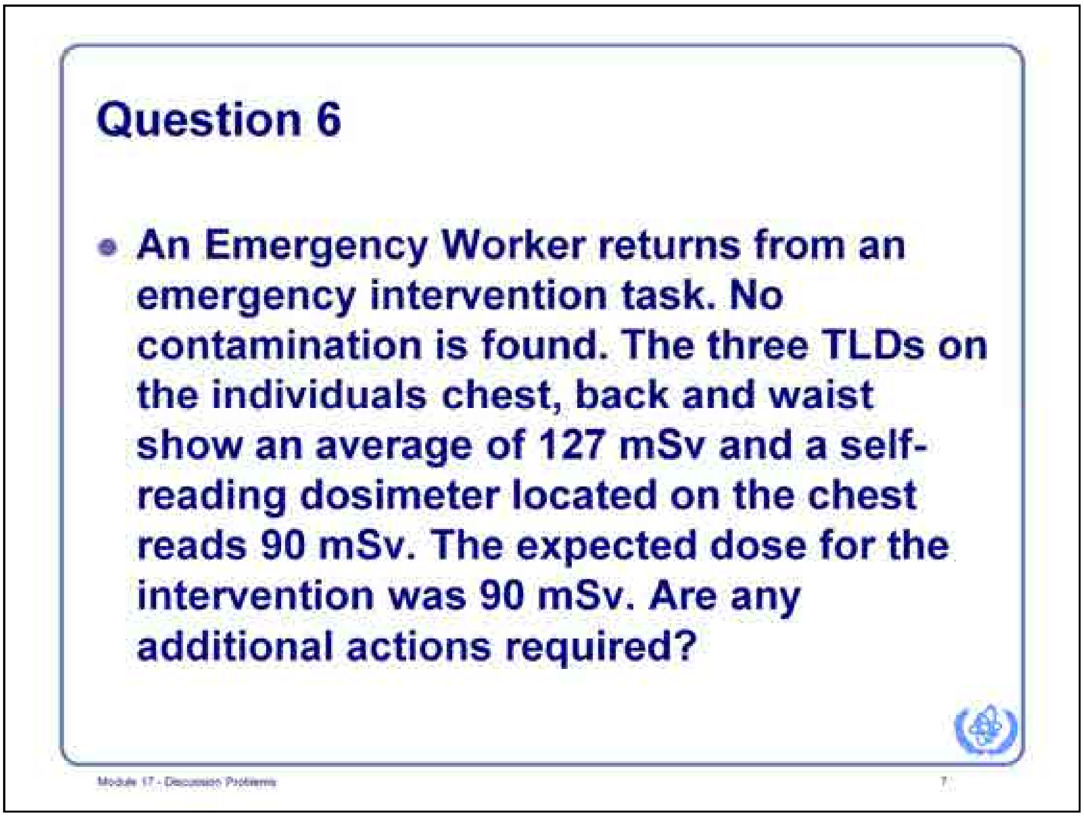
Question 3

- In 1983 an operator at the RA-2 reactor in Argentina violated operating procedures during a modification of the core configuration and caused a critical excursion. The reactor became prompt critical and the operator was exposed to a fatal dose of radiation. What might be the root cause of this event?


Question 4
• Table C.2, Protective Actions based on Environmental Measurements, proposes sampling locally grown produce, water and milk from local grazing animals out to 10 times the distance that OIL3 is exceeded. Why is this appropriate?
Module 17 - Discussion Problems

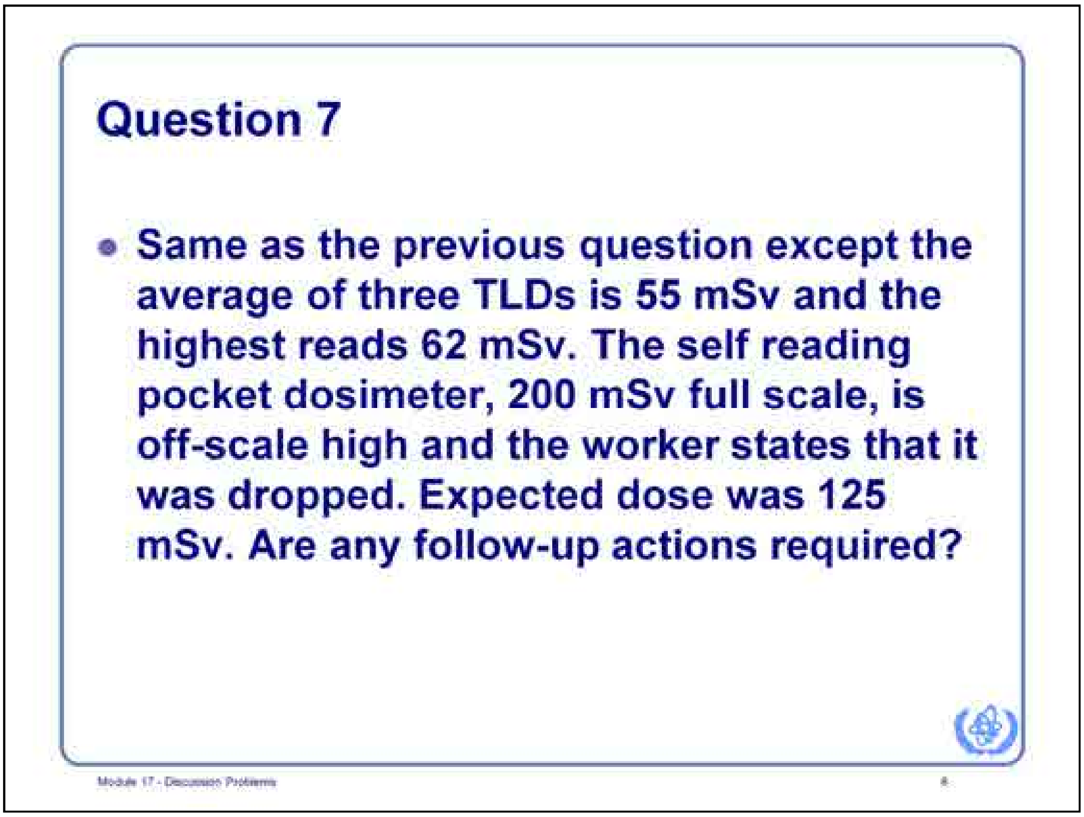
Question 5

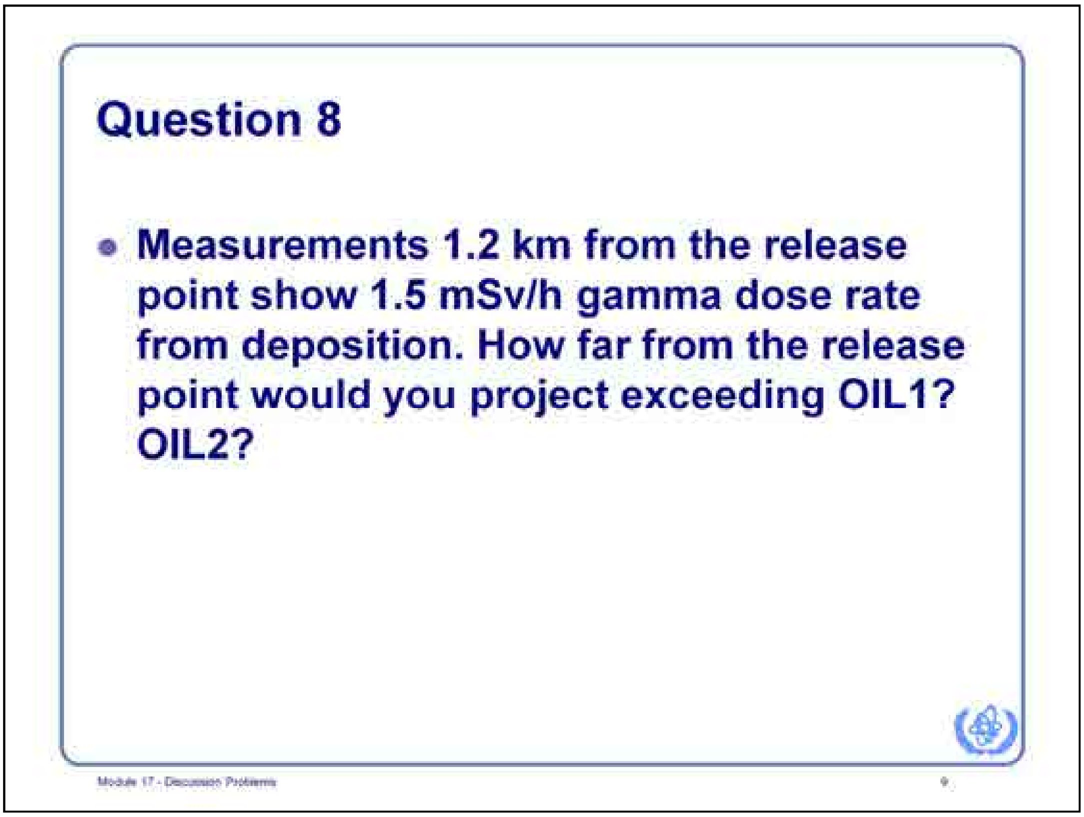
- What are the benefits of sheltering while awaiting environmental monitoring results when a release has occurred or is imminent as opposed to immediately evacuating the population from the UPZ.

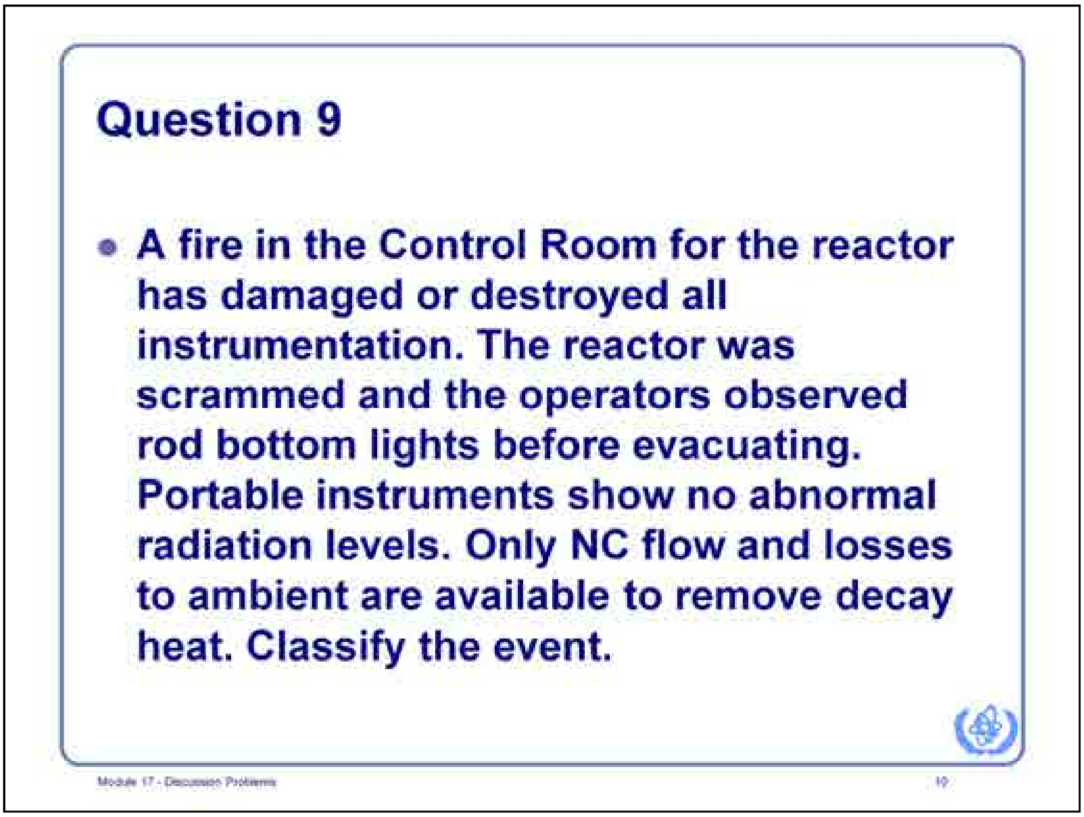


The Instructor might have to coach to avoid endless discussions on which reading is the right value or which is more accurate.

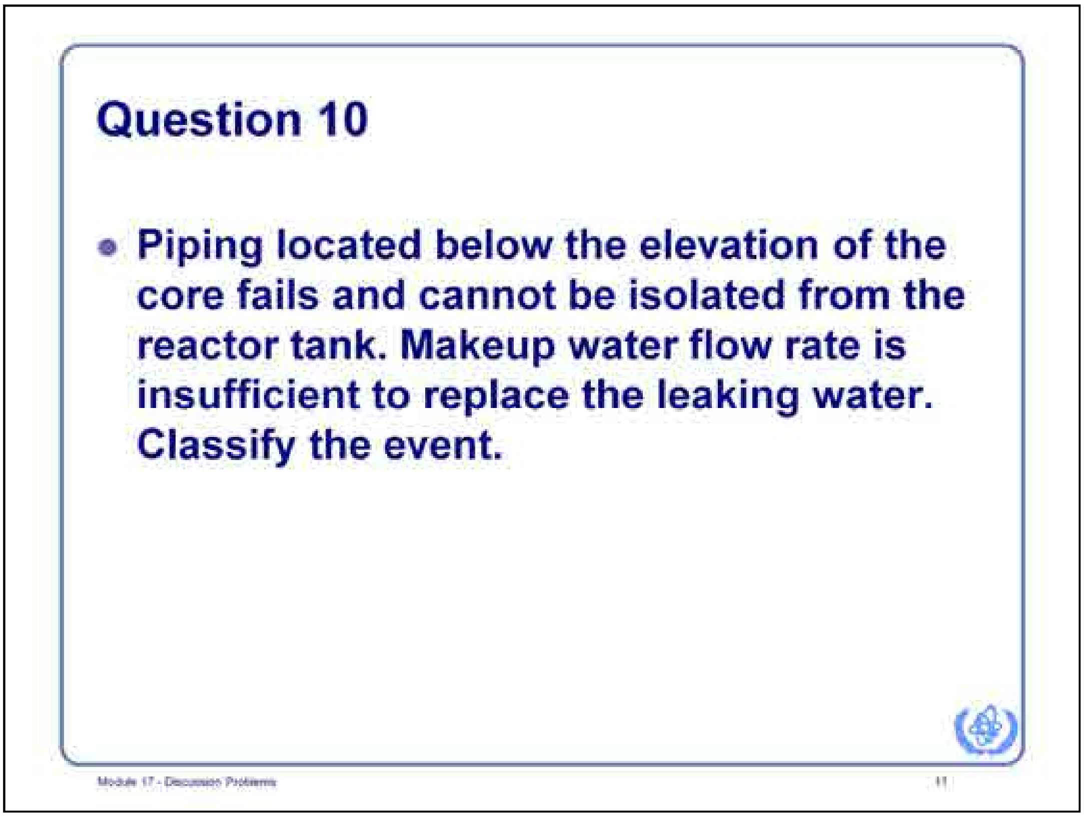
The participants might not relate the >100 mSv TLD readings to medical management protective actions.


Question 7
• Same as the previous question except the average of three TLDs is 55 mSv and the highest reads 62 mSv. The self reading pocket dosimeter, 200 mSv full scale, is off-scale high and the worker states that it was dropped. Expected dose was 125 mSv. Are any follow-up actions required?
Module 17 - Discussion Problems
8


Question 8
Measurements 1.2 km from the release point show 1.5 mSv/h gamma dose rate from deposition. How far from the release point would you project exceeding OIL1? OIL2?
Module 17 - Discussion Problems
9



The Instructor may have to coach to steer the participants away from trying to correct the problem by using portable instruments, such as a thermocouple bridge to measure fuel temperature.



Here again, the participants may focus on correcting the leak or trying to provide more makeup water. The focus should be on classification and notification. Operating staff are responsible to activate the emergency procedures for this scenario.

Question 1

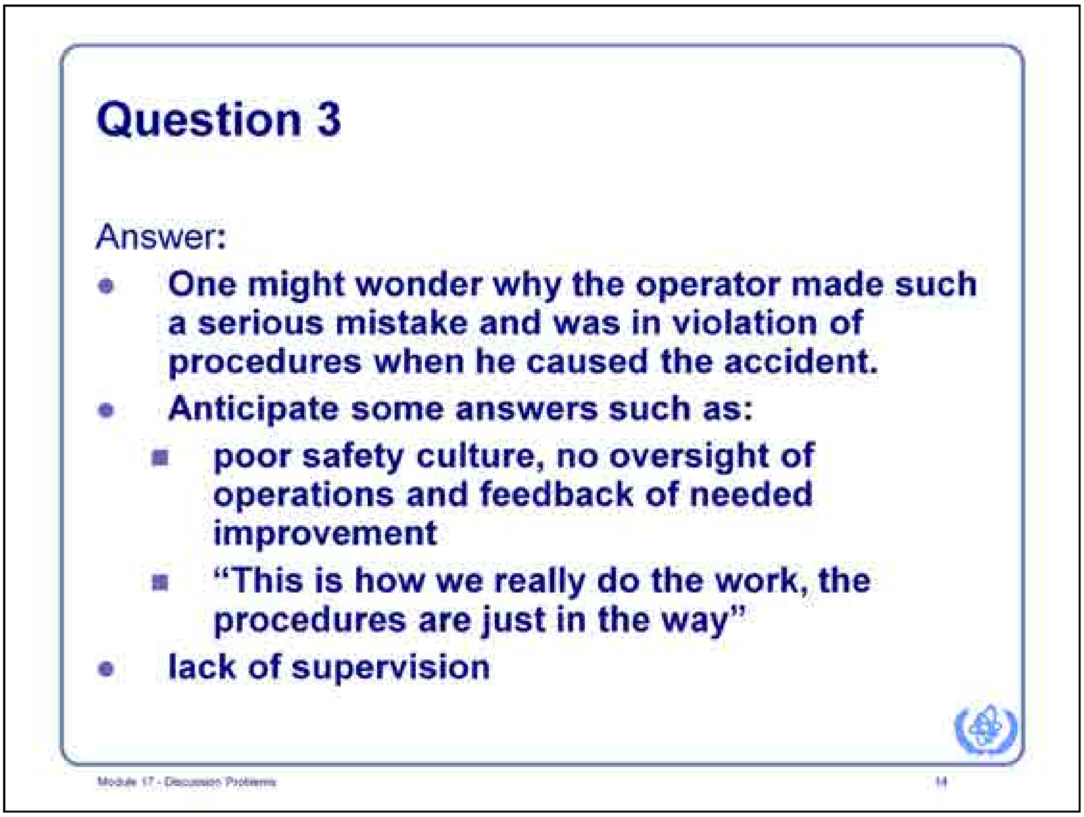
Answer:

- **The question has many answers, so treat the question as a starting point for discussion. One response is that an inadvertent criticality has the potential for very high power levels relative to the design power level of the fuel elements. Another is that past experience shows that more frequent manipulation of reactor components in a research reactor, as compared to a nuclear power plant leads to errors, and usually the individuals doing the movement are at a high risk of radiation exposures.**

Question 2

Answer:

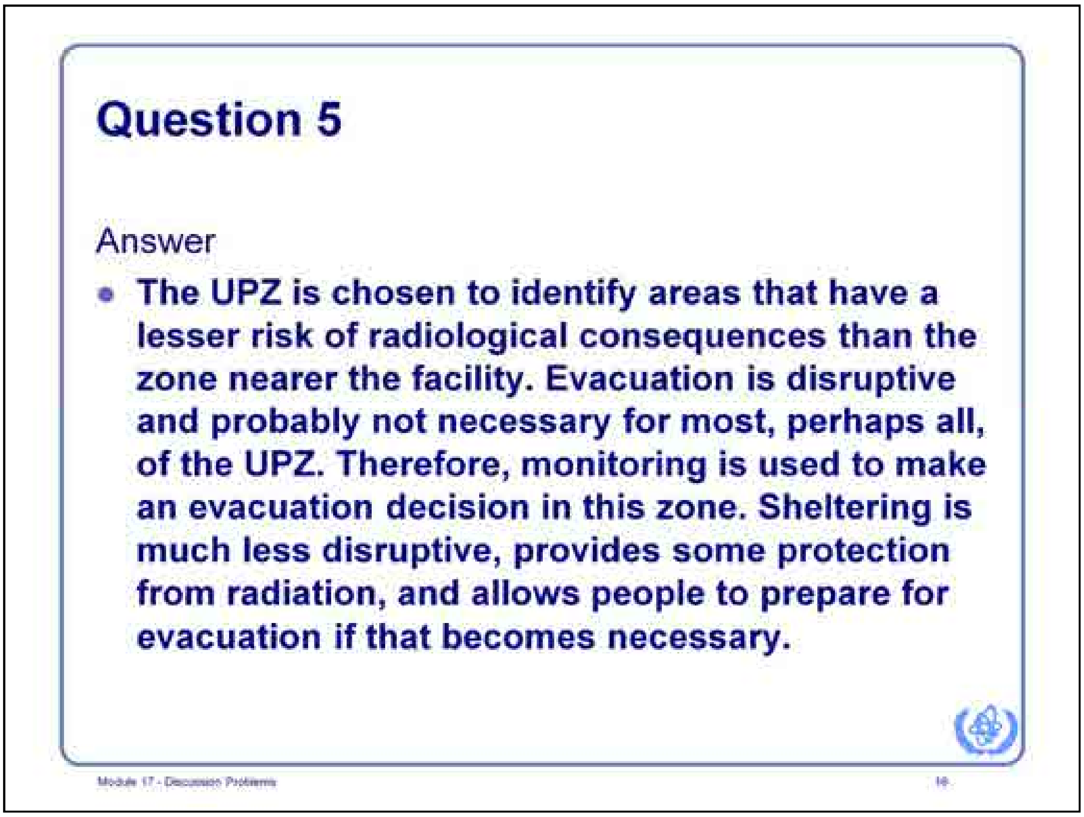
- **This is another question that can lead to discussion. Anticipated answers include availability of natural circulation and low decay heat, depending on reactor design and operating power.**


Question 3
Answer:
One might wonder why the operator made such a serious mistake and was in violation of procedures when he caused the accident.
Anticipate some answers such as:
poor safety culture, no oversight of operations and feedback of needed improvement
"This is how we really do the work, the procedures are just in the way"
lack of supervision
Module 17 - Discussion Problems
14

Question 4

Answer

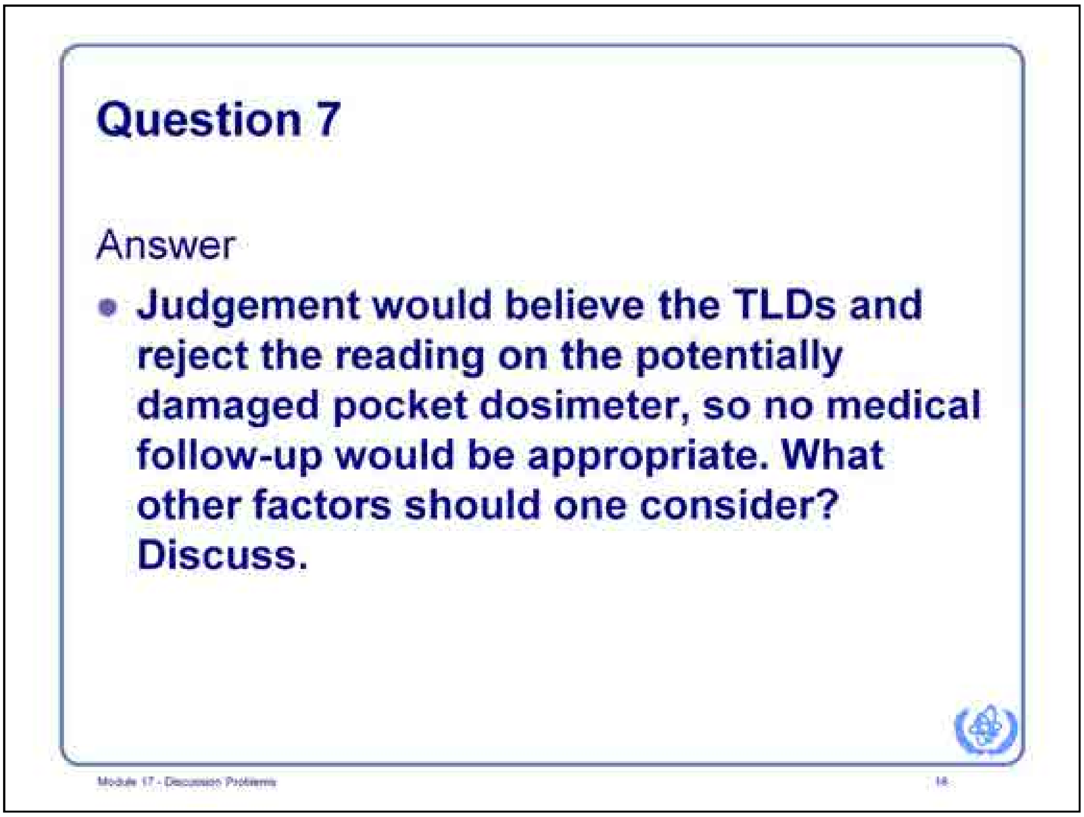
- **A release may deposit hot spots or other unevenly distributed radioactive contamination. Sampling beyond areas with recognized excessive contamination is performed to identify, or refute, this potential concern. Negative results are also a benefit to public confidence and reduce psychological concerns in the potentially affected areas.**


Question 5
Answer
The UPZ is chosen to identify areas that have a lesser risk of radiological consequences than the zone nearer the facility. Evacuation is disruptive and probably not necessary for most, perhaps all, of the UPZ. Therefore, monitoring is used to make an evacuation decision in this zone. Sheltering is much less disruptive, provides some protection from radiation, and allows people to prepare for evacuation if that becomes necessary.
Module 17 - Discussion Problems
16

Question 6

Answer

- **In this case the TLD readings are as valid as the pocket dosimeter and are >100 mSv. The Emergency Worker should be enrolled in a tracking system with medical follow-up to detect early signs of stochastic effects.**



Consider any radiation reading that the EW noted, how do they compare to the expected values?

How long did it take to perform the task and how does that compare to the expected duration?

Does the product of the time required to perform the task and the observed radiation readings substantiate the TLD readings, or the pocket dosimeter reading?

One needs to be cautious about creeping OILs. Values near, but not above recognized OIL values should not automatically invoke the OIL. Recognize that the IAEA believes that the OILs are conservative, and adding additional conservatism can be inappropriate and will reduce the confidence in the OIL values. Think of a similar situation where the readings are close to, but less than a case where protective actions are invoked when an OIL is approached, but not exceeded. The individuals involved may find it difficult to understand when the protective actions are triggered. Why in one case, but not a similar one?

On the other hand, one reading below and one reading above a certain OIL and both readings equally valid, one should react to the higher reading. In some countries, the TLD is the legal record and the self-reading dosimeter is used only for the EW to verify the planned dose is not being exceeded.

Question 8

Answer

Projections use Worksheet C.3 for simple linear distance extrapolation (no rain) or square root extrapolation for rain conditions. Then:

Measured	At	Project	No rain	Rain
1.5 mSv	1.2 km	OIL1	$1.2km \times \left(\frac{1.5mSv}{1.0mSv}\right) = 1.8km$	$1.2km \times \sqrt{\frac{1.5mSv}{1.0mSv}} = 1.5km$
		OIL2	$1.2km \times \left(\frac{1.5mSv}{0.1mSv}\right) = 18km$	$1.2km \times \sqrt{\frac{1.5mSv}{0.1mSv}} = 4.6km$

Module 17 - Discussion Problems 19

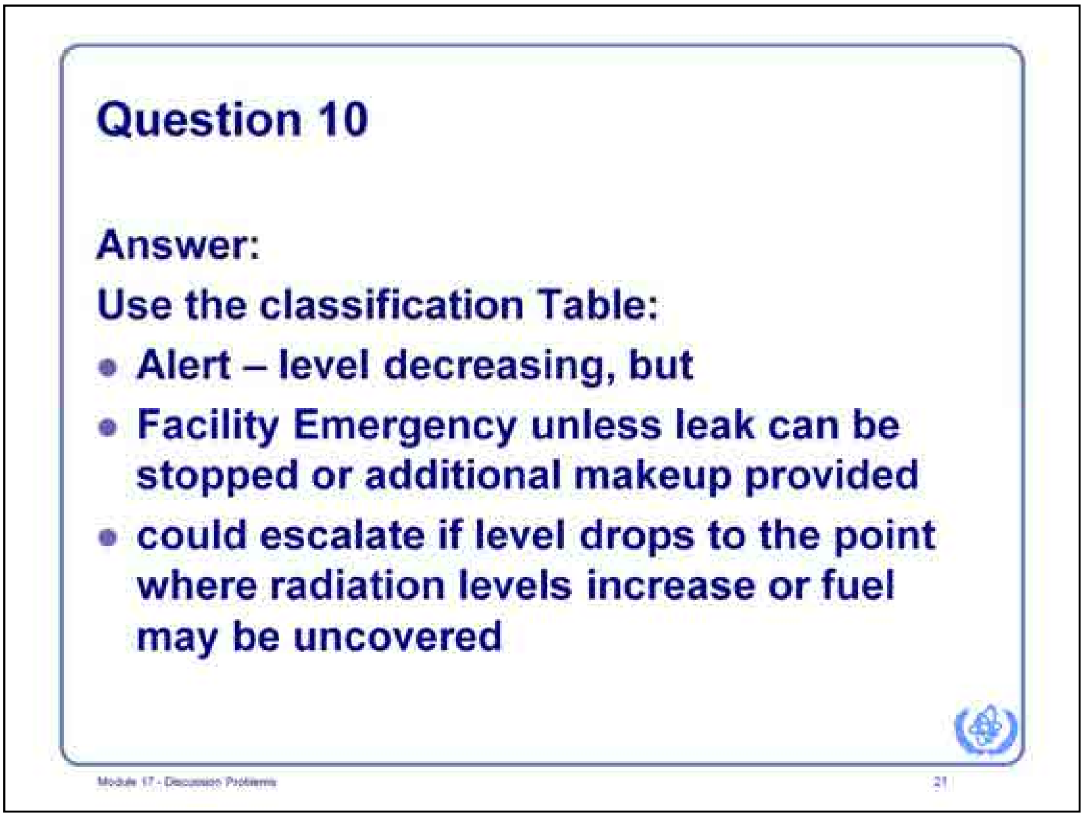
Question 9

Answer:

Use the classification Table:

- **Facility Emergency due to loss of control and instrumentation.**
- **could elevate to Site Area Emergency, need to evaluate potential for fuel damage**

Module 17 - Discussion Problems 20



Initially calling this an Alert seems to underestimate the consequences.

This example is expected to generate discussion of the pluses and minuses of calling a higher class, or sticking with Alert until it is apparent that radiation levels will become a problem, or even worse, fuel will be damaged.

IAEA Training Course for Research Reactor Emergency Response

Development of a Response Capability

Development and Implementation of an Action Plan

Seminar

Block 4: Development of a response capability

Module 18: Development and implementation of an action plan

Learning objectives: Upon completion of this module, the participants will:

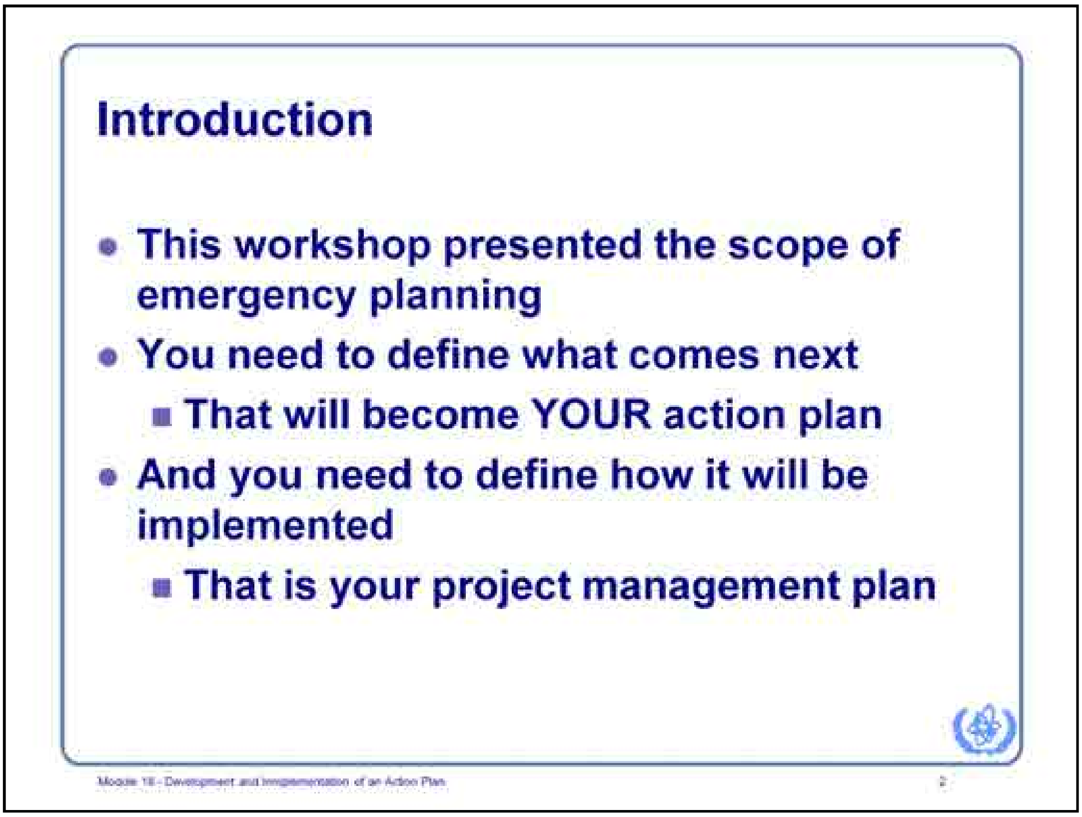
- understand the need to develop an action plan as a follow up to this workshop
- understand basic project management principles
- know what a project management plan should contain
- be familiar with the project management process

Activity: Seminar, questions and discussion

Duration: 1 hr

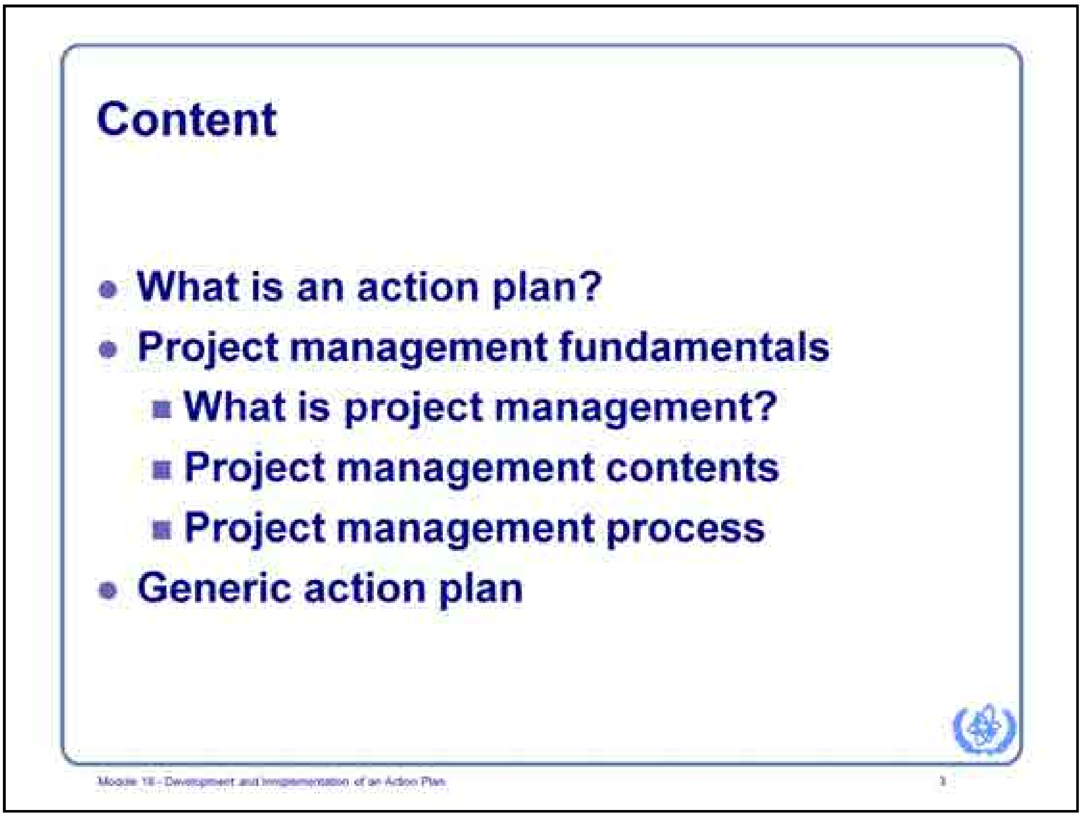
Materials and equipment needed: none

References: none



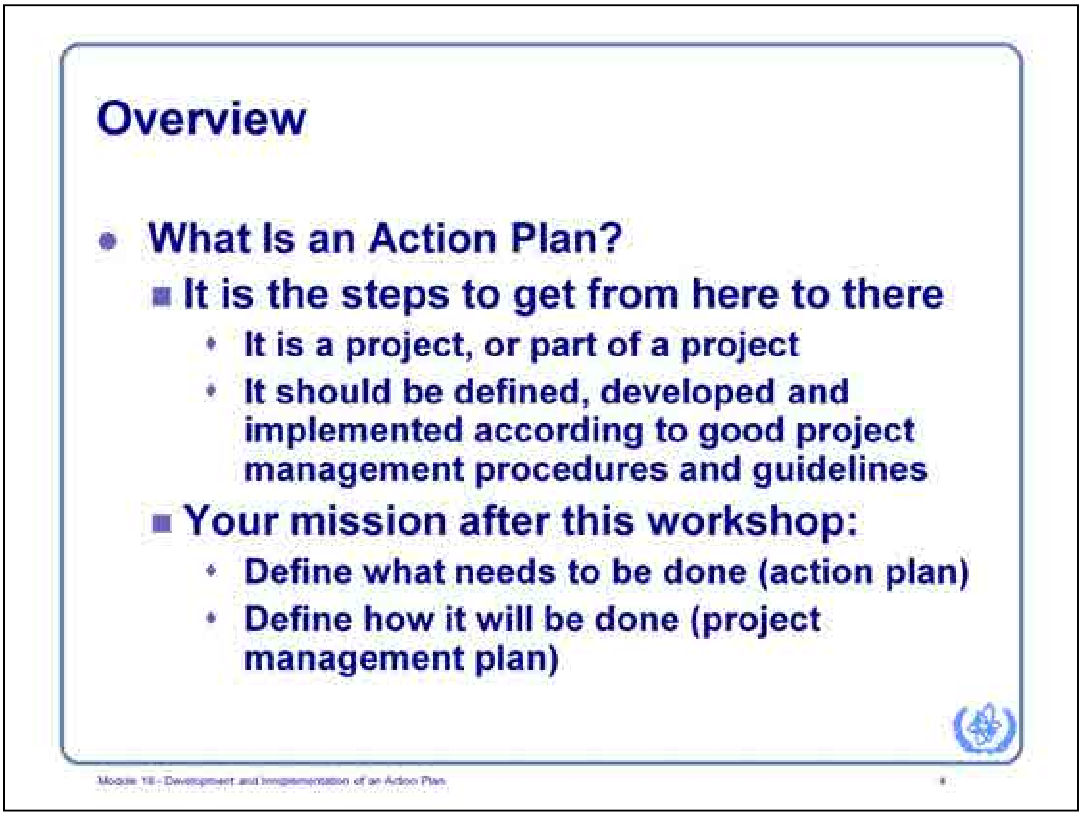
Lecture notes:

After this module, you will be asked to follow the project management process steps and develop a project plan for follow up actions arising from this workshop. So please pay attention to the process description. You will find that it provides a useful tool for the management of any project.



Lecture notes:

The purpose of this module is to review the process of developing and implementing an action plan. We have all to some degree been involved in 'Project Management' either formally as part of our work, or at home. This session focuses on the project management plan and project management process. It also highlights some of the potential problems that are often encountered when trying to implement a project.



Lecture notes:

An action plan is a commitment to do something and reach a desired point. The action plans says what you want to accomplish, not necessarily how. To effectively implement an action plan, you need to establish a project management structure.

Lecture notes:

Project management is a relatively new science, although it has in effect been applied in one form or another for centuries. There are now project management professionals because, more and more, organisations have realised that the successful completion of projects requires specialised skills and knowledge as well as a systematic approach to project definition, implementation and evaluation.

This module will not make a project management professional out of you but it will give you the basics to know what is important when trying to manage a project.

Lecture notes:

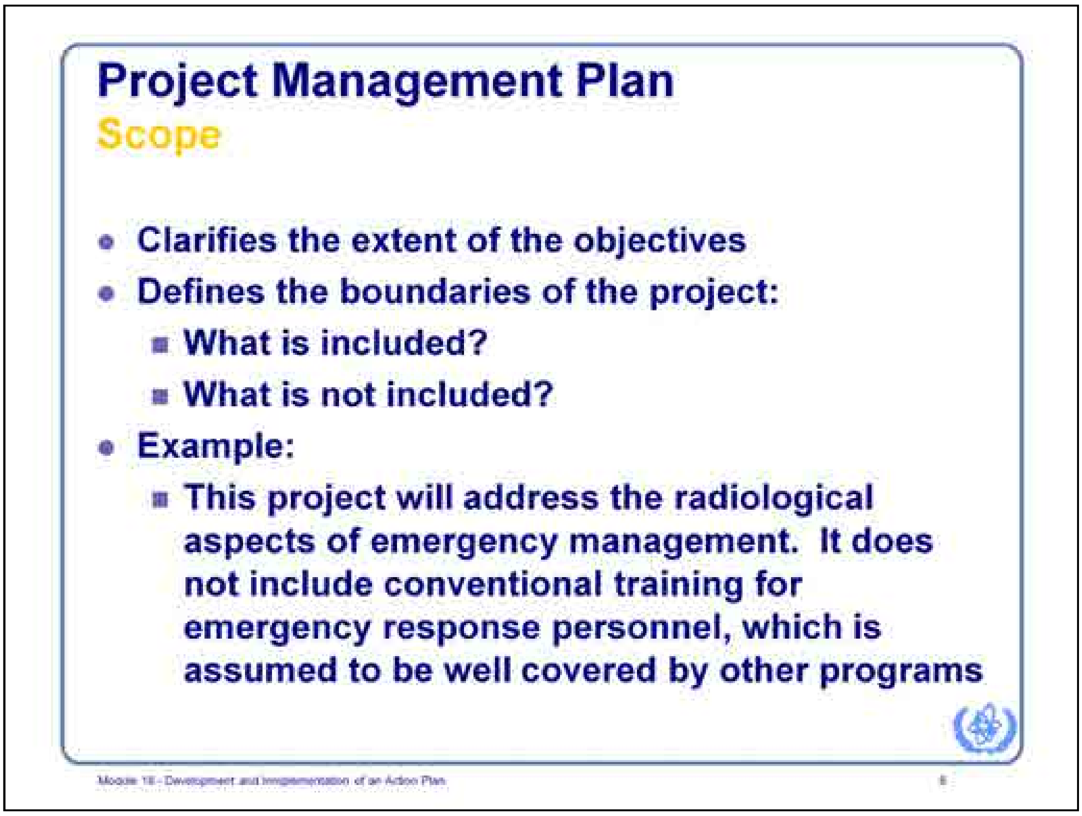
A good project management approach relies on the development of a good project management plan. This plan becomes the procedure to follow for implementing the project and provides the yard-stick against which project progress can be evaluated.

This slide shows the main components of a project management plan. In the next few slides, we will examine each one in detail.

Lecture notes:

Objectives define what do you want to achieve. Of course, unless this is clear, well defined, measurable, realistic and achievable, your project may be very difficult to manage. Furthermore, if no one else agrees with your objectives, there is a good chance that your project will a) not be approved or b) never be completed.

There are also projects that are defined in such a way that they never end! This category of self-sustaining projects is not uncommon but it represents a drain on resources and it is generally completely ineffective.



Lecture notes:

The scope defines what you will do and what you will NOT do. This is important because, quite often, projects objectives are interpreted differently by different people.

Project Management Plan
Milestones

- Define the intermediate results that must be achieved to get to the final objective
- Example:
  - Generic plan modified
  - Generic procedures adapted
  - Training program defined
  - Training schedule promulgated
  - Training completed
  - Validation completed
  - Project evaluation completed

Module 18 - Development and Implementation of an Action Plan 8

Lecture notes:

The milestones are like “check-points” within the project. They are intermediate results that should be achieved. They are a good way of measuring progress.

Lecture notes:

The tasks are what their name implies: they describe how the work will be done, by whom and what is to be expected as a product of the task.

Lecture notes:

Responsibilities is often one of the weakest aspects of projects. It is extremely important to define who is responsible for what in the project. Normally, this is done by task. Several organizations may be involved in a single task, but there should always be one that is responsible and accountable to the project manager for ensuring that the job is done.

Project Management Plan

Responsibility Matrix

Activity	1	2	3	4
Send invitations	P, X		I	
Procure equipment	C	P	X	D
Train technicians		X	P	

P : Manages Progress
X : Does
D : Decides
d : Decides jointly
I : Must be informed
C : Must be consulted
A : Available to assist

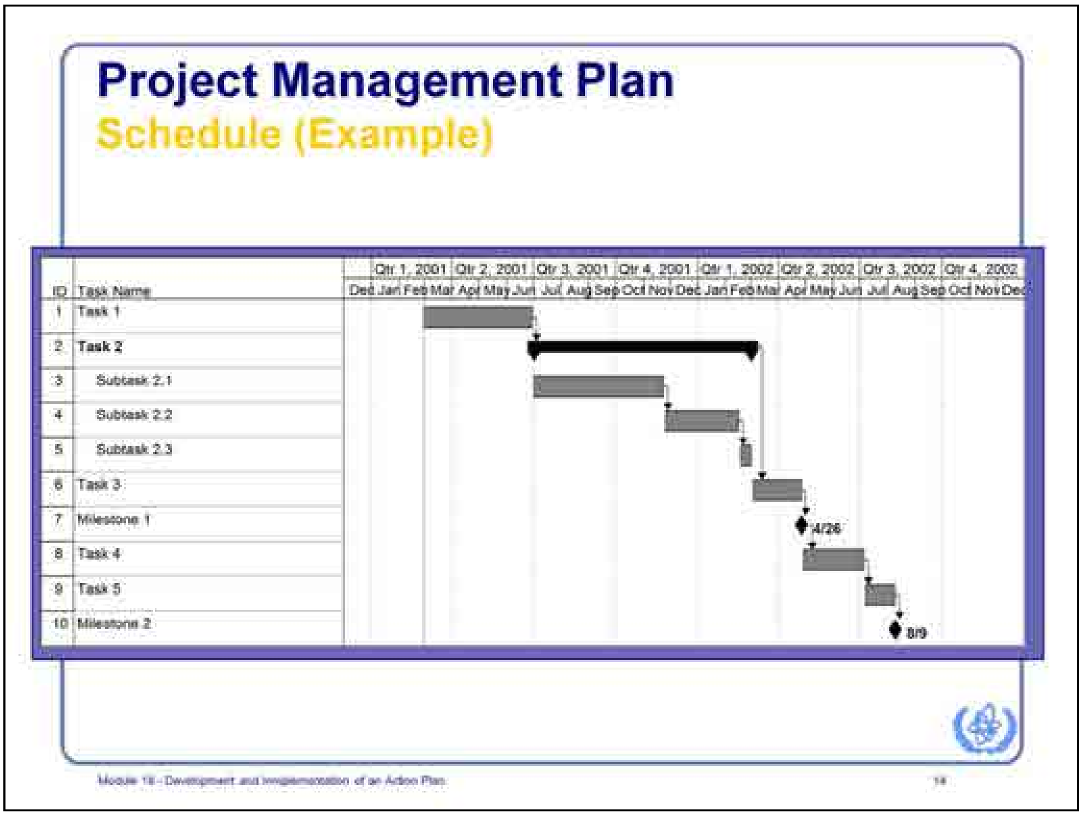
Module 18 - Development and Implementation of an Action Plan 12

Lecture notes:

A responsibility matrix is a tool that can be used to clarify the roles of each person in the project team. Often with cross-functional teams it is critical to define not only who is responsible for carrying out the task but also who has to be consulted or informed about its completion. The responsibility matrix is a tool to ensure that such actions are carried out.

Lecture notes:

The schedule is, as its name implies, an estimate of when the tasks will be completed. Unfortunately, your planning often suffers constraints, such as if tasks need to be done in the time that is less than what is considered to be necessary. Only adding more resources can solve that problem. Of course, in most projects, some tasks finish early and some finish late. So there are two schedules: the baseline, which is the planned estimate; and the actual, which is the schedule of the work that was already done. By comparing the two, you get an idea of whether the project is on track or not. Sometimes, it is necessary to make adjustments to the baseline schedule to reflect the impact of earlier tasks.



Lecture notes:

This is an example of a schedule presented in the form of a Gantt chart, which is a standard way of presenting project schedules.

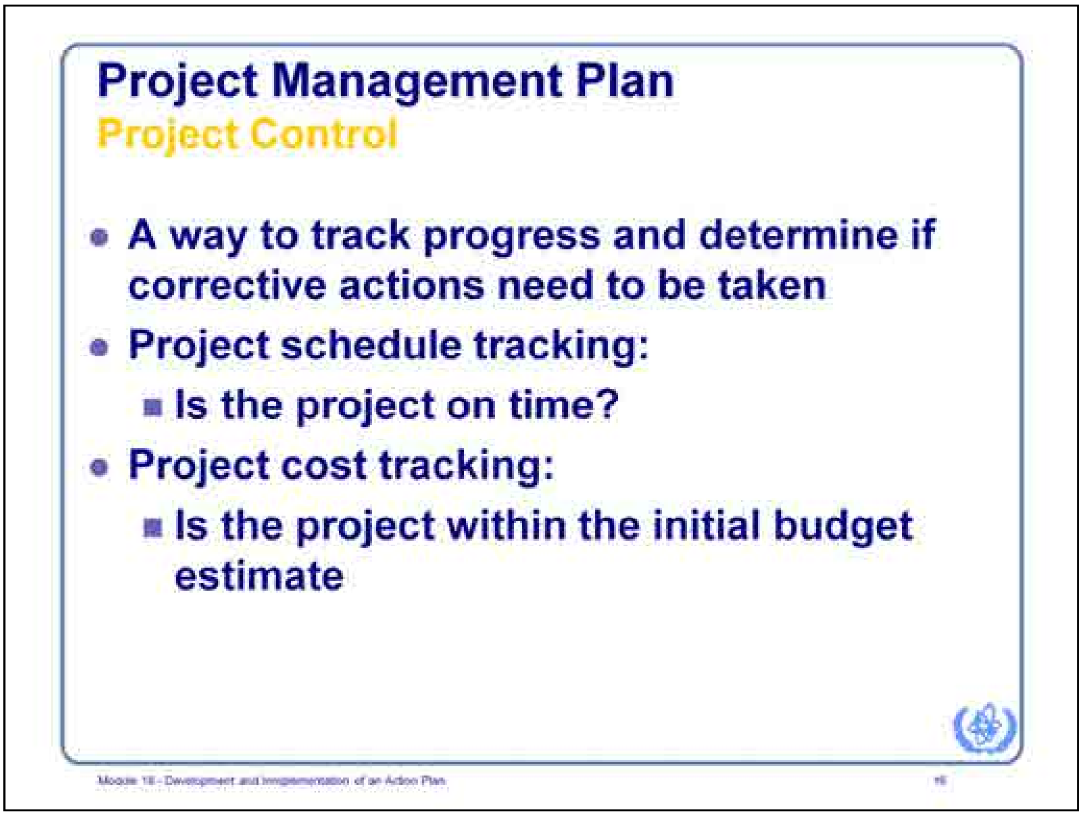
There are many software tools to help prepare the schedule and most will generate the Gantt chart as a way of visualizing the schedule. These same tools define the critical path and show other information about the tasks which are not on the critical path. The critical path is the sequence of tasks that defines the overall length of the project, that is, the sequence of tasks that must start and end on the proposed times in order not to delay completion of the project. Slippage in critical path tasks are day for day slippage in the project, unless the slippage is so severe that non-critical tasks now become critical. For example, each task is defined in relation to the other tasks in terms of what must be done to start a particular task. This creates a chain of work that is the time period in which the task can be done given its duration.

Lecture notes:

The budget is the amount of money available for the project. The first budget estimate should be based on a preliminary estimate of the amount of work that needs to be done. However, quite often, the money available is smaller than the initial budget estimate. But that is another issue, which we will discuss later.

You estimate budget for each task. In the cost, you should include all cost items required to run the project, i.e. labor (either in terms of funds or man-hours, or both), equipment, travel, hotels, and other “hard” costs. In many government projects, the labor cost is not included, because the salaries of government employees are paid regardless. However, be aware that this is a hidden cost, as it takes resources away from other projects. Also, if private companies are to be involved, they will charge labor costs.

Showing the labor cost in man-hours can be deceptive. If one expects three people to be available for a task, but fewer actually work the job, then the time to complete will probably be incorrect.



Lecture notes:

Project control is an inherent part of any good project management structure. It is a way to measure the effectiveness of project implementation. Project control is an continuous task and should be included in the task breakdown. Large projects normally have a dedicated "project controller" as part of the project management team.

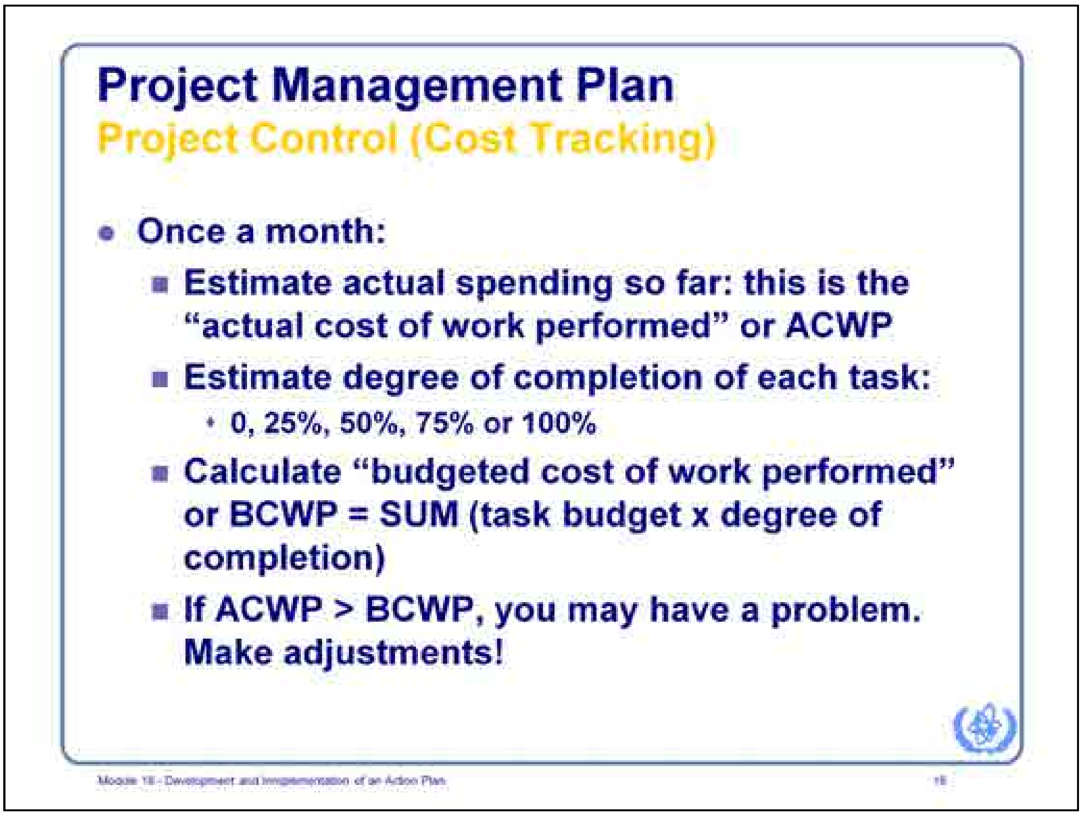
Project control include schedule tracking and cost tracking.

Normally, once a month, the project management team should get together and assess the progress of tasks against schedule and the spending to date against the budget.

A good software tool will allow updates on task status and keep the delays, or gains visible to the Project Manager.

Lecture notes:

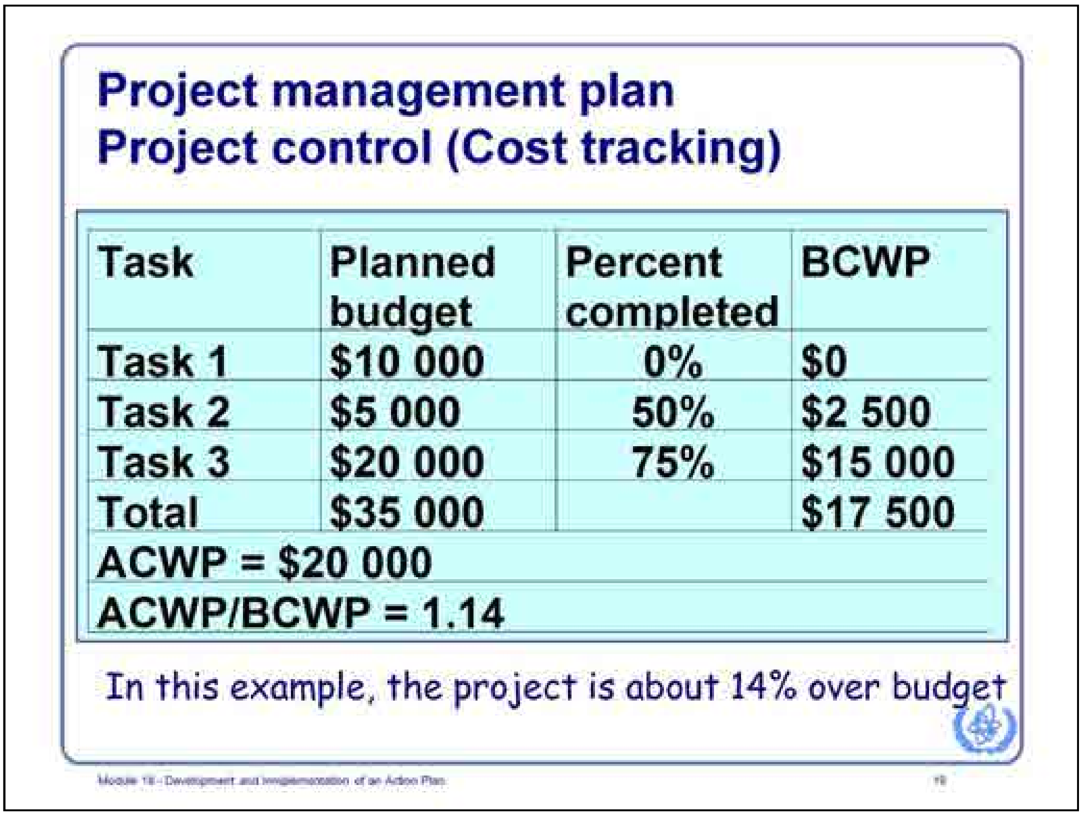
Schedule tracking involves verifying that the project tasks are completed on time. If not, then adjustments need to be made. If the timeline is not that critical, delays may be acceptable. But if it is critical and many subsequent tasks may be affected by a delay in one task, then the solution should be to increase the level of effort. In some extreme cases, the project scope may have to be reduced in order to prevent the failure of the entire project.



Lecture notes:

Cost tracking is a very powerful tool to monitor project performance. First, the actual spending to date must be calculated.

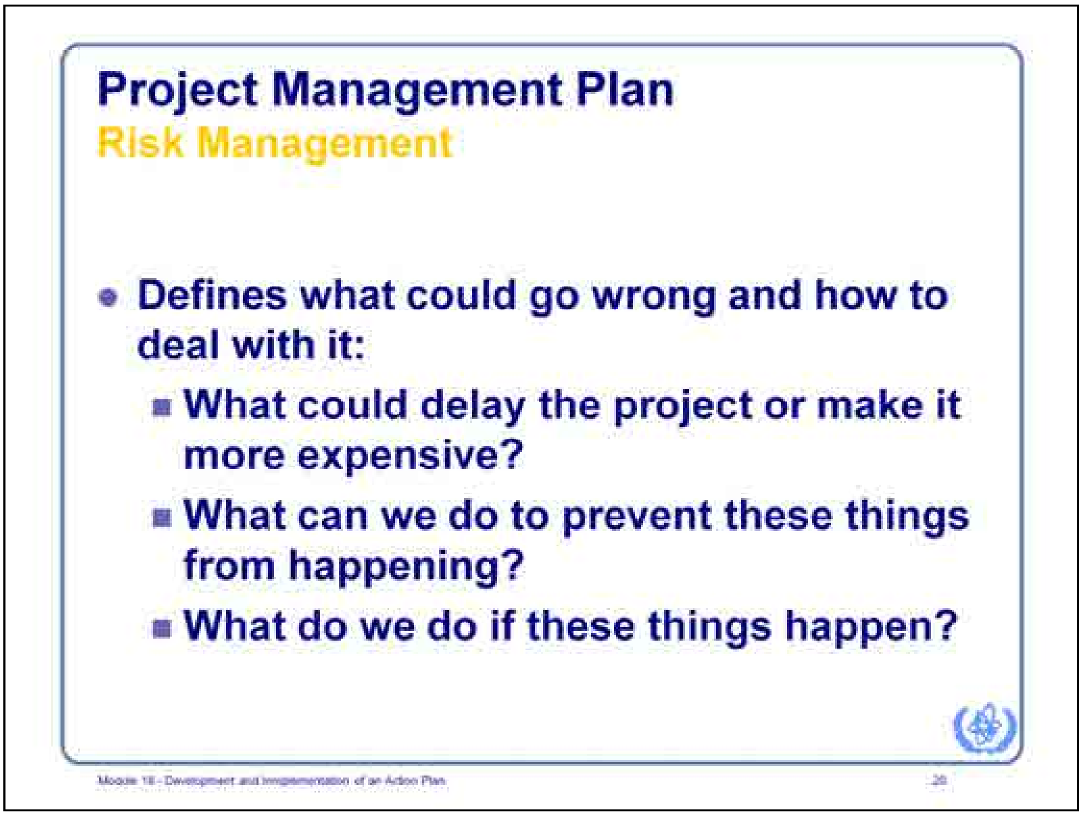
Each task has an estimated budget attached to it. It is also possible to estimate the degree of completion of each task. Normally, it is sufficient to determine only an approximate completion stage, for example 0, 25, 50, 75 or 100% (not started, started, half finished, almost finished and completed). By multiplying the degree of completion and the task planned budget, one gets a theoretical value of the work that was done. This is of course based on the early estimate, which may have been inaccurate. This gives us the budgeted cost of work performed, which is equal to the value of the work performed. By comparing this value to the actual spending, we know if the project is cost more, or less, than what we originally anticipated. If the ACWP is much higher than the BCWP, it means that a) the work is not done effectively, or b) the original estimate was too low; or c) work needs to be more focused. In either case, it means that adjustments to the project scope of project budget may have to be made.



Task	Planned budget	Percent completed	BCWP
Task 1	$10 000	0%	$0
Task 2	$5 000	50%	$2 500
Task 3	$20 000	75%	$15 000
Total	$35 000		$17 500
ACWP = $20 000			
ACWP/BCWP = 1.14			

Lecture notes:

This is an example.



Lecture notes:

Finally, every project management plan should contain a risk assessment and management plan. This is an honest evaluation of what could go wrong and could threaten the success of the project. Unless the analysis is absolutely honest and objective, the risk management plan will be useless. In practice, it is tempting for project management staff to ignore the real risks. This step is also known as potential problem analysis and should include options to resolve or reduce the risk to the project from the potential problems.

An example of a risk is: what happens if the government changes in the middle of the project? Or what if we run out of money?

The risk management plan then addresses what can be done at the beginning and throughout the project life to minimize that risk. Often, the best risk management strategy involves good project communication and good project control.

Lecture notes:

The steps described in this slide and the next one are a very simplistic description of the process to implement a project management plan. The first step is obviously to determine the project goals and to appoint someone who will manage it. The project manager will also need to establish a project management team. Remember that a good project manager is not necessarily the best technical person. Also, a project manager should have some authority to get the work done, otherwise the project will go nowhere. This can be done through a ministerial appointment.

A critical idea is to keep the project organization simple. Don't require too many approvals and decisions from too many people - otherwise nothing will ever get started let alone done.

You also will need an effective communication system, with regular meetings to improve and maintain cohesive teams. A common information system may be necessary to make sure everyone has access to the same and latest information. If the project is critical, it may be necessary to develop a contingency plan in case of some critical delay or failure.

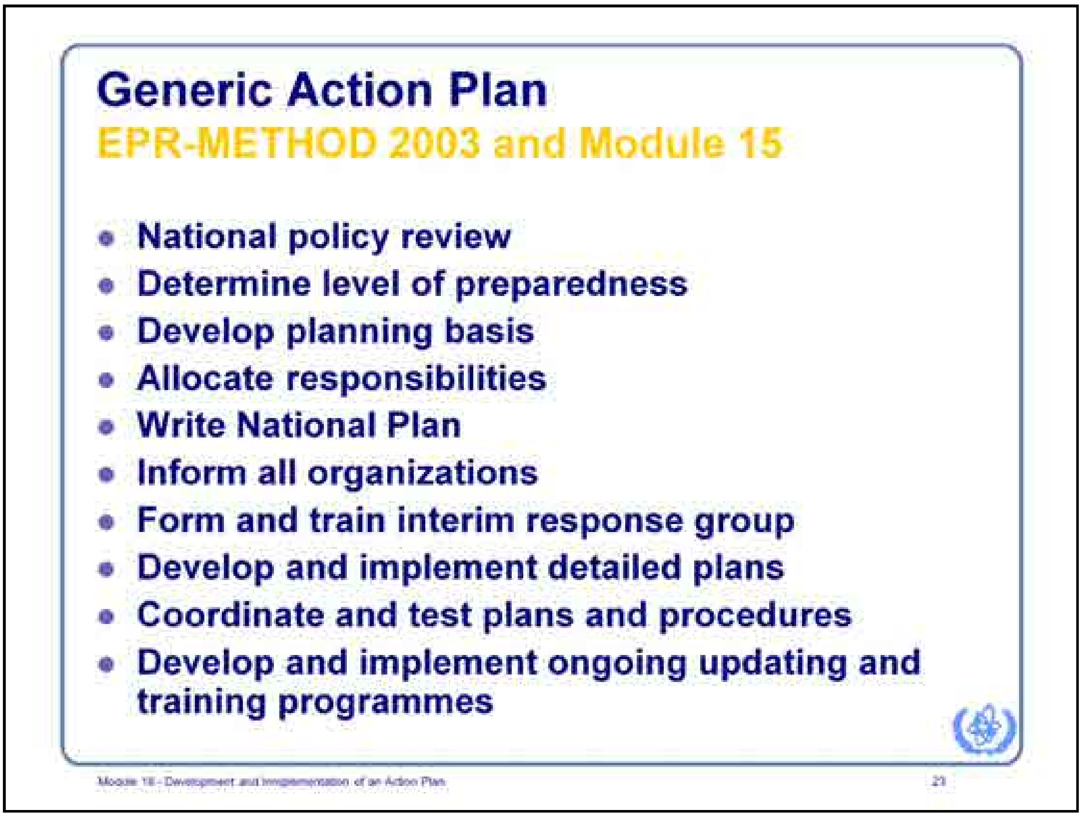
A preliminary project plan can be developed, on which the budget will be determined. In practice, the available budget is not always equal to the required budget. It is then necessary to make adjustment to the project objectives and scope.

Lecture notes:

Before the project management plan is finalised, make sure it is communicated to the main people and organisations involved. Get their comments and make the necessary adjustments. Unless all the major players agree that the project management plan is realistic and achievable, trying to implement it will be constantly met with obstacles and lack of co-operation.

Then, the work starts!

Throughout the project, monitor its progress. At then end (and there should be an end!), evaluate the effectiveness of the project against the set objectives.



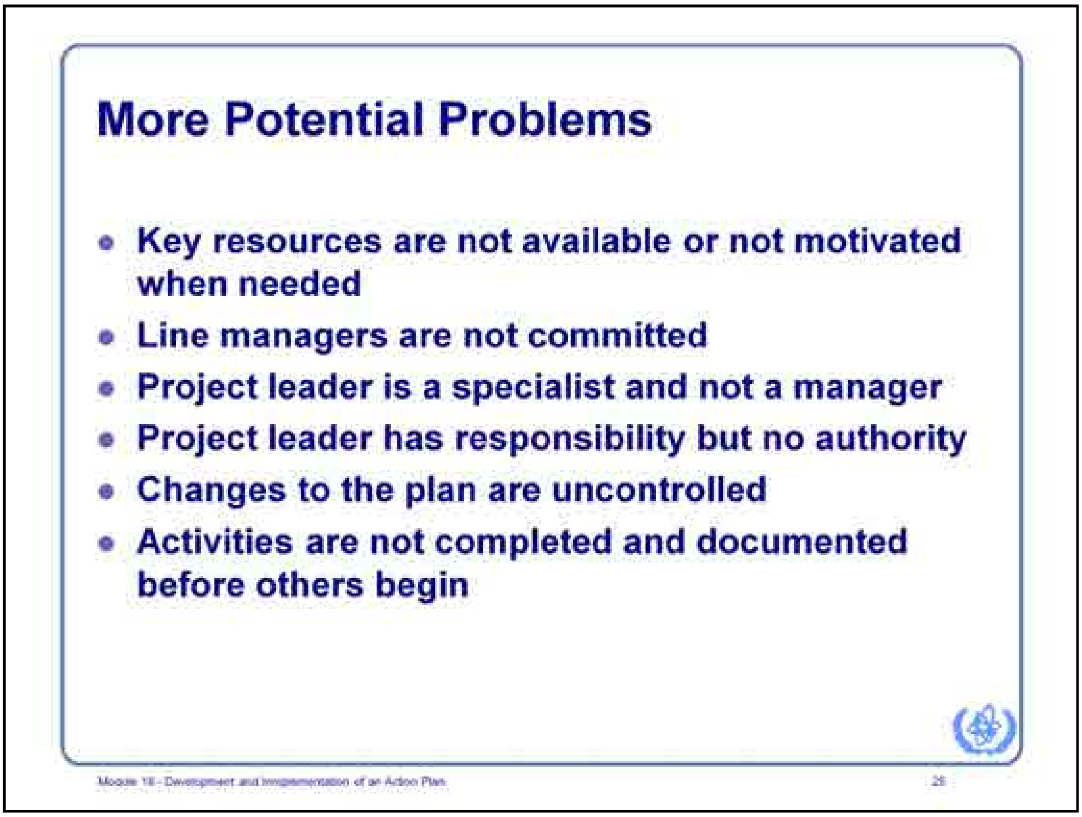
Lecture notes:

In the context of Emergency Preparedness and Response a major project can be seen as ‘developing a national capability’, which has ten steps, which in themselves can be seen as sub-projects. The planning and implementation of this scheme is a major challenge in project management. But it is necessary if we are to achieve the goals of the project.

Lecture notes:

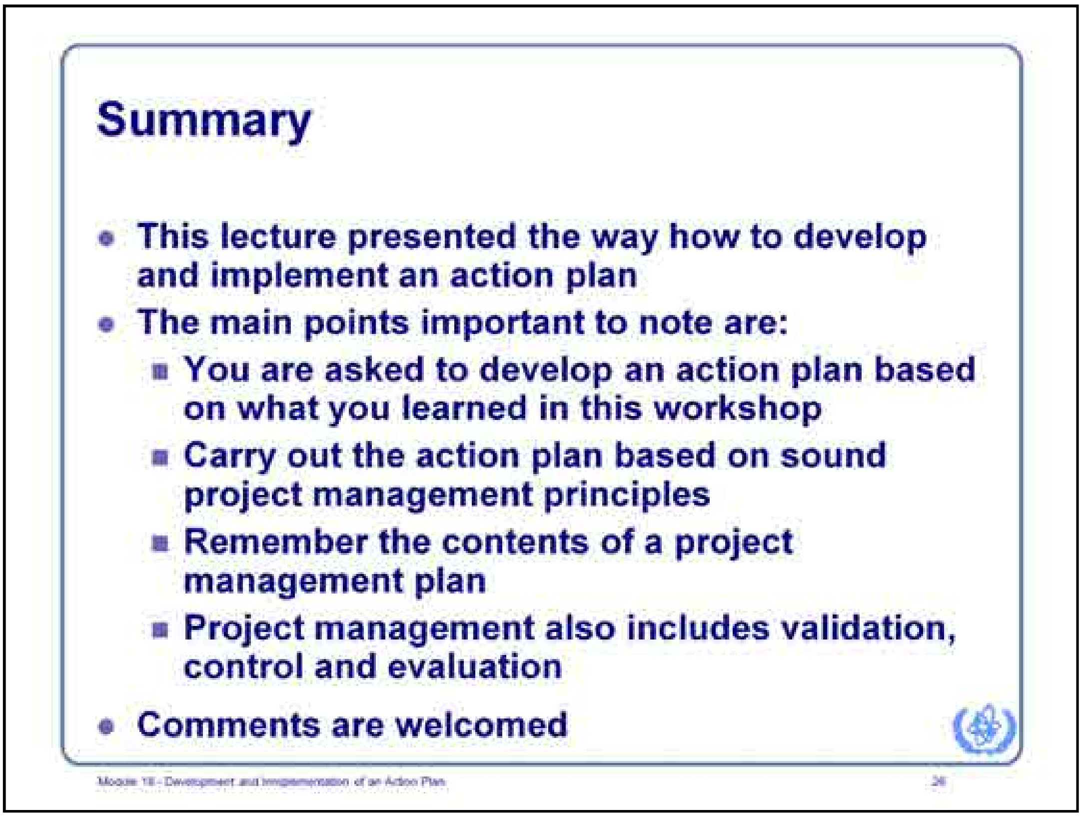
What are typical problems in carrying out projects ?

Here is a list of some of them.



Lecture notes:

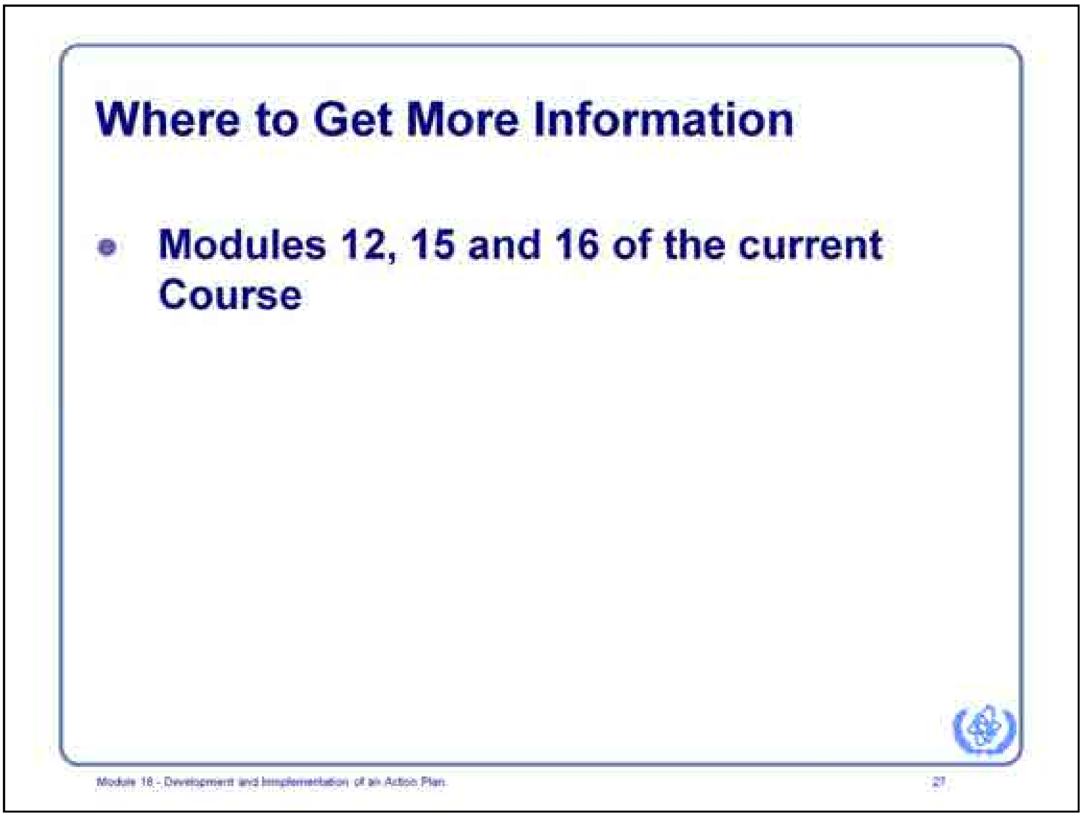
Here are some more. We need to have a system in place to avoid these pitfalls. A good and realistic project management plan and and effective project manager are key to avoiding these risks.



Lecture notes:

Let’s summarize the main subjects we did cover in this session. This lecture presented the way how to develop and implement an action plan.

We did cover the topics describing the need to develop an action plan as a follow up to this workshop, basic project management principles, a project management plan structure, project management process.



Questions

1. What is an action plan?
2. Define what is project management.
3. List the main parts of a project management plan.
4. List three potential problems that could threaten the success of a project.
5. What is project control?
6. What are ACWP and BCWP?
7. How is BCWP calculated?

IAEA Training Course for Research Reactor Emergency Response

Development of a Response Capability

Preparation of a Specific Action Plan

Work Session

Block 4: Development of a response capability

Module 19: Preparation of a specific action plan

Learning objectives: Upon completion of this module, the participants will:

- be able to identify country specific needs
- be able to develop an appropriate action plan within an appropriate project management structure

Tasks:

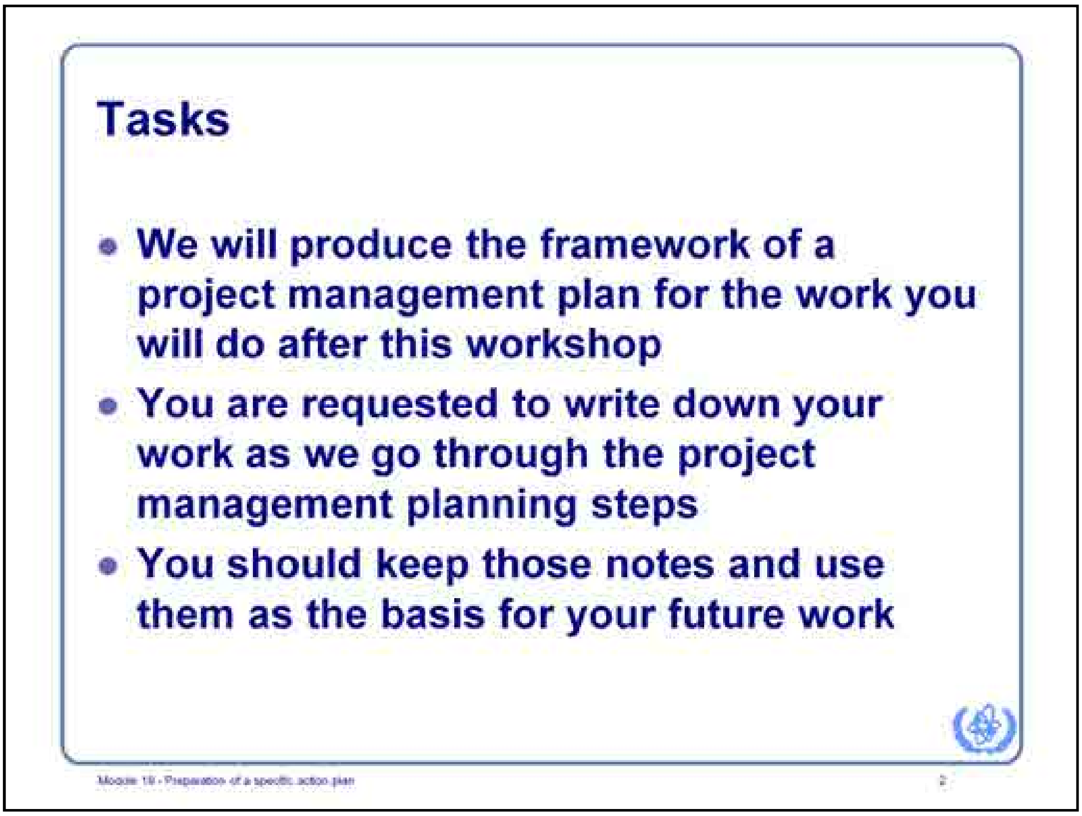
- to identify specific needs for the respective country
- to draft the framework of a project management plan for the respective country
- to discuss the drafted project management plan

Activity: Work session, discussion

Duration: 1 hr

Materials and equipment needed: Work session notes

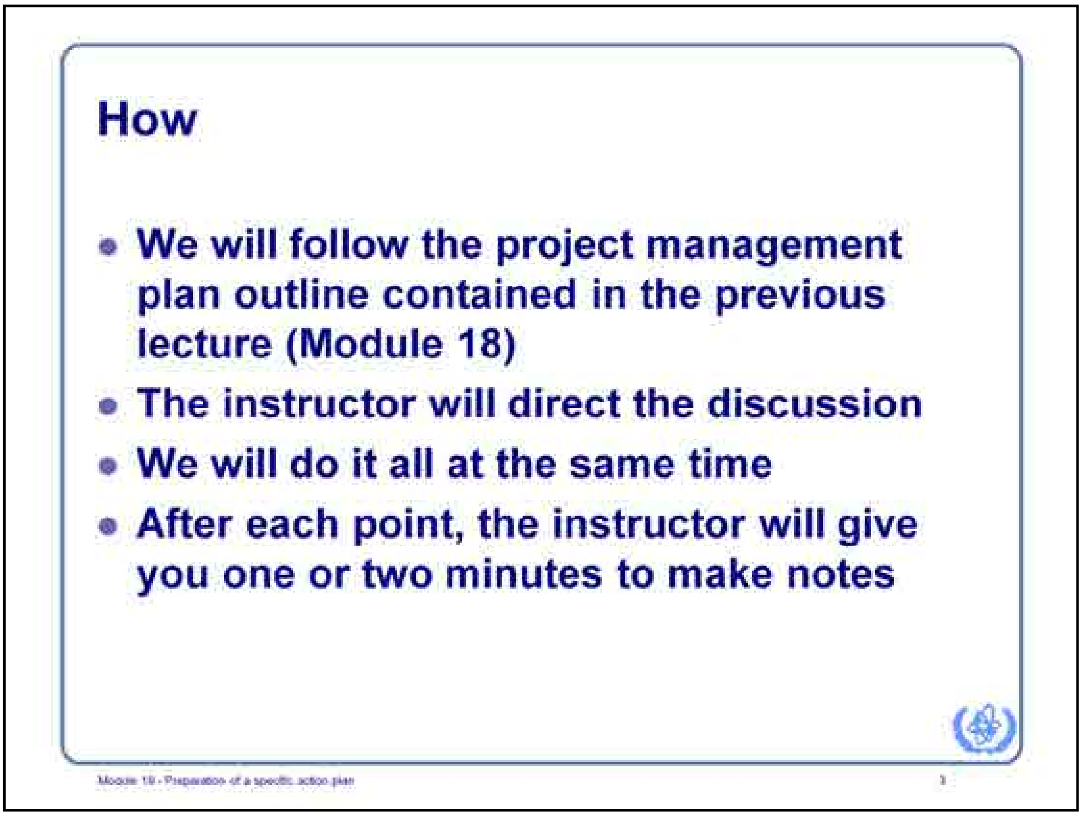
References: none

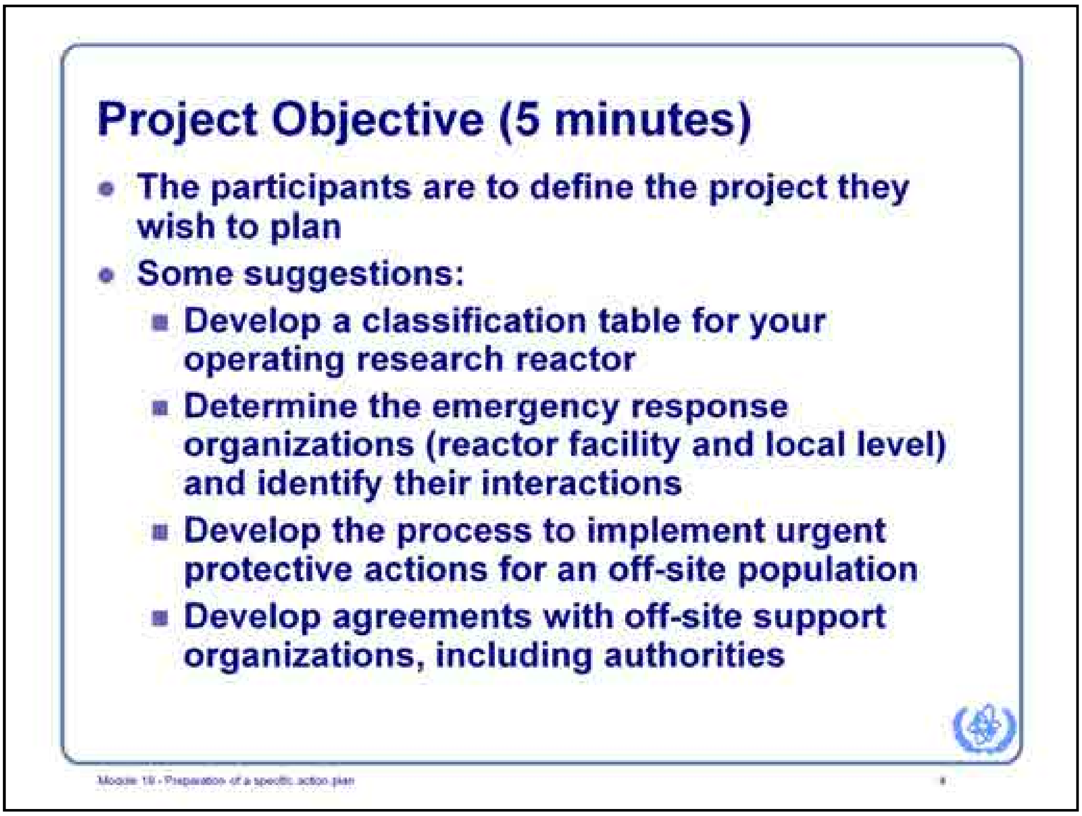


Instructions for instructor

This work session will be a guided discussion with the whole group of participants at once. The instructor must:

1. Ask that the group define the objective
2. Emphasize that the participants need to make clear and clean notes, and that they are expected to use these notes for follow-up work in their country.
3. Address the project management plan contents point by point. There is one point per slide in the next slides.
4. Provoke thoughts! Ask questions and make the participants think about some of the challenges. You will not have time to ask everyone. Ask one of two persons for each point what they think it means for them in their country. Discuss with the others.
5. There are 8 points to address (budget is not counted). You therefore have approximately 5 to 7 minutes per point. You should spend no more than 4 minutes per point except for the “tasks”, for which you should leave about 15 to 20 minutes.
6. Give the participants 1 or 2 minutes to make some notes after each discussion. For the discussion on “tasks”, leave them more time.

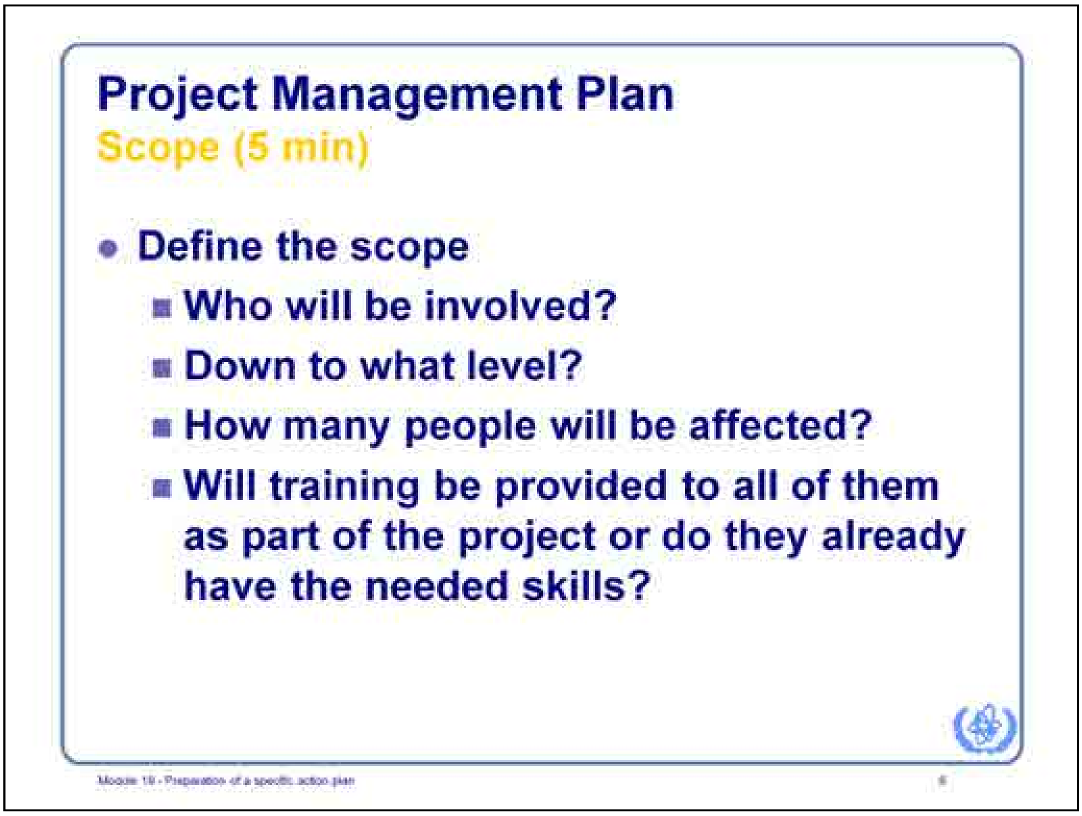

How
We will follow the project management plan outline contained in the previous lecture (Module 18)
The instructor will direct the discussion
We will do it all at the same time
After each point, the instructor will give you one or two minutes to make notes
Module 19 - Preparation of a specific action plan
3



Instructions for instructor

The project to be planned must be established by the participants. Remind them that they are not trying to prepare the work, but the project plan using the outline that follows..

Deliverables are the items that will exist when the project is completed. It may be written and approved procedures or agreements, it may be something else. It must be stated in terms of tangible items created by the work of the project.

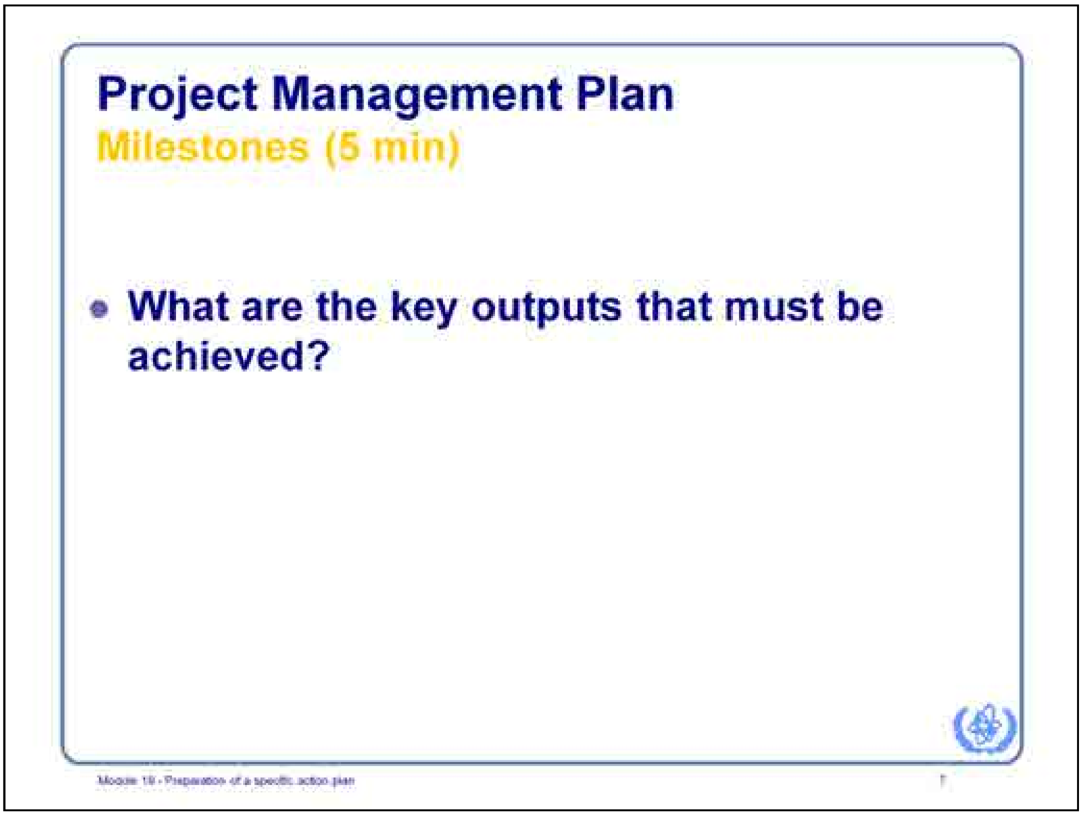


Instructions for instructor

In planning for research reactor emergencies, one of the challenges is the potentially large number of organizations that could be involved and the large number of people, down to the local emergency responders, that may need to be trained. Discuss with the particiapnts the following questions:

- How will your project handle that?
- Are you considering training everybody in all aspects of emergency management or just some and on just some key areas?

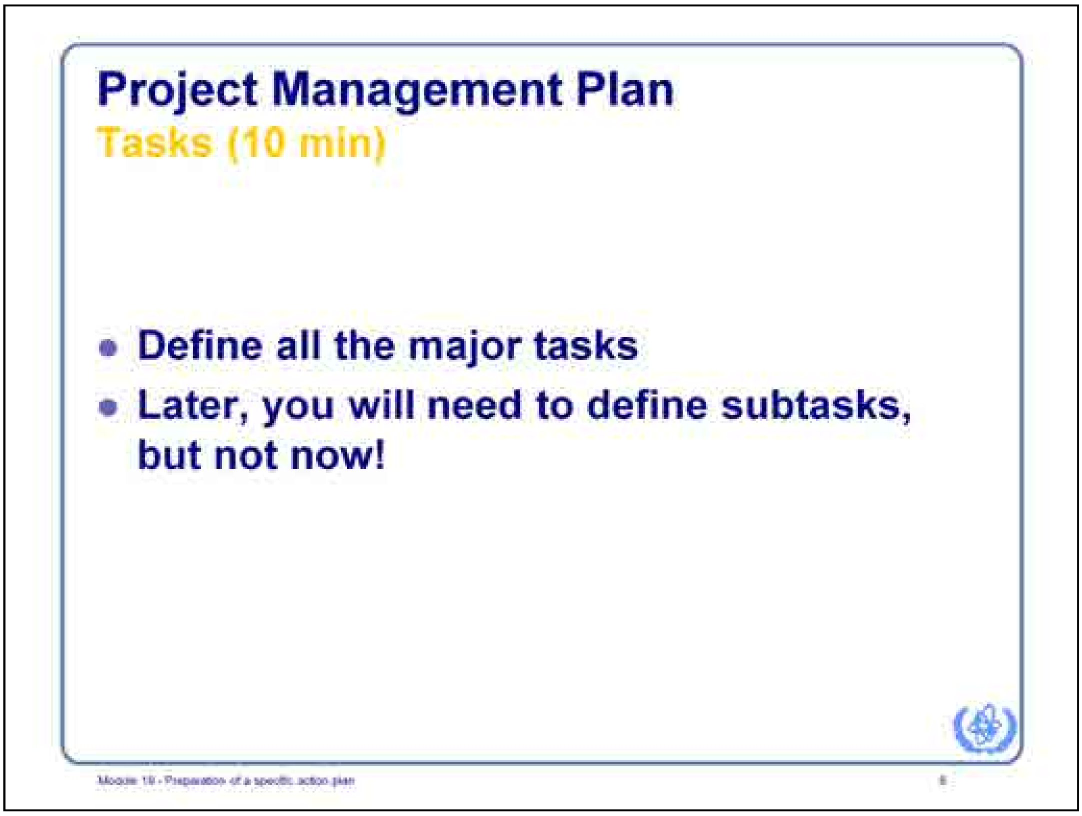
•If training people is part of the project, then the planners will need to know how many and where will they come from.



Instructions for instructor

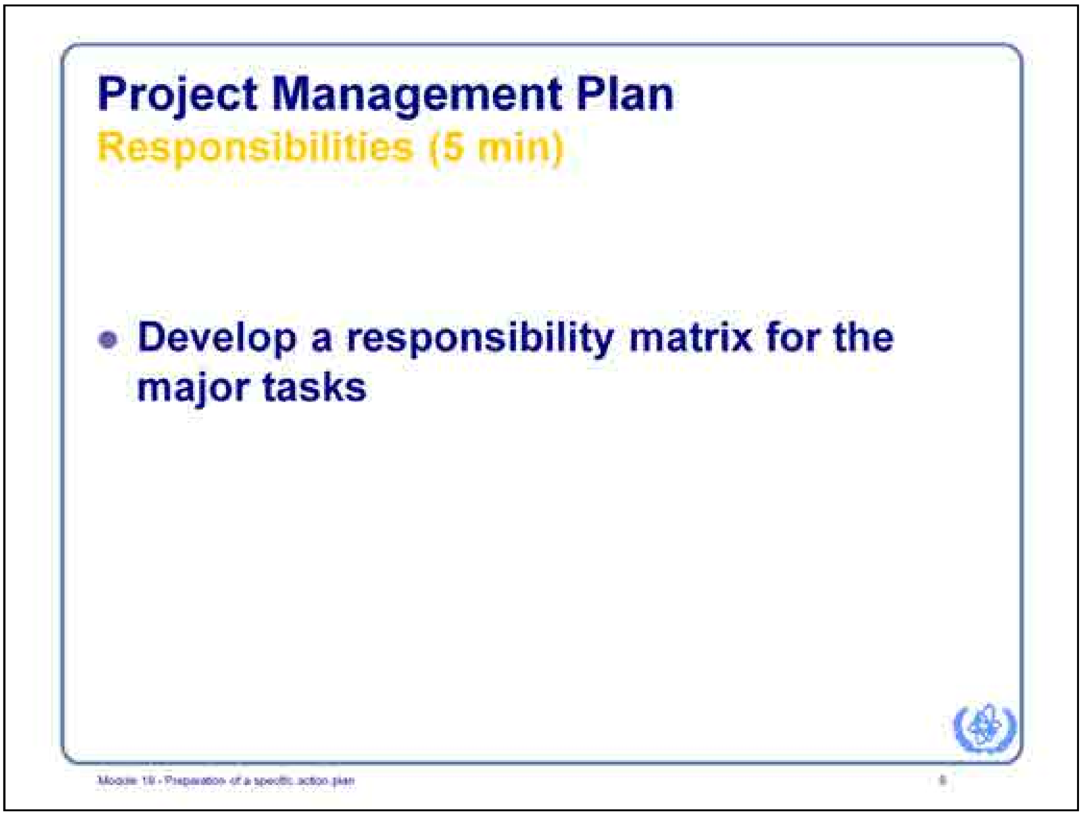
Instruct participants on to pay attention on the following steps:

- Define the intermediate results that must be achieved as part of your project.
- Focus on the ones for which you may be responsible.
- Do not address the national project goals unless you are specifically responsible for their implementation.



Instructions for instructor

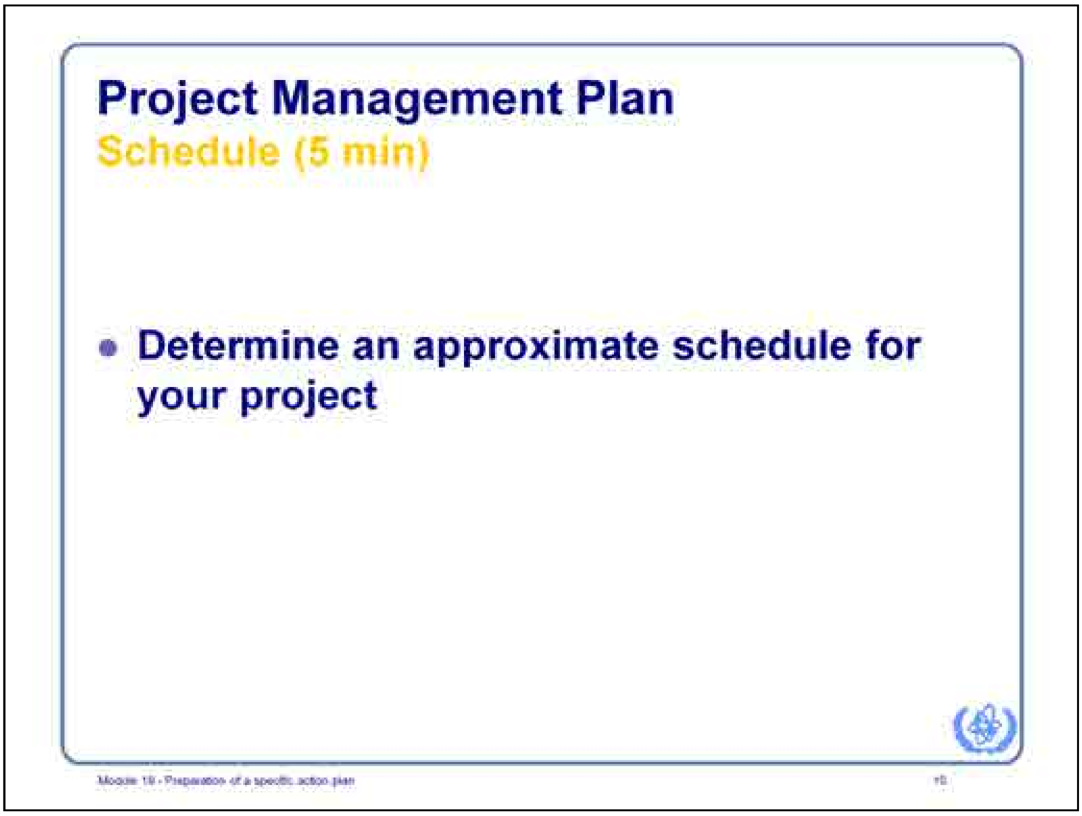
Give participants more time here. Ask them to draw a diagram showing the different tasks that will have to be accomplished and how they relate to each other.



Instructions for instructor

Instruct the participants to:

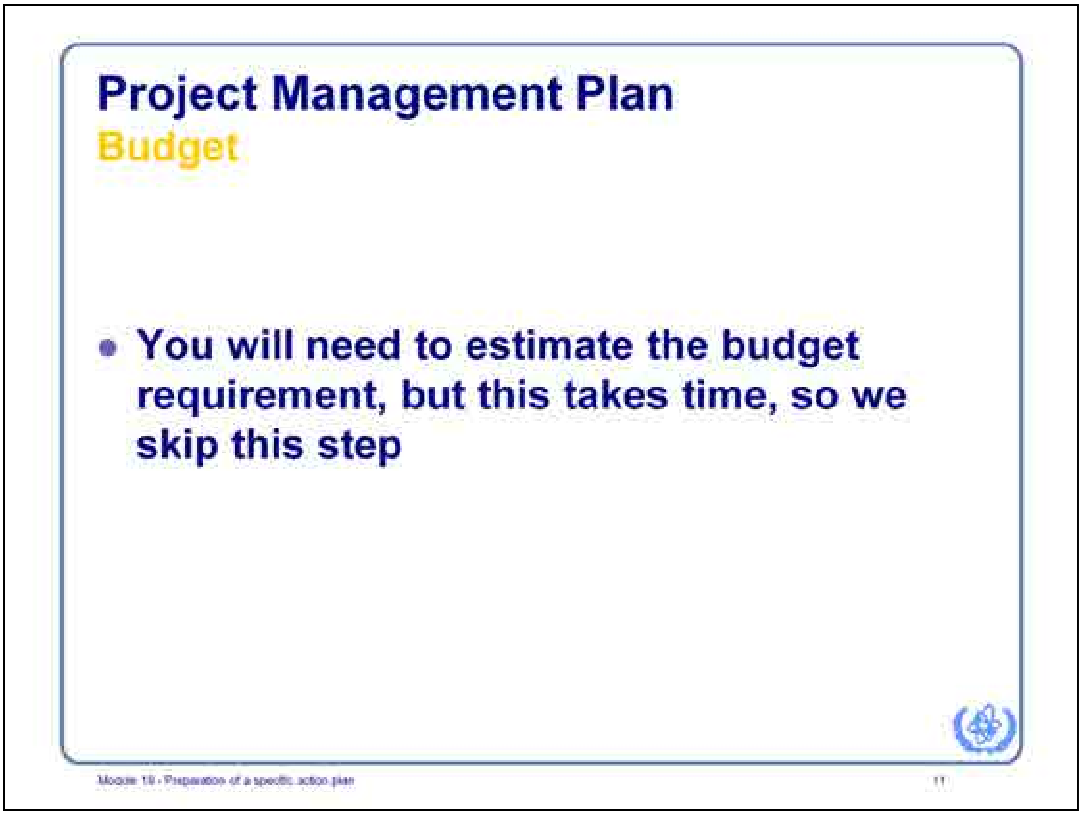
- Identify who the main project players will be
- Draw a matrix showing who will work on what task
- Show the probable responsible organization and support organization for each task.



Instructions for instructor

Ask participants to:

- Estimate when each task could start and when it should finish
- Be realistic
- To estimate what is the total project time required



Instructions for instructor

Skip the step because it would take too much time.

Instructions for instructor

Ask the participants the following questions:

- How will you control the project?
- Who will be in charge of controlling the project?
- What will you do if the project gets behind schedule?
- What if the cost becomes too high?
- Who will make those decisions? Be realistic.

Instructions for instructor

Ask the participants to:

- List five major risks.
- Rank them as very high risk, high, medium or low.

Ask them to be prepared to explain why they ranked them this way.

Conclusion

- You now should have the basis for a project management plan
- Of course, you will need to discuss the concept and refine the plan
- IEC would like to be informed of your progress in this task

Module 19 - Preparation of a specific action plan

IAEA Training Course for Research Reactor Emergency Response

Tabletop Exercise

Exercise Preparations

Block 5: Tabletop Exercise

Module 20: Exercise Preparations

Learning objectives: Upon completion of this module, the participants will:

- Be informed of the exercise conduct

Tasks:

- to identify rooms used for the exercise
- initial locations of the players
- how the exercise will be controlled

Activity: Lecture, discussion

Duration: 0.5 hr

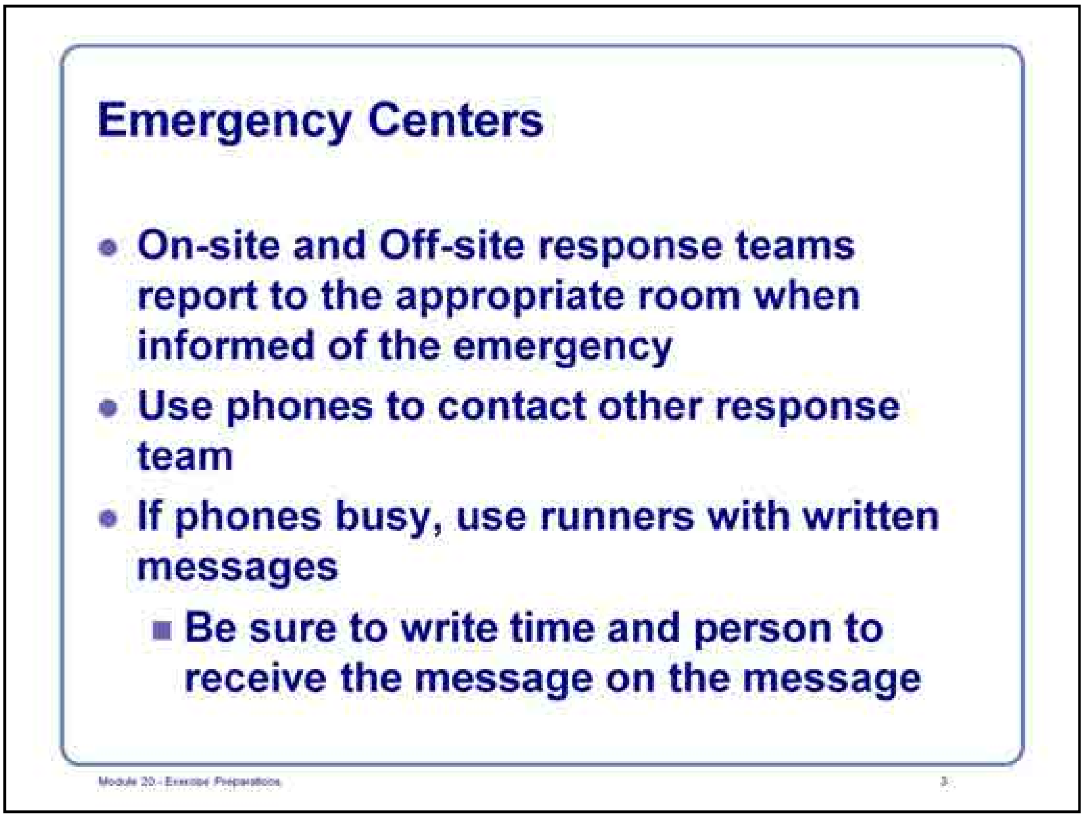
Materials and equipment needed: Work session notes

References: none

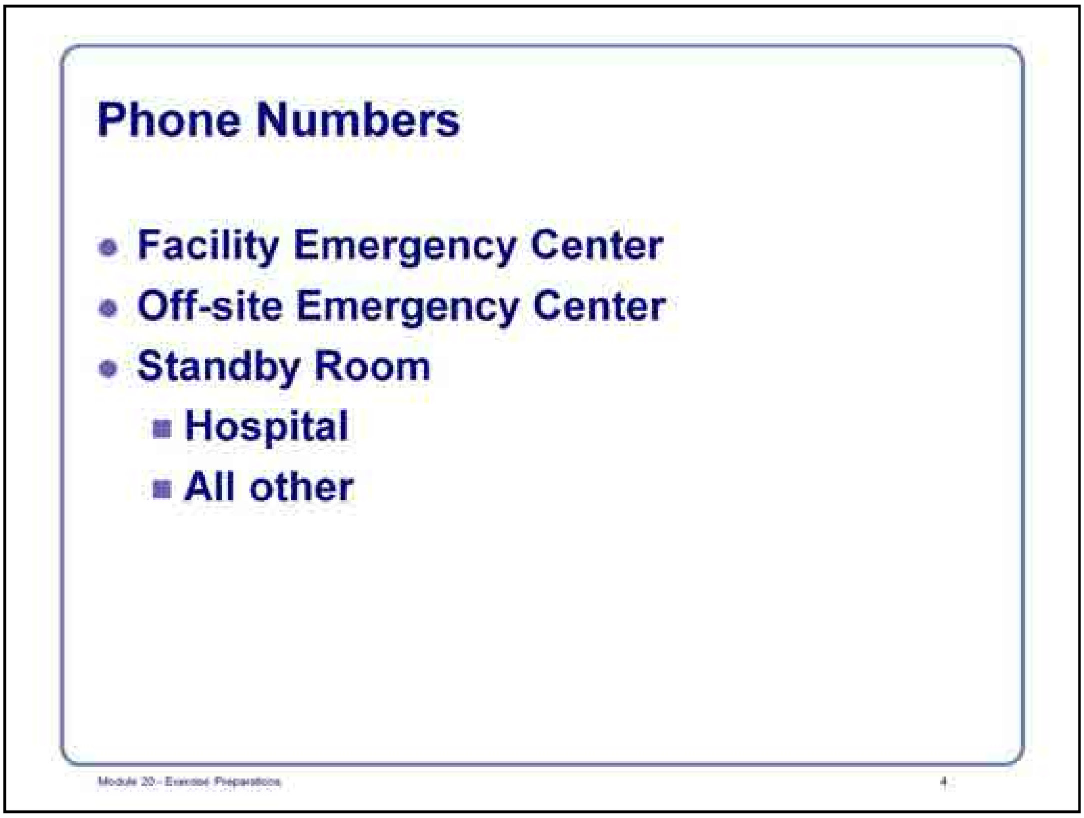
Ground Rules

- Three rooms for this exercise
  - Reactor facility
    - Reactor Control Room at first
    - Facility Emergency Center after Reactor Hall evacuated
  - Off-site Emergency Center
  - Standby Room

Lecture notes:



Lecture notes:



Lecture notes:

Lecture notes:

Lecture notes:
Instructor provide the names of the individuals in these positions.

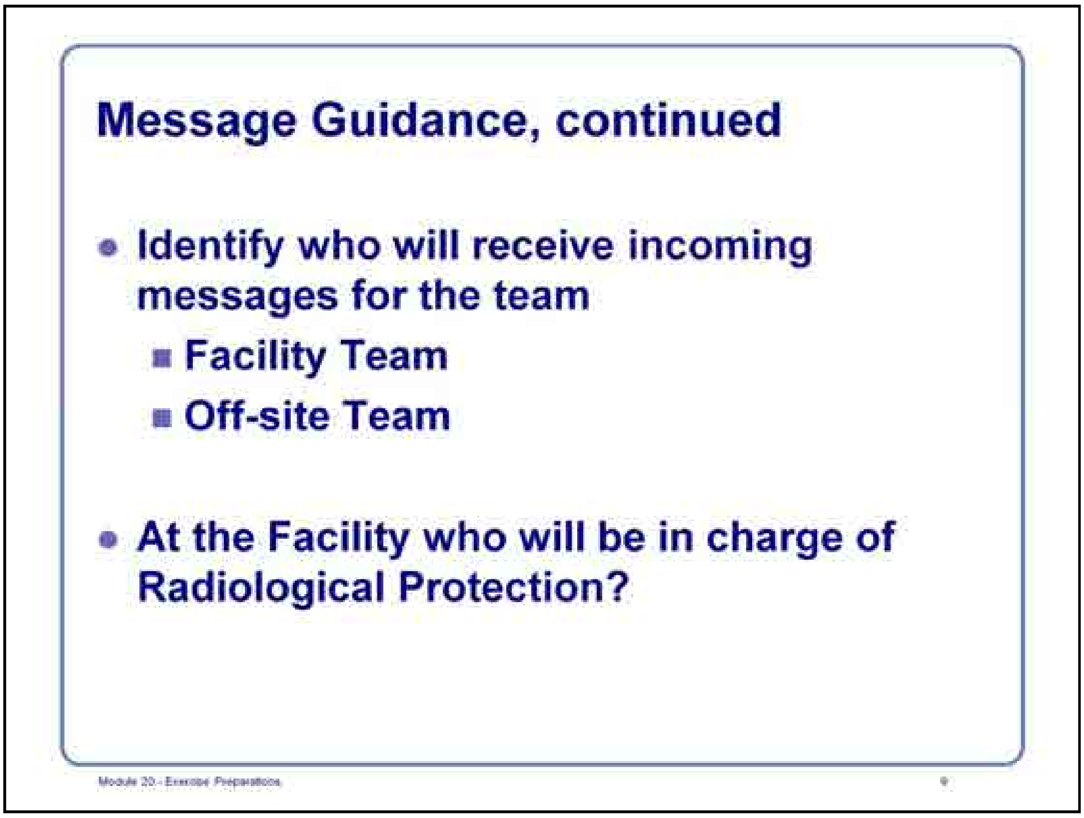
Lecture notes:
Instructor provide the names, the Controllers may also be tasked to evaluate.

Message Guidance

- Announcements to on-site and media to be written out, with time of the announcement, signed by the response team leader, and given to the controller for that organization
- If the controller doesn't have a signed message in writing, it is as if the information was never distributed
- Please write the messages in English

Module 20 - Exercise Preparations 8

Lecture notes:



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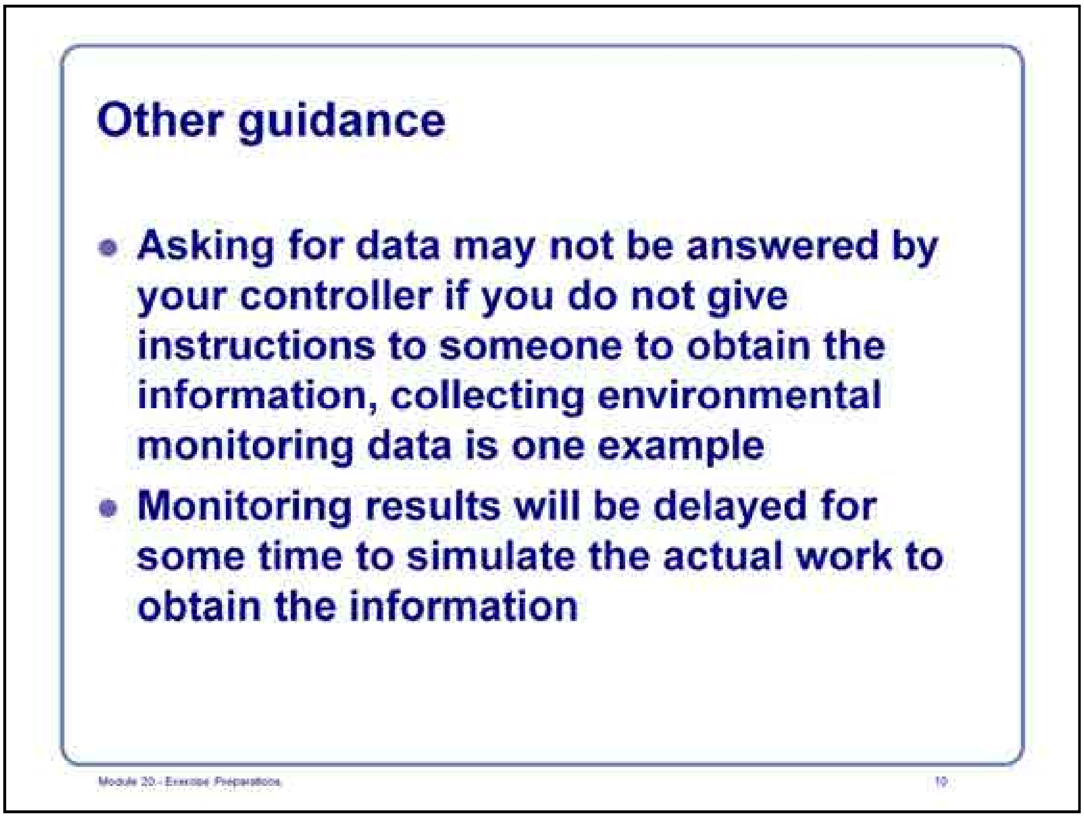

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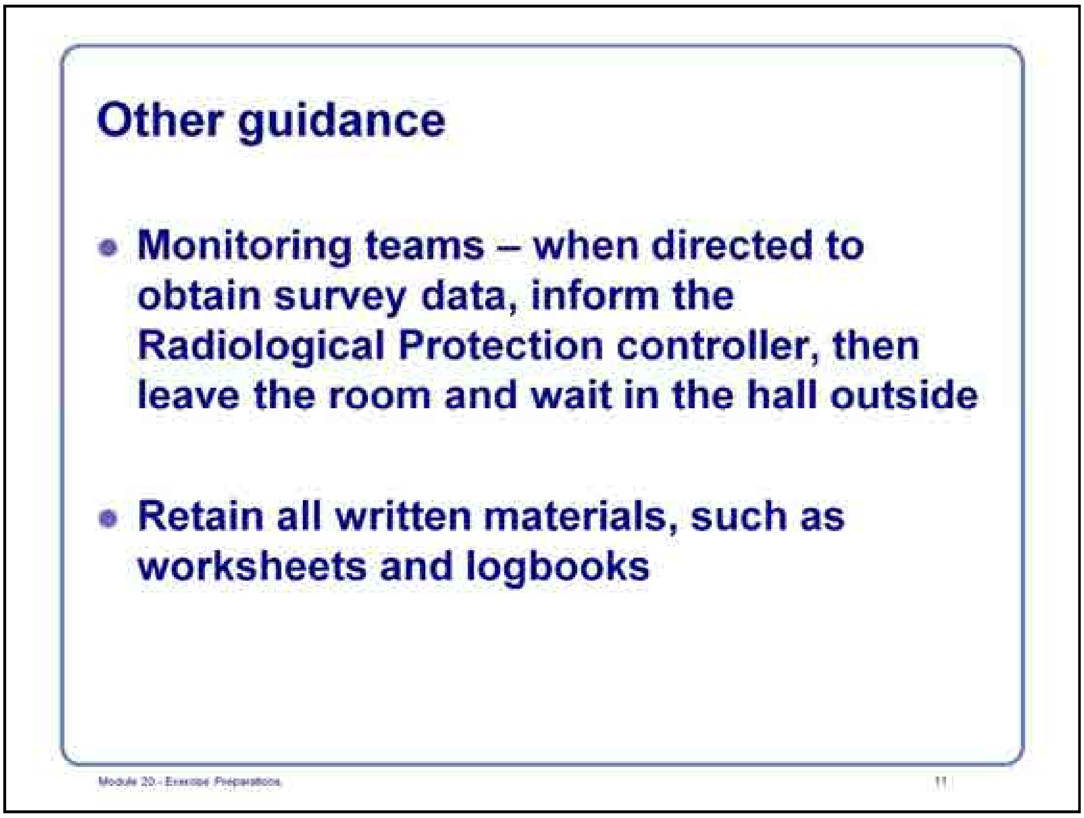

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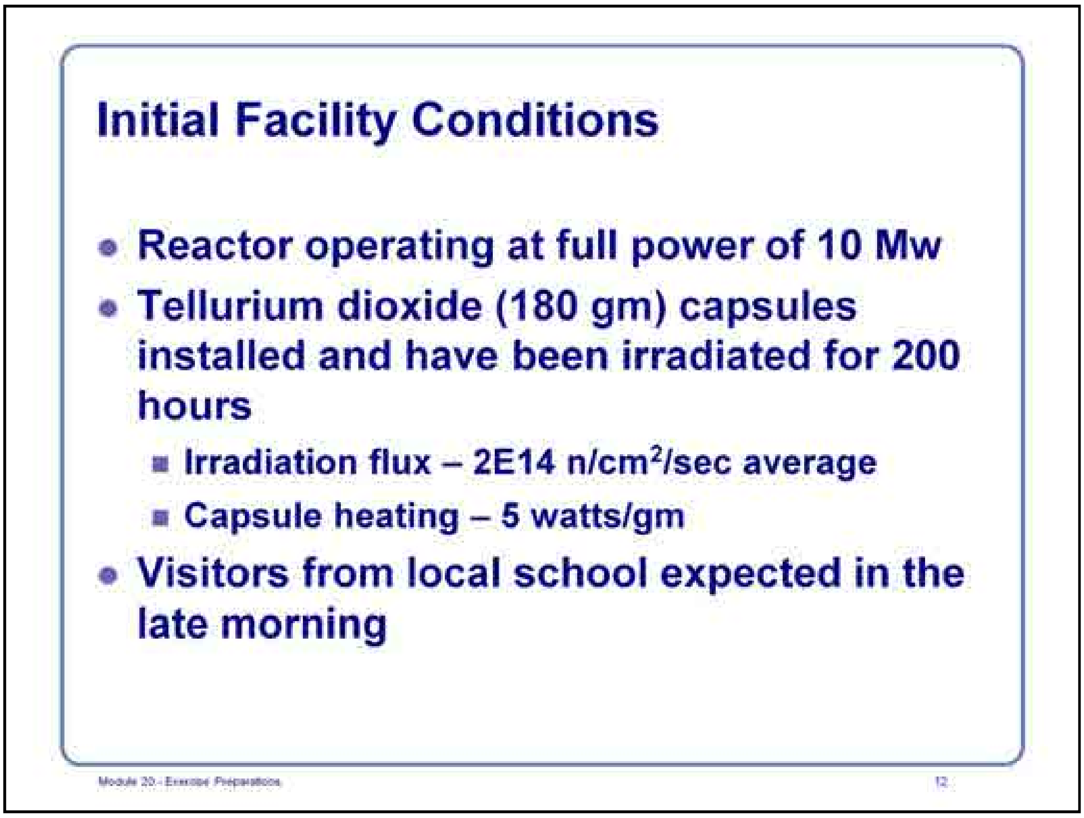

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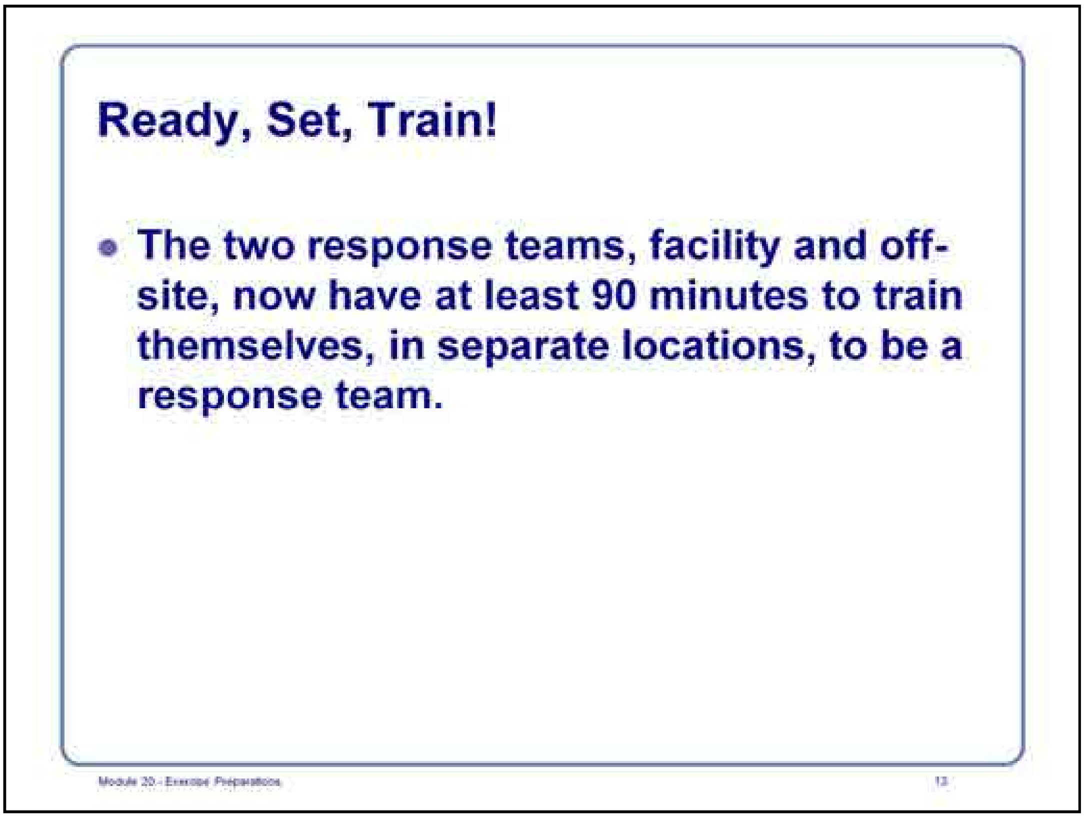
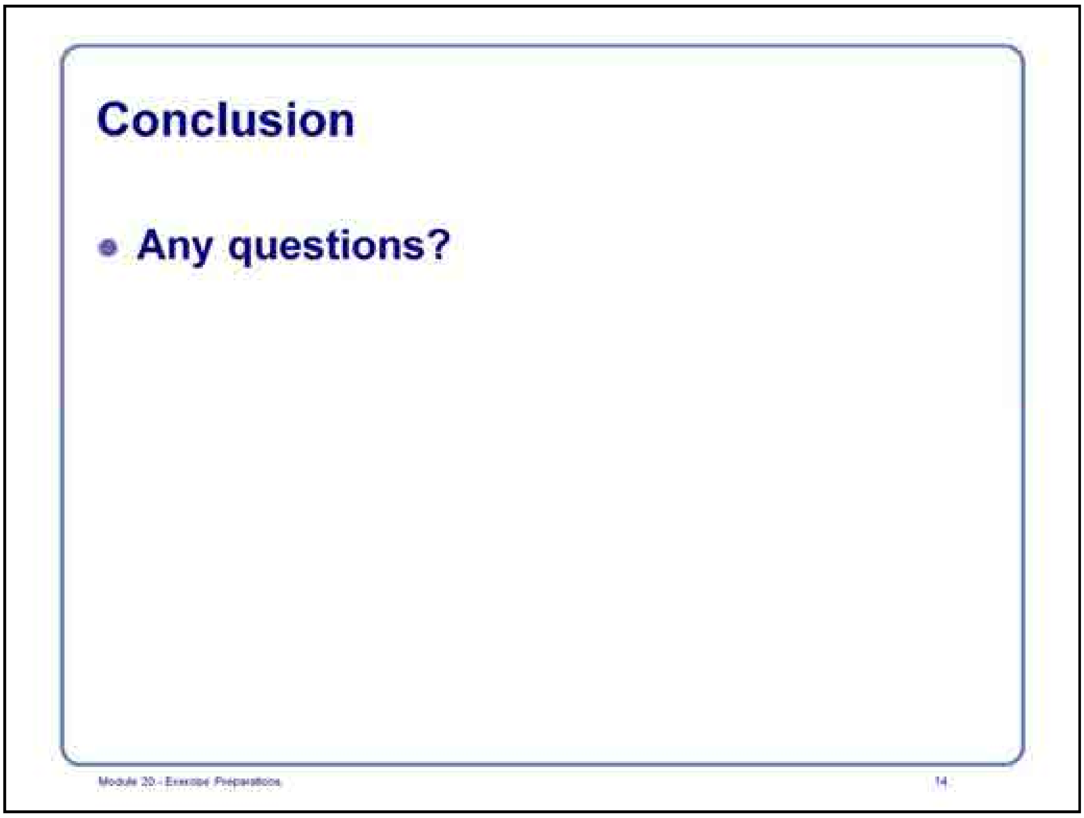


Lecture notes:

Train however you feel comfortable. One suggestion is to identify an individual or team of individuals for each role on the response team that you expect to need in the response.

Instructor notes:

Give room assignments for the self-training, and a specific time that the participants should expect to be prepared to start the exercise. The time while the responders are training will be used to train the Controllers and Evaluators (Module 22) which is expected to take about 90 minutes. It may help to select an individual to be the Facility Response Manager.



Lecture notes:

IAEA Training Course for Research Reactor Emergency Response

Tabletop Exercise

Controller and Evaluator Training

Block 5: Tabletop Exercise
Module 21: Exercise Controller and Evaluator Training

Learning objectives: Upon completion of this module, the participants will:

- Understand the responsibilities of each controller and evaluator

Tasks:

- Describe control of the exercise
- Give guidance to each controller and evaluator

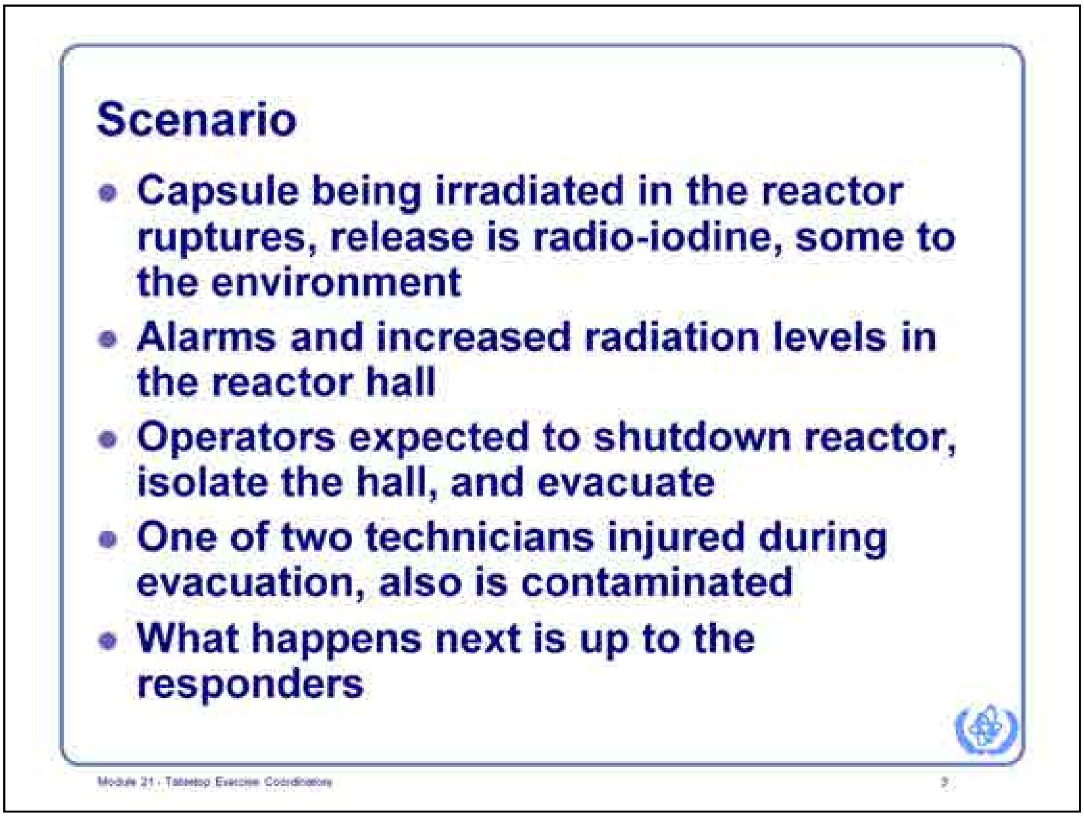
Activity: Lecture, discussion
Duration: 1.5 hr

Materials and equipment needed: Lecture notes, Exercise Manual

References: none

Ground Rules

- Your copies of the Exercise Guide are not to be shared with the other players
- Notes on actions aren't very useful unless they have a time associated with them
- Three rooms for this exercise
  - Reactor facility
    - Reactor Control Room at first
    - Facility Emergency Center after Reactor Hall evacuated
  - Off-site Emergency Center
  - Standby Room


Scenario
Capsule being irradiated in the reactor ruptures, release is radio-iodine, some to the environment
Alarms and increased radiation levels in the reactor hall
Operators expected to shutdown reactor, isolate the hall, and evacuate
One of two technicians injured during evacuation, also is contaminated
What happens next is up to the responders
Module 21 - Tabletop Exercise Coordinators
3

Expected Immediate Actions

- Expect the operators to:
  - contact site emergency response team
  - may contact off-site
  - may ask for ambulance
- Emergency Response Team may:
  - interview operators to understand situation
  - notify all site personnel
  - may evacuate site staff to assembly areas
  - contact off-site unless already complete
  - request ambulance
  - direct surveys be performed
  - consider reentry to search for others

Module 21 - Tabletop Exercise Coordinators 4

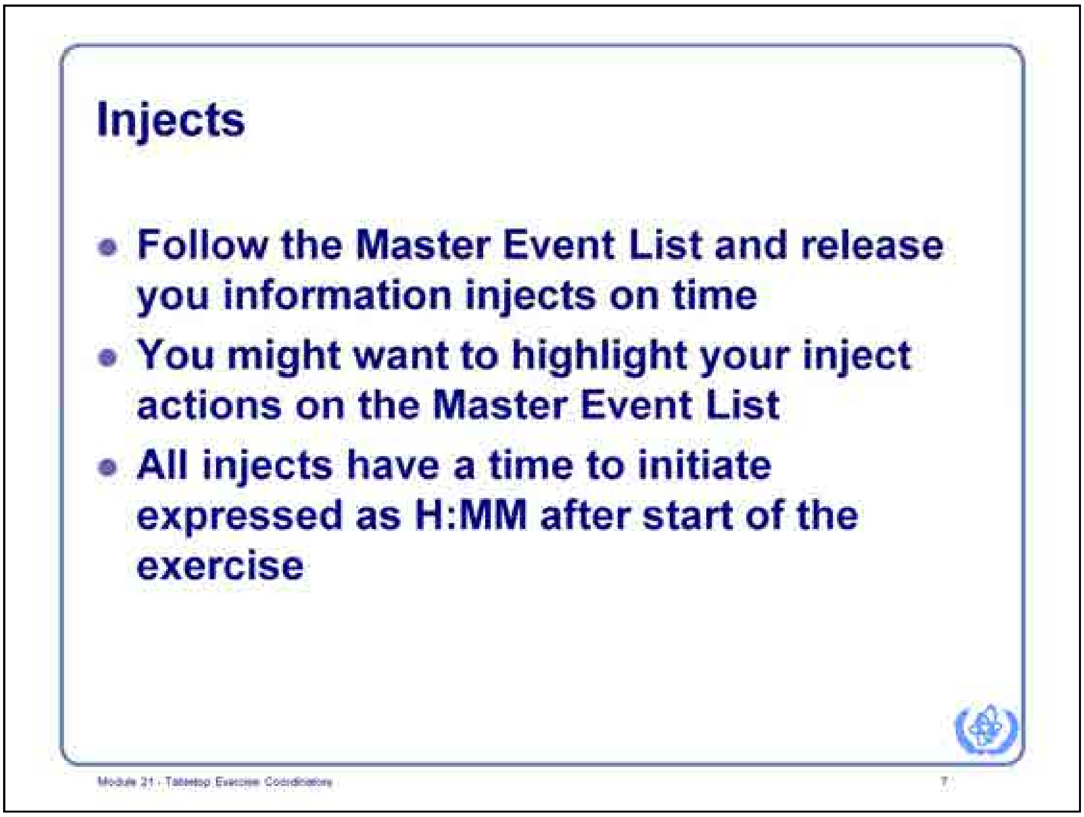
Expected Actions

- Site subsequent actions could include
  - receive and assess survey data
  - inform off-site that no risk to public
  - try to deal with the reluctant hospital
  - consider reentry to assess conditions
  - start press release
  - send school children back
  - notifications to others (school, family of injured technician)

Planned Distractions

- Reporters wanting information
- Distraught site personnel in Clinic
- Wild rumors on the news
- Distraught wife of injured technician
- Worried school administrator
- Unwanted protective action recommendations
- Concern for city water supply

Module 21 - Tabletop Exercise Coordinators 6


Injects
Follow the Master Event List and release you information injects on time
You might want to highlight your inject actions on the Master Event List
All injects have a time to initiate expressed as H:MM after start of the exercise
Module 21 - Tabletop Exercise Coordinators
7

Master Event List

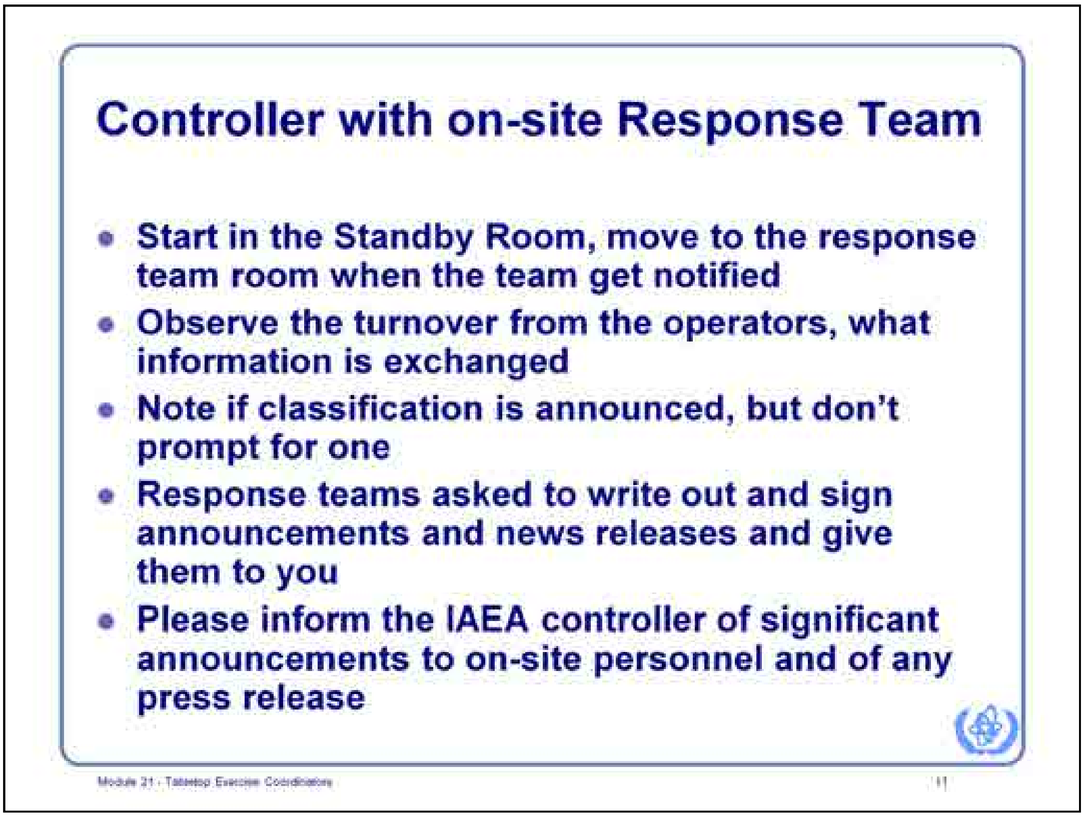
- We are unlikely to change the injects if they seem inappropriate, but we may delete some, please consult with the IAEA Controller if you think that is advisable
- Lets take several minutes to review each event on the list

Radiological Protection Coordinator

- Start in the simulated Reactor Control Room
- Monitoring teams are asked to inform you when they are directed to perform surveys
- Ask what protective actions they were told to implement
- Provide the data after several minutes, see the Injects
- If Section 5 doesn't have the data, the readings are background

Module 21 - Tabletop Exercise Coordinators 9

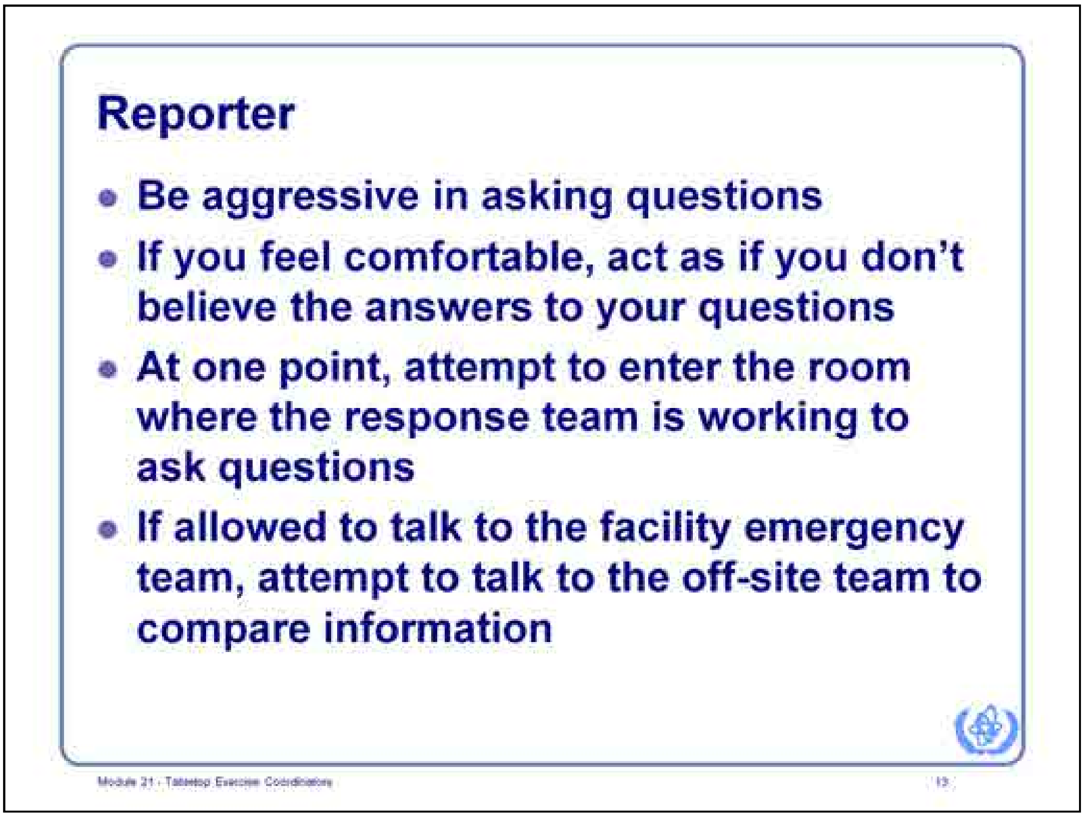

Operator Controller
No additional support until the operators tell you who they will call, and place a phone call to the Standby Room to ask for that support.
On-site response team may be a single call
Off-site response team may be a single call, but must be a separate call
Note if the operators make a classification, don't prompt them for one
Module 21 - Tabletop Exercise Coordinators
10


Controller with on-site Response Team
Start in the Standby Room, move to the response team room when the team get notified
Observe the turnover from the operators, what information is exchanged
Note if classification is announced, but don't prompt for one
Response teams asked to write out and sign announcements and news releases and give them to you
Please inform the IAEA controller of significant announcements to on-site personnel and of any press release
Module 21 - Tabletop Exercise Coordinators
11

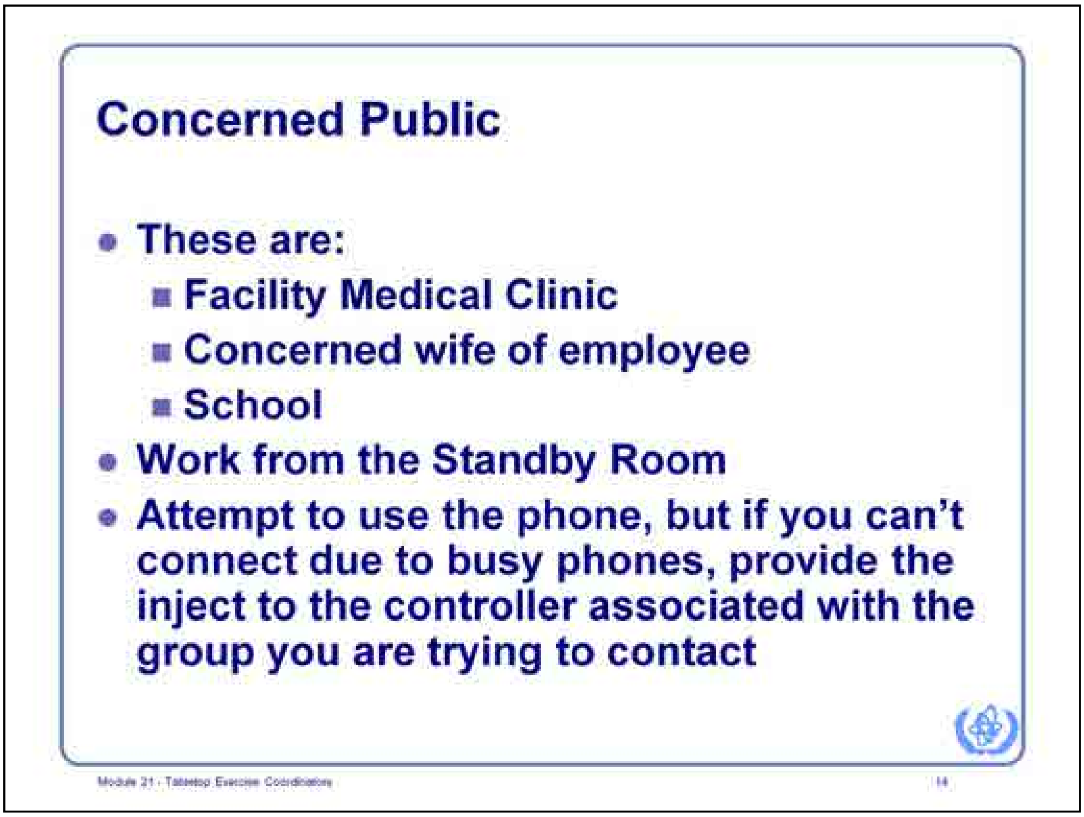
Controllers with off-site Response Team

- **Start in the Standby Room, move to the response team room when the teams get notified**
- **Response teams asked to write out and sign announcements and news releases and give them to you**
- **Note if the off-site response team is informed of the emergency class**
- **Please inform the IAEA controller of announcements to on-site personnel and of any press release**

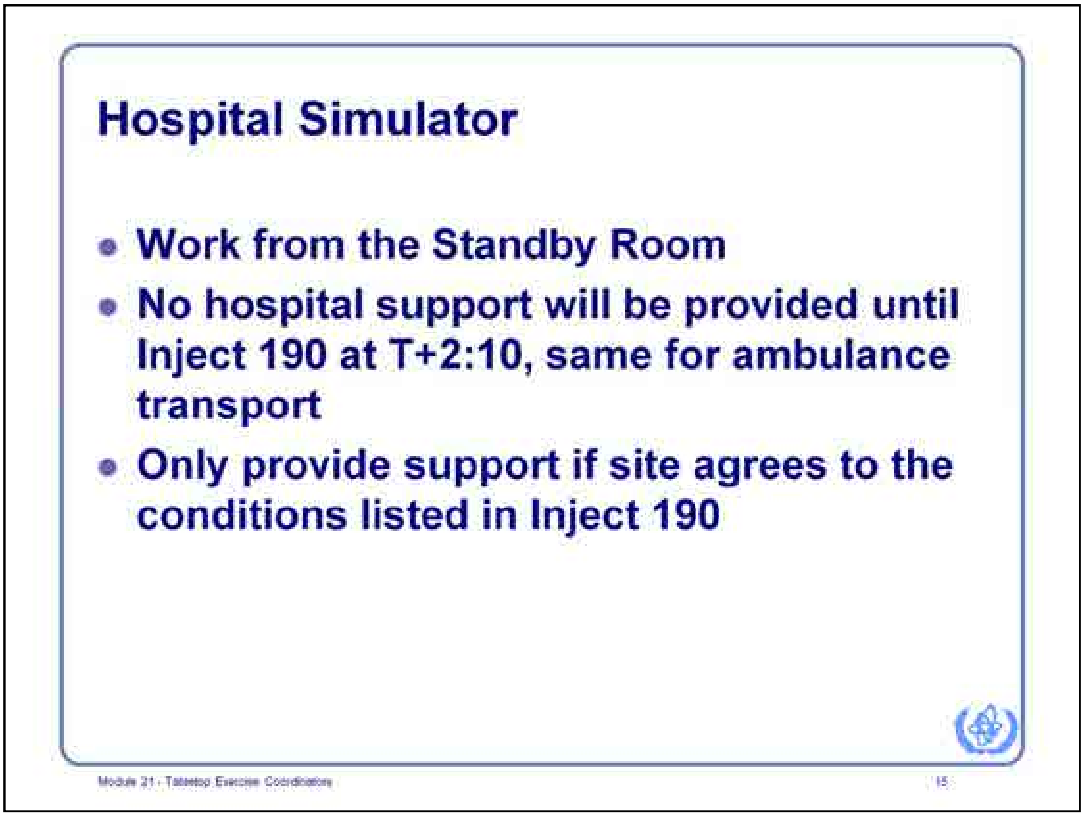
Module 21 - Tabletop Exercise Coordinators 12



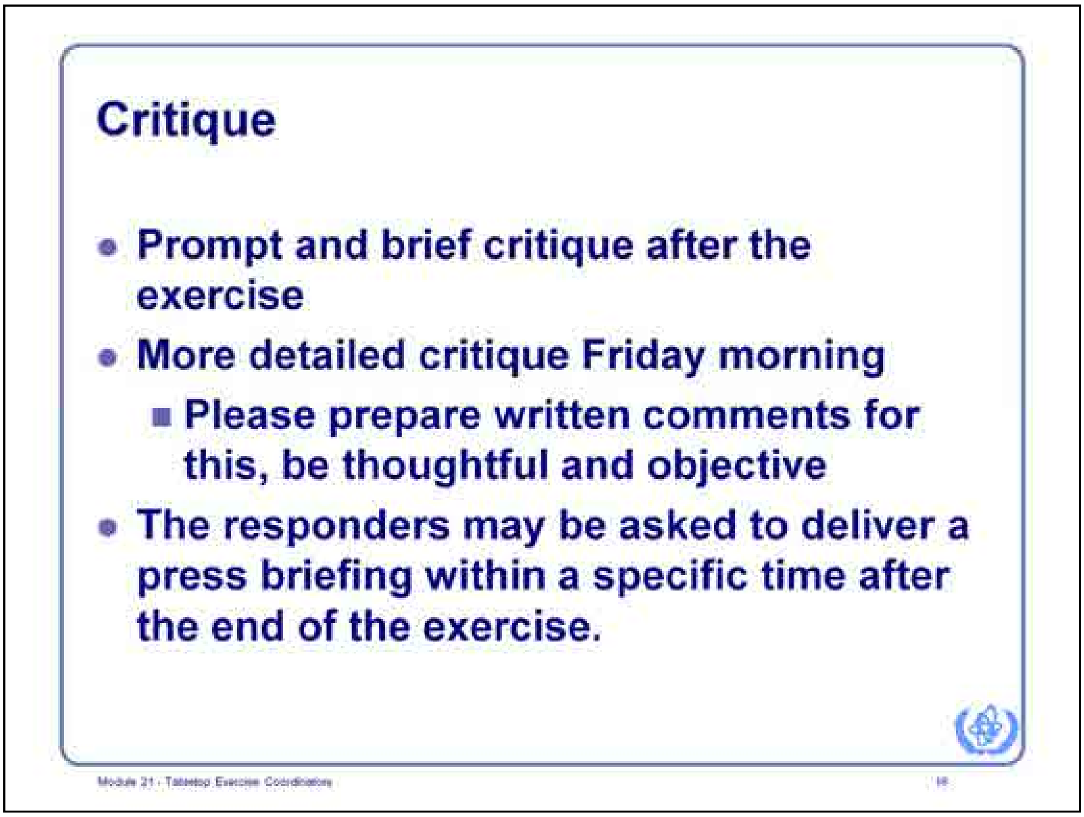
One individual will be assigned the position of an outside reporter who is diligently attempting to collect information, but not by subterfuge.



One person will actually play three roles with phone calls or communication through the Controllers. The injects are far enough apart in time that this shouldn't cause conflicts.



This role may be the same person playing the three roles of Concerned Public.



Presentation of the press briefing will depend on amount of time available.

Conclusion

- Any questions?