

# 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 exposure/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

<b>Date</b>	<b>Recovery</b>	<b>Fire Description</b>	<b>Offsite Release</b>
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.**