Accidents and Emergencies

Module Objectives

- Describe health physics actions and activities related to emergency planning, preparedness, response, and recovery.
- Identify the health physicist's role in accidents and emergencies.
- Identify the types of accidents involving the release of radioactive materials that might occur.

Emergency Planning

- The emergency response plan is the administrative document that establishes the licensee's commitments to emergency preparedness, response, and recovery during radiological emergencies.
- The emergency response plan should provide information on:
  - Types of accidents that might occur
  - Classification of postulated accidents
  - Responsibilities for emergency response/management
  - Off-site support services (e.g., police, fire, hospital, etc.)

Emergency Planning

- Radiological procedures should describe emergency response action for health physics personnel
- The activities that should be included are:
  - Interactions with site emergency response/control functions.
  - Emergency radiological monitoring and environmental sampling – how to perform radiological surveys and environmental sampling.
  - Post accident sampling and analysis – procedures to be used to assess the extent of the damage and radiological hazards. This should include how to collect handle and store post accident samples.

Emergency Planning

- Radiological dose assessment – provides steps for determining qualitative and quantitative assessment of the radiation exposures resulting from accidental radiological releases and subsequent dose assessment.
- Personnel protection – assists in minimizing personnel exposure to radiation. Protective actions are selected with regard to adverse conditions such as release of toxic gases or inclement weather.
- Decontamination – provides for emergency decontamination of personnel, equipment, and facilities. Alternate personnel decontamination areas and how to relocate to these areas should be identified.

Emergency Planning

- Exposure Control – provide guidance for exposure authorizations, dose guidelines, and post exposure assessments.
- Protection action recommendation – provide the steps necessary to determine protective action recommendations for the public.

Protective Action Recommendations

- The following considerations should be included in protective action recommendation procedures.
  - Site/facility status
  - Radiological conditions
  - Meteorological conditions
  - Time of day/day of week
  - Duration of release
  - Plume modeling and estimations
  - Sheltering versus evacuation

Protective Action Guides

- Protective action guides (PAG) have been developed to provide projected doses and recommended protective actions for personnel and the public in the event of a radiological accident.
- PAGs are based on guidance from the EPA contained in document “ Manual of Protective Action Guides and Protective Actions for Nuclear Incidents”.
- The PAGs recommend that protective actions should be considered by responsible officials if projected “whole body” doses are in the range of 1 to 5 rem.
- NRC recommends protective actions at an (effective) dose of 1 rem.

Protective Action Guides

- The 1 rem PAG is recommended for the determination of evacuation or sheltering of personnel and the public.
- PAG are also recommended for emergency response activities of employees.
  - 10 rem for protecting valuable property
  - 25 rem for lifesaving or protection of large populations
  - >25 to 100 rem for lifesaving or protection of large populations with voluntary consent after being advised of the risks. Volunteers over age 40 preferred.

Emergency Preparedness

- Emergency training programs are established to ensure that facility personnel are prepared to respond to, manage, mitigate, and recover from emergencies.
- Training of the emergency response organization (ERO) health physics personnel should cover the following areas:
  - Emergency responsibilities
  - Emergency equipment
  - Emergency facilities
  - Skills training, drills, and exercises

Health Physics Responsibilities

- During and after an emergency health physics personnel accomplish important tasks in the following areas:
  - Timely initial assessment of the actual or potential consequences of an emergency.
  - Monitoring and evaluating the specific indicators necessary to continually assess the consequences of emergency events.
  - Monitoring and evaluating indicators related to safety, health, environmental, and security conditions that may affect (mitigate or exacerbate) the emergency.
  - Projection of potential on- and off-site consequences.

Health Physics Responsibilities

- Health physics personnel will be expected to perform the following activities during and after an emergency:
    - Locate and track hazardous materials released to the environment.
    - Estimate the integrated impact of such releases to the public and environment.
    - Direct measurements of the radiation exosure/dose rates resulting from the presence of radioactive materials in air or on contaminated surfaces.
    - Sample and appropriately analyze air, water, soil, and vegetation.

Health Physics Responsibilities

- Due to the critical nature of the role of emergency health physics personnel formal job descriptions stating minimum qualifications and experience should be established.
- Many emergency functions are similar to those performed by the staff during normal operations, while other functions may be unique to the emergency environment.

Emergency Response Organization (ERO)

- The ERO shall include personnel that are available 24 hours a day to coordinate and implement the radiological field monitoring and environmental sampling efforts.
- The ERO should include the following response teams:
  - Monitoring teams
  - Sampling teams
  - Staff to direct and coordinate team efforts
  - Personnel to analyze the samples, interpret the measurement results and other information provided by the teams.

Emergency Response Organization

- ERO teams are responsible for sampling and monitoring in the field as well as directing response to an emergency.
- The ERO manager is responsible for directing the emergency response with support from other groups including health physics.
- The on-scene coordinator relays information to and from the ERO director.
- Should have additional personnel assigned to back up ERO personnel if they are not available.

Emergency Recovery

- After the emergency conditions have been stabilized and the facility is moderately "safe" recovery can begin.
- The recovery effort consists of returning the plant to its pre-emergency condition.
- Extra precautions should be taken due to potential or actual damage to safety systems, process equipment, and structures as a result of the emergency.
- Detailed planning prior to reentry is essential to ensure that adequate precautions and controls are established to protect the health and safety of workers.

Emergency Facilities and Equipment

- Emergency facilities and equipment are required to support the emergency response.
- The type and quantity required will depend on what hazardous materials exist at the site and the operations performed.
- A facility should have a secure site for the ERO to operate from; sometimes the ERO may be off-site.
- A facility should be set up for decontamination of personnel which includes a shower with ability to capture the water and analyze it before release.

Emergency Facilities and Equipment

- Emergency equipment for health physics emergency functions include the following:
  - Equipment for offsite monitoring/sample collection
  - Radiation survey equipment
  - Air sampling equipment
  - Protective clothing
  - Respiratory protection equipment
  - Radios for communication
  - Dosimetry devices, including self-reading dosimeters

Emergency Facilities and Equipment

- Emergency kits should be prepared and sealed to minimize tampering.
- A routine inventory of the kits should be performed to assure the readiness of the kit in the event of an emergency.
- The kit should be prepared to handle both injured and contaminated personnel.
- Remember: medical treatment, especially for life-threatening conditions, ALWAYS takes precedence over radiological decontamination issues
- Also: chemical toxicity (U, HF) frequently is worse than radiological hazards

Consequence Assessment

- Methods and equipment for monitoring and assessing actual or potential consequences of a radiological emergency shall exist at facilities for both onsite and offsite emergencies.
- Actual releases are generally determined by installed effluent monitoring systems when the releases are from monitored release points.
- Releases from unmonitored locations may be estimated from inventory data, nature of the event, and the physical characteristics of the released material.
- Field monitoring data should be used to verify effluent monitoring data and estimates.

Special Considerations

- Consideration should be given to the chemical toxicity of uranium when determining protective actions and dose assessments.
- Assessments for postulated accidents should be completed and placed in the emergency plan with copies at an emergency command facility.
- Real time meteorological data should be available along with measured or estimated source terms and location of release.

Protective Action Response

- Protective actions are taken to avoid or minimize personnel and public exposures to a uranium release.
- The response should focus on minimizing inhalation or ingestion of material.
- The following three methods should exist onsite:
  - Evacuation of personnel from affected areas, and method of accounting for personnel.
  - Sheltering of personnel in a protected ventilated zone.
  - Personal protective equipment.

Protective Action Response

- Offsite responses are implemented by local authorities.
- The response usually involves one of two methods:
  - Evacuation of the public to an area of expected low dose.
  - Sheltering in place, in which residents shut down their ventilation systems, seal their homes and occupied structures, and remain inside those structures until instructed to leave.

Medical and Health Support

- Medical services for injured personnel take precedence over contamination control.
- If the injury is not severe then time can be taken to survey personnel before transport to hospital.
- If personnel must be transported to offsite medical facility then precautions should be taken to ensure contamination control.
- Facilities should work with offsite medical facilities to prepare for handling contaminated patients.
- Most medical personnel have little familiarity with radiation/contamination issues.

Decontamination

- Procedures should be established for monitoring and decontamination of personnel.
- Normal facility procedures should be used with special provisions for emergencies.
- This allows personnel to be familiar with the procedures.

Accidents

- The historical accidents that have happened at uranium recovery facilities are important because they provide a basis for theoretical calculations of releases and offsite doses for possible accidents can be determined.
- This provides the basis for emergency planning and for the development of plans and procedures for emergency preparedness, response, and recovery.

Historical Accidents

- Historically accidents at natural uranium recovery facilities have not been serious from a radiological standpoint, even though some accidents have been severe, and even fatal.
- This is primarily the result of the low specific activity of uranium and the low volatility of the uranium compounds present.
- Most of the accidents at uranium recovery facilities involved a fire or releases of recovery tailings.
- Despite the serious nature of some of the accidents, doses offsite have been minimal.

Accidents

- According to NUREG-1140 “A Regulatory Analysis on Emergency Preparedness for Fuel Cycle and Other Radioactive Material Licensees,” a postulated fire in the solvent extraction circuit was postulated as having the greatest significance for emergency preparedness.
- Based on the accident scenario the offsite dose would be less than 100 mrem.
- With ISL the possible accident scenarios are fires, spills, and leaks of material from equipment and piping.

Fires in Uranium Recovery Facilities Through 1986

Date	Recovery	Fire Description	Offsite Release
3-19-59	Vanadium Corporation of America Durango, Colorado	Fire in yellowcake dryer	None detected
6-25-65	American Metal Grand Junction, Colorado	Fire in ore dryer for 3 to 5 minutes, $2,600 damage	None detected
2-68	Western Nuclear Jeffery City, Wyoming	Workers started a fire to thaw a frozen ore dryer, fire ignited propane from a leaking tank	None detected
11-10-68	Petromics Company Shirley Basin, Wyoming	Solvent extraction circuit, $300,000 damage	None detected
12-25-68	Atlas Corporation Moab, Utah	Solvent extraction circuit, cause unknown, $1,000,000 damage	None detected
10-23-80	Minerals Exploration Sweetwater, Wyoming	Major fire burned in recovery before it started operation	None; radioactive material was not yet being processed
1-2-81	Atlas Corporation Moab, Utah	Fire in yellowcake scrubber stack for 15 minutes	None detected

Fire Control at Uranium Recovery Facilities

- Regulatory Guide 8.31 "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable" makes the following recommendations for fire control.
  - Designs features should include automatic fire detection and suppression equipment in high fire potential areas.
  - In the event of fire there should be provisions for drainage of solvent to sumps or to outside lined ponds.
  - Fire detection systems should be checked weekly and fire drills performed at a minimum of semiannually.

Fires at Uranium Recovery Facilities

- Health physics actions taken primarily involve the assessment of contamination (airborne and surface) both onsite and potentially offsite.
- Protection of accident responders (both onsite and offsite responders) is also be a responsibility.
- This includes the proper monitoring (which could include bioassay samples) and contamination control (survey of fire fighting equipment) before offsite responders leave site.

Spills and Leaks

- Spills and leaks are likely accidents at uranium recovery facilities.
- Most of the solutions that would be spilled consist more a chemical hazard than radiological.
- The response would be to stop the spill or leak monitoring to define the extent and amount of material involved in the spill or leak.
- The restoration of the spill area would have to be negotiated with the regulators to determine the cleanup level for both radiological and chemical constituents.