Lesson 4: Protective Actions & Emergency Classification System

Lesson Overview

In this lesson you will learn about protective actions for reactor accidents and the emergency classification system.

Upon completion of this lesson, you will be able to:

- Describe accident classification and protective action decisions.
- Describe Nuclear Regulatory Commission (NRC) general emergency protective action guidance.

Remember you can access the glossary in one of two ways throughout this course. You can select the glossary button in the top right hand corner of each main content screen. In addition, on content screens you can select underlined words to access their definitions in the online glossary. Selecting an underlined word will take you directly to its definition in the glossary.

This lesson should take approximately **35 minutes** to complete.

Response Objectives

In the first section of this lesson, you will learn about protective actions that can be taken after reactor accidents. These are the emergency responses taken after an accident to reduce negative effects.

The objectives of emergency response after a reactor accident are to:

- Reduce the risk from or mitigate an accident at its source.
- Reduce the occurrence of severe deterministic health effects by keeping acute doses to critical organs below critical thresholds (50–100 rem).
- Take action to reduce cancer-producing effects.
- Do more good than harm in accordance with EPA/FDA guidelines.

Information Available at the Time of Event

At the time of the event, there is very little accurate information, but there may be a great deal of inaccurate information. Unfortunately, this is the time when the most important decisions need to be made.

Because of all the uncertainties involved, it is preferable to create a range to bound the possible consequences (consequences if the containment fails early, later, or not at all). Do not estimate conservatively or add conservatism just to be sure! The results will become meaningless and impossible to compare.

Information Provided to Decision Makers

Decision makers feel overwhelmed with information after an accident because the same information is being reported from different groups. Technical staff supporting the decision maker should:

- Provide known information (emergency class and core status).

- Try not to bias the decision maker.
- Give a best scientific estimate (not a conservative estimate).

There are priorities for decision makers following protective action guides (PAGs). Each of these priorities will now be covered in detail.

Priorities: Prevent Early Health Effects

The first priority after an accident is to prevent early health effects among the population in the path of the release.

Risks of Taking No Protective Action

By taking no protective action, an individual living near the plant has a 67% chance of exceeding 200 rem exposure.

Sheltering in a normal-frame home reduces the risk to 66%—virtually no reduction.

Even if the individual evacuates as the plume arrives, there is still a 55% probability of receiving a fatal dose of radiation.

Only evacuation before the plume arrives reduces the probability significantly, to 3%.

Research on Severe Accidents: Evacuation and Sheltering

Research on severe accidents tells us what actions we need to take and when we need to take them. The conclusion of past research shows:

- Core melt and early containment failures account for most of the risk of death off-site.
- Only evacuation before the release or shelter in a large building can substantially reduce the risk to those living within one mile of a plant where an accident occurs.
- Evacuation in plume does not increase the risk.

Why Wait to Evacuate?

To reduce the risk from a severe reactor accident, evacuation should be ordered early—before or shortly after a release.

Evacuation is much more effective than sheltering in reducing the potential for early deaths or health effects.

Urgent protective actions should be taken before or shortly after a release from a core damage accident.

Core damage can be predicted before a release, but the characteristics of a release cannot be predicted once the core has been damaged. Therefore, actions to be taken must be determined based on the status of the core.

Priorities: Reduce Stochastic Effects

As you learned earlier in this lesson, the first priority after an accident is to prevent early health effects among the population in the path of the release. The second priority after an accident is to reduce

stochastic effects (cancers) from the release. In the next section of this lesson you will learn about stochastic effects.

Thyroid dose can be an important determinant of stochastic effects at great distances, via the ingestion pathway (i.e. consuming contaminated food such as milk). Many individuals who were children at the time of the Chernobyl accident and were exposed to released materials, even at great distances from the reactor itself, now have thyroid cancer.

Thyroid Blocking

Thyroid blocking is the process of preventing radioactive iodine from reaching the thyroid by first giving the individual large amounts of stable, nonradioactive iodine.

The stable iodine is most effective if taken 1 to 2 hours before the individual inhales the radioactive release.

If taken shortly after the individual inhales the radioactive release, it is still effective, but effectiveness drops rapidly to about 50% in 2 to 3 hours.

Chernobyl: Potassium Iodide Side Effects

18,000,000 single doses of potassium iodide (KI) were administered in Poland as a result of the Chernobyl accident. Though intended for children, doses were taken by some adults.

Out of all 18,000,000 doses administered, only two serious reactions were reported: both by adults who were allergic to iodine.

Based on this experience, there do not seem to be serious side effects from the use of KI as a prophylactic to reduce thyroid dose.

Protective Action Strategy

To reduce public risk for core damage accidents, officials should take the following protective action strategies:

- Evacuate or provide shelter within a two mile circle and five miles in the downwind sector and one sector on either side.
- Take thyroid blocking near the plant.
- Restrict consumption of locally grown food to at least 50 miles.
- Monitor to locate and evaluate hot spots in order to prevent severe deterministic health effects.
- Monitor to locate where food restrictions and relocation are warranted based on predetermined Derived Response Levels (DRLs).
- Revise the DRLs once the release mix is known.

Psychological Considerations

Psychological health effects should be expected after a nuclear accident. Past experience has shown that the effects are caused by a fear of radiation.

At Chernobyl, some actions taken by officials did more harm than good. Rural populations were relocated to cities, where the psychological impact of the accident, combined with the stress of relocation and higher crime and alcoholism rates, effectively reduced life expectancy.

Factors to Increase Public Trust

Trust in officials enhances popular compliance. Factors that build trust include:

- An ongoing information program
- Clear and simple advice during the accident
- Consistent advice and assessment (one official information point)

Emergency Classification System

Now that you have learned about protective actions you will learn about the system for defining which situations and accidents warrant prompt action, the emergency classification system.

Purpose of the Emergency Classification System

The emergency classification system for nuclear power plant accidents is designed to identify those accidents that warrant prompt action. It is the basis for fast, coordinated local, state and national action.

The nuclear power plant accident classification system is the basis for fast coordinated local, state, and national action for activation and notification, protective actions before a release, and notification of nearby states/counties if there is a potential of release.

The classification system is based on environmental monitoring and risks of core damage, judged by the critical safety system and barriers (core damage indication).

Accidents that Do Not Require Immediate Action to Protect the Public

Three classifications provide notification that something out of the ordinary is occurring:

- Notification of Unusual Event (NOUE)
- Alert
- Site Area Emergency (SAE)

In these cases there is no need for immediate action to protect the public.

General Emergency (GE)

A General Emergency (GE) means that there is actual or projected severe core damage or that the operators have lost control of the plant. A GE warrants taking protective actions without any further discussions or meetings. The declaration of the emergency alone leads to protective actions being initiated. The reactor operator must also provide a protective action recommendation to off-site decision makers.

Frequency of General Emergencies

Statistically, the chances of a GE are between 1 in 5,000 and 1 in 10,000 per reactor year (RY).

The probability of a reactor accident is low; however, should such an accident occur, the consequences could be severe.

Reference Documents

Now that you have learned about protective actions and emergency classification, you will learn about reference documents with which you should be familiar. These include:

- The Nuclear Regulatory Commission's (NRC's) Response Technical Manual (RTM-96), used for accident assessment
- The NRC's Response Coordination Manual (RCM-96), used for accident coordination
- Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants (NUREG-0654/FEMA REP-1 rev.1)
- The Federal Radiological Monitoring and Assessment (FRMAC) Manuals

The next screens will provide more in depth information about each of these documents.

Response Technical Manual (RTM–96)

RTM-96 describes methods for assessing core damage and performing dose projections for those in the path of the release. The resulting estimates will help officials determine or confirm where to recommend protective actions for the public.

On the next few screens you will learn how RTM-96 includes information on the NRC's responsibilities, core damage assessment, classification, and protective action decision making.

RTM–96: NRC Responsibilities

The National Response Framework and the associated Nuclear/Radiological Incident Annex designates the NRC as a coordinating agency and as the lead technical agency. The NRC, because of its licensing authority, is the lead for an accident at a nuclear generating station. One of the first NRC on-site actions after such an accident is to begin assessing core damage.

On the next few screens you will learn how RTM-96 addresses core damage.

RTM-96: Core Damage Assessment

RTM-96 Section A outlines steps in assessing core damage. These steps include:

- Assessing the status of critical safety functions for indications that the core is uncovered
- Monitoring for indications that the core may soon become uncovered
- Projecting core damage if uncovered and informing decision makers
- Monitoring radiation levels to confirm and assess core damage
- Continue to assess core damage

Core damage assessment is a continual process. It should be conducted with the big picture in mind, and one instrument alone should never be used as the sole basis of a core assessment.

RTM-96: Condition Assessment Tool

RTM-96 is the NRC's principal tool for assessing core condition based on the amount of time the core was uncovered.

Other RTM-96 tables and charts show that containment monitor response is a key indicator of core damage.

NUREG-0654: Importance of Classification

Classification is the most important aspect in assessment of the accident in the early phase. Rapid classification and action, if necessary, is crucial. Classification as a GE will dictate immediate action and distinguish the accident from the other three possible classifications, none of which require immediate action. Unlike most exercise scenarios, GEs will possibly begin as GEs, requiring an immediate protective action for the public.

RTM-96: Protective Action Decision Making

RTM-96 includes a decision-making tool for determining protective actions necessary in the event of core damage or loss of control of the facility.

Response Coordination Manual (RCM-96)

In addition to RTM-96, you should also be familiar with RCM-96 which describes the types of interactions that may occur between the NRC and the other response organizations to provide an effective, coordinated response to a radiological emergency.

RCM-96 is a compilation of NRC documents that discusses various aspects of a response to an event at an NRC-licensed facility. The documents in RCM-96 focus primarily on non-technical coordination rather than technical analysis. Several documents that were previously published as NUREGs have been updated and are included.

Federal Radiological Monitoring and Assessment Center (FRMAC) Manuals

Other important reference documents with which you should be familiar are the FRMAC manuals. These are a multi-volume set of texts that provide a standard methodology for all activities associated with the FRMAC's environmental radiological monitoring, sampling, radioanalytical, and quality assurance programs.

These procedures are intended for use in responding to an emergency and processing relatively large numbers of samples in the shortest possible time.

The Department of Energy (DOE) has the responsibility for maintaining and revising the FRMAC manuals.

Lesson Summary

Let's summarize what you have learned in this lesson:

- Protective actions for reactor accidents take several priorities into consideration:
    - Preventing early health effects
    - Reducing stochastic effects

    - Following protective action strategy
    - Psychological effects
- The emergency classification system categorizes reactor accidents as: Notification of Unusual Event (NOUE)
    - Alerts
    - Site Area Emergencies (SAE)
    - General Emergencies (GE)
- Several reference documents assist with monitoring and classifying reactor accidents:
    - RTM-96
    - RCM-96
    - NUREG-0654/FEMA REP-1 rev.1
    - FRMAC Manuals

The next lesson will cover the foundations of EPA Protective Action Guides, including units of dose, exposure pathways, and health effects.