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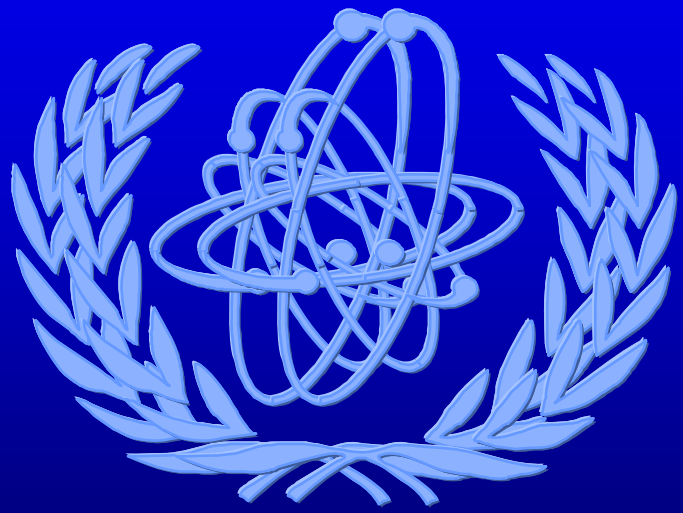
IAEA Training in Emergency Preparedness and Response

Review of Fundamentals



Non-radiological Safety

Lecture

Introduction

- **Non-radiological safety at nuclear facilities is concerned with events at non-nuclear components of the facility which can trigger radiation emergency**
- **Objective of this lecture is to present non-radiological safety issues at nuclear facilities**
- **We all know very well: nuclear reactor should be safe, safe and safe**

Content

- Physical protection systems (PPS)
- Fire protection systems (FPS)
- Electric power supply systems (EPSS)
- Water flow safety systems
- Civil engineering issues
- Hazardous materials
- Summary

Protection and Safety Systems

- Protection and safety systems at nuclear facilities are numerous: physical protection, fire protection, water flow safety, civil engineering safety, etc.
- Non-radiological protection and safety systems represent an integral part of the facility itself
- Not being properly dealt with they may initiate radiation emergencies

Physical Protection Systems (PPS)

- **What PPS is for?**
  - **To protect nuclear material from theft**
  - **To protect nuclear material from illicit use**
  - **To protect nuclear facility from terrorist action**
  - **To protect nuclear facility from action of mentally distorted person**

Physical Protection System Structure

- **Physical protection system hardness is suitable to:**
  - **Category of nuclear material to be protected**
  - **Susceptibility of nuclear facility for un-permitted entrance to sensitive areas**
  - **Design basis threat (DBT)**

PPS Functions

- Intrusion detection with sensors, access control and assessment (CCTV)
- Adversary delay barriers: outer layers and inner layers
- Response forces and communication

Detection

- Exterior and interior intrusion sensors
- Alarm assessment
- Alarm communication and display
- Entry/Exit control system

Access Delay

- Protective force guards
- Passive barriers
- Delay time versus response forces capability and communication

Response Forces

Response Force Communication

- Adversary detection
- Interruption of adversary action
- Adversary neutralization

Emergencies in PPS

- If special nuclear material has been effectively stolen, public security was violated
- If on nuclear reactor has been effectively committed act of sabotage, public security could be violated

Emergencies in PPS (Cont'd)

- **Range of adversary tactics:**
  - **Deceit**
  - **Stealth**
  - **Force**

Fire Protection Systems (FPS)

- **Fire on reactor facility is grave and dangerous event because**
  - **It can cause cut-off or destroy rector control system**
  - **It can damage reactor cooling system**
  - **It can make impossible to access to important for facility safety areas**

Reactor FPS Objectives

- The following objective are achieved
  - To prevent fires from starting
  - To detect and extinguish quickly those fire which to start, thus limiting damage
  - To prevent spread of those fires which are not been extinguished, thus minimizing their effects on essential facility function

FPS Structure

- Fire protection system consists of
  - Fire detection
  - Fire signalisation
  - Extinguish installations and equipment
    - Stationary extinguish installation
    - Portable extinguish equipment
    - Auto-extinguish installation (sometimes)

Fire Protection Vital Areas

- Control room
- Reactor control system relay room
- Emergency electrical power system
- Uninterruptible power supply (UPS) equipment
- Special nuclear material vault
- High radioactivity reactor products

Fire Protection Special Remarks

- Special nuclear material stored in vault can not be evacuated, in case of fire till arrangement of indispensable physical protection
- High activity radiation sources stored in non-clad lead containers in fire area must be cooled to avoid lead melting
- Containers with radioactive iodine must have particular fire protection

Fire Fighting Exercises

- **Fire fighting exercise objectives**
  - **To verify ability to take immediate reactor personnel action to extinguish fire**
  - **To verify ability to use portable extinguishers, protective suits and oxygen respirators**
  - **To verify ability to coordinate fire fighting action with professional fire brigades coming to facility**

Electric Power Supply System (EPSS)

- **EPSS function is to make available of reliable power for essential functions as**
  - **Protection system**
  - **Instrumentation**
  - **Reactor core cooling**
  - **Lighting**
  - **Ventilation**

EPSS Structure

- **EPSS consists of**
  - **Major EPSS fed from central (national) grid usually by means of two independent power transmission lines, connected to different part o central system**
  - **Uninterruptible power supply system**
  - **Emergency electrical power system**

EPSS Structure (Cont'd)

- **Reactor systems need different genders of electrical feeding**
  - **Alternating current (AC) low voltage, in Europe 380/220 V**
  - **AC various voltage to auxiliary circuits supply**
  - **Direct current (DC) from battery to emergency supply, to sensitive electronic and to UPS uses**
  - **DC from converters to charge batteries**
  - **AC from diesel-generators to emergency supply**

Emergecy EPSS

- **It takes energy:**
  - **From batteries for some second up to some hours**
  - **From diesel-generators after its start-up**
    - **some seconds or couple of minutes, up to the moment normal power supply is restored**

Water Flow Safety System

- **Reactor design protects facility for abnormal situation as water flow caused by**
  - **Catastrophic rainfall**
  - **Flooding**
  - **Water supply and sewerage systems out of order**
  - **Fire extinguish action**

Water Flow Protection Measures

- Safety sensitive areas are located on higher levels (floors)
- Safety system containing rooms are structured with gravity outflow to draining system
- If some safety important system has been located in underground of reactor building it has an outflow

Civil Engineering Issues

- An emergency situation can be caused by partial or total destruction of reactor building
- A serious destruction can be result of
  - Earth-quake or other catastrophic events outside of our control
  - Some flying object crash, for instance aircraft

Civil Engineering Damage

- **Reactor building structures can be also severely damaged by**
  - **Hurricane winds**
  - **Tornado striking facility**
  - **Explosion of gas cylinder**
  - **Missile impact from whatever source**

Civil Engineering Protection Measures

- Solid construction of reactor buildings
- Anti earth-quake building construction, if necessary
- Strict interdiction of aircrafts flying over reactor site
- Considering in emergency planning

Hazardous Materials

- In reactor facility is vitally recommended to avoid or minimize quantities of hazardous materials as
  - Strongly toxic substances
  - Explosives
  - Pressurized cylinders with combustible gases

Summary

- Specification of emergency important non-radiological issues were discussed

- All these issues you have to consider also in your emergency plan

Where to Get More Information

- **International Basic Safety Standards, IAEA Safety Ser. No. 115, available also in electronic form**
- **Emergency Preparedness Exercises… IAEA Safety Ser. No. 73**
- **Safety requirements of research reactors, IAEA Draft DS 272 Rev. 1 (April 2001)**