Regulation DD-26.0: Radioactive Works

26.1 The person involved in working with radioactive material shall be trained and authorized by the company.

(Ionizing radiation spreads through space like light or heat. Generally, the farther you are from a source of radiation the lower your dose rate. Distance is very useful for protection when handling physically small sources. The dose rate from a small source is inversely proportional to the square of the distance from the source. This “inverse square law” means, for example, that if the distance from the source is doubled, the dose rate will be one fourth. If you get too close to a source, the dose rate can increase substantially. The dose rate at 0.1 inch from a small source will be 10,000 times higher than 10 inches from the source. Ionizing radiation imparts energy to living cells. In large enough doses, this energy can damage cellular structures, such as chromosomes and membranes. If not repaired, this damage can kill the cell or impair its ability to function normally. Whether this damage is harmful depends on many factors, including the type of cell, the absorbed dose and the rate of absorption. The top management must set up a written Radiation Safety Policy. This policy must be posted on conspicuous place.)

26.2 **Effects of High Doses of Radiation**

Individuals and populations exposed to high doses of radiation display various types of detrimental effects. Examples are erythema(reddening of the skin), epilation (loss of hair), cataracts and “acute radiation syndrome.”

26.3 **Precautions while carrying out radiography works & Radiography bunker requirements.**

The following methods can reduce exposure by increasing the distance between the operator and the source**:**

- Avoid direct handling of sources of penetrating radiation. Never directly handle unshielded multi-millicurie sources.
- Use forceps, tongs, custom-designed holders and spacers to maintain distance between your hand and the source.
- Design simple tools for securely handling sources
  (e.g. a Lucite block with cylindrical holes to hold a vial).
- Routinely store sources at the back of benches and ventilated enclosures remote from normal access.
- Time, distance and shielding are the critical elements that must be controlled to ensure the protection of people who work with radioactive material that emit penetrating radiation.

- Use of PPE should be as per clause 26.6 mentioned below.
- The radiography bunker should have the concrete casing of 1meter with the shielding material to arrest any outside exposure of radiation. The different methods to use the shielding material are explained below in detail in a separate paragraph.
- Warning signs & danger signs are to be displayed at adequate locations & the area should be restricted for any unauthorized movement of personnel.
- The bunker should have a red warning light on the door & should be kept on whenever the radiography operation is on.
- The bunker should be minimum at the distance of 10 meters from any other process/activity in the facility.

Methods to reduce exposure by using shielding materials include the following:

- There is a variety of shielding materials that shall be placed between you and the source to absorb most of the radiation and effectively reduce the intensity of radiation and in some cases eliminate it that would otherwise reach you.
- The choice of shielding material shall depend on the type of radiation and other functions served by the shields (such as containment, transparency or structural support). Lead, concrete, aluminum, water and plastic are examples of commonly-used shielding materials.
- Beta rays are less penetrating than other rays, hence pure beta ray emitters can be effectively shielded by lighter materials such as glass, water or Lucite.
- When high energy beta rays are emitted and absorbed, secondary radiation is generated. The intensity of this secondary radiation increases if the beta rays are absorbed in high-atomic-number shielding material. This secondary radiation is more penetrating than the beta rays. When large quantities (i.e. Greater than100 mCi, or 3.7 GBq) of a pure beta emitter like 32P are used, the quantity of secondary radiation may be excessive unless shielded. The best shielding configuration in this case is touse, a 1/2-inch-thick Lucite acrylic sheet, or similar material, adjacent to the 32P to absorb the beta rays, while minimizing the creation of secondary radiation. Use sheets of lead foil outside the shields of Lucite to absorb the more penetrating secondary radiation like bremsstrahlung and x-rays.
- When planning an operation, calculate the shielding needs using half-value layers and gamma-ray constants or dose-rate measurements.
- Check the adequacy of shields in all directions accessible to personnel by monitoring around (and especially beneath and behind) the operation.
- Store radioactive materials emitting penetrating radiation in lead containers with lead lids.
- Where space permits, concrete blocks may be used to enclose a radioactive storage area.

- Use mirrors, periscopes or transparent shields – for example, lead glass windows – to view operations. Avoid direct viewing by peering around shadow shields.
- Use a rigid frame to secure potentially-unstable shielding materials.
- Use custom-designed shields for syringe barrels when millicurie quantities are being handled.
- Avoid direct exposure to high-energy, beta-emitting sources. The dose rate to the skin from beta rays is 10 to100 times as high as for gamma rays of the same energy and intensity.
- Whenever practical, use dilute solutions of high energy beta-emitting radionuclide's since the larger volume of liquid will effectively absorb more of the beta rays.

26.4 Prevention of Internal Radioactive Contamination

The main objective of controlling radioactive contamination is to prevent internal doses to workers. The primary means of contamination control is to prevent it by containing the radioactive materials during all handling phases. Radioactive contamination can enter the body by ingestion, inhalation or absorption through intact or damaged skin. To prevent internal exposure, it is necessary to intercept each of these contamination routes.

Preventing Ingestion

In areas where unsealed radioactive materials are handled, do not eat, drink, smoke, apply cosmetics, pipette by mouth or place fingers, pens and pencils in your mouth. Physical barriers can prevent accidental ingestion due to explosion or splashing.

Preventing Inhalation

Inhalation intakes shall be prevented by ensuring that radioactive materials are secured in sealed containers. Suitable containers include NENSure™ vials, crimp-sealed vials, flame-sealed ampules or vacuum systems and vessels vented through traps or filters. When sealed systems are impractical or additional precautions are necessary, radioactive materials that could become airborne should be handled in ventilated enclosures, such as fume hoods. Fume hoods provide protection by drawing air past the worker into an enclosure and safely exhausting it. In this process, small releases are diluted to negligible concentrations by the air flow.

26.5 Fume Hood Precautions

- Minimize the area of the window opening to maintain an air flow velocity of about 100 linear feet per minute. Avoid excessive velocities at the face of the fume hood in order to prevent turbulence.
- Check the fume hood for proper function before use. Adequate air flow can be indicated by a paper vane suspended from the upper edge of a window opening.
- Keep your head out of the fume hood and keep the sash in the closed position when processing radioactive materials.

- Keep equipment and operations toward the rear of the fume hood to avoid impeding the flow of air through the window.

26.6 Personal Protective Equipments

Protective Clothing When Handling Radioactive Materials

Protective clothing must be worn at all times. It must be worn properly, it must be the right fit and it must be in good condition.

Protecting Your Body and Clothing

- Any time you are in an area where unsealed sources of radioactive material are being used, wear a lab coat.
- A lab coat, properly fastened, will protect against casual contamination. However, it is not effective against spills or splashing and it does not protect your head, neck, hands or feet.
- Disposable lab coats are best for working around long-lived radionuclide's.
- Reusable lab coats are acceptable when handling short-lived radionuclide's, provided they are stored for a sufficient time to permit decay of any contamination prior to being washed.
- Both cloth and disposable lab coats may be reused if they are free from contamination and in good condition. They should be stored in a controlled area and you should monitor lab coats both during operations and after removing them.
- Particular attention should be paid to the sleeves, pockets and lower front surfaces of the coat.
- All lab coats should be fire-resistant. Waterproof aprons, full-body jump suits and hoods provide additional protection in environments where the potential for more severe contamination is present.

Gloves

- Whenever your hands are near unsealed radioactive material, you should wear gloves. Gloves are secondary protection only. They should not be used to handle radioactive materials directly.
- When you no longer need gloves, they should be carefully removed, monitored and disposed or stored appropriately.
- Rips or holes make gloves ineffective. Be careful working around hot surfaces, sharp objects or chemicals that can attack the glove material.
- Periodic changes of gloves are recommended. The greater the potential hazard, the more frequent a change of gloves is needed.
- Wearing two pair of gloves and frequently changing the outer pair is also a good safety practice.
- Gloves should be monitored frequently.

- Don't use contaminated gloves or gloves that may be contaminated.
- If you are wearing gloves and they are exposed to radionuclide's that emit penetrating radiation, remove the gloves as quickly as possible to minimize skin exposure. This is particularly important when handling high-energy beta emitters.

Footwear

- Don't wear sandals or open-toe shoes.
- Comfortable, sturdy footwear should be selected that will protect against contamination or injury due to broken glass or corrosive materials. In some cases, steel-toed shoes may be desirable to protect against physical hazards.
- In controlled areas where low-level floor contamination is a potential hazard, a separate pair of work shoes for use only in that area should be used.

Eye and Face Protection

- Safety glasses provide protection for your eyes and face; however, remember that this is secondary protection only.
- Safety glasses are of some use in protecting against low-penetration radiation, such as low-energy x-rays and medium-energy beta particles but provide little protection from penetrating gamma radiation.

Respiratory Protection

- Is a must for operations that create radioactive dust, vapor or gases.
- Vented enclosures with protective filters are available for such operations.
- Use of respiratory protection devices in lieu of such primary controls is not advisable. In cases where entering a contaminated zone is unavoidable or in emergency situations, respiratory protection may be necessary.
- It may also be useful for certain decontamination operations.
- If you wish to use respiratory protection, you first must have a medical examination. Also, you must be trained in the proper selection, fitting, operation and maintenance of the devices.
- Safety and medical departments within your organization are responsible for issuing authorizations to use respiratory protection and for maintaining records.

26.7 **Waste Disposal**

- Radioactive Waste disposal is not allowed in Dubai. User of spent Radioactive Material must arrange with their supplier for the return of radioactive waste or decayed source to port or country of origin or to approved disposal sites.
- Where the expected annual dose from radioactive waste is less than 0.01 mSv to members of the public, the generator may refer to the Competent Authority for disposal options.

26.8 **Requirements for a Radioactive Waste Storage Area**

- Radioactive waste storage area should be a dedicated facility with centralized access, but off the normal traffic paths.
- When the waste to be stored is heavy, or heavy machinery is needed to move waste containers, the floor must be designed to accommodate the anticipated loading.
- Basement floor is preferred for storing & will be the best location and this may also be a better place to store waste that emits a significant radiation field.
- The floor and interior surfaces should be covered with nonporous materials to facilitate decontamination if a leakage or spillage occurs and to enable the storage area to be kept clean.
- If liquids are to be stored, the need to provide recessed floors, dyking or drainage to holding tanks should be considered.
- The need to provide forced ventilation to prevent the build-up of solvent fumes or airborne radionuclide's should be considered.
- The air should be exhausted to a safe area outside the building through a single duct designed to enable the air concentration to be accurately monitored. The need to provide diagnostic air sampling systems to locate the origin of released airborne activity in the storage area should also be considered.
- The storage area should be provided with protection from fire and flood. Lighting should be adequate to enable waste containers to be identified, inspected and safely handled.
- The need for climate control should be considered. For long term storage, a dry even cool temperature is preferred to minimize the degradation of the waste. The storage area should be organized to enable different waste categories to be segregated and accessible for placement, periodic inspection, monitoring and routine and emergency retrieval.
- The area might need to accommodate freezers for storing biological waste and shielding for containers emitting penetrating radiation. Shielding may be effected by surrounding containers by other containers or by using shielded storage bins or temporary concrete block walls. These should be constructed with consideration of the need to periodically inspect the waste containers. The storage space should be organized to enable handling equipment to be safely used.

26.9 **Controlled Area**

- Any work area where radiation exceeds 7.5 mSv /hr. shall be designated as controlled area. Management must ensure that only classified persons are allowed in controlled area. Persons below 18 years old are not allowed in controlled area.
- Controlled area must have a standard Radiation Hazard symbol, a barricade and blinker lights.
- When radiation work is conducted in an operating area where other personnel could be exposed to ionizing radiation, the management of the establishment shall establish a work permit system to prevent exposures to non classified personnel.

26.10 **Transportation of Radioactive Material**

- Radioactive Material shall be packed, marked, labeled and transported as per **Code of Practice for the Management of Dangerous Goods (in the Emirate of Dubai.)**, IATA and IMDG regulations as applicable.
- Before each package of radioactive material is offered for transportation, it shall not have a radiation level exceeding 2 mSv/h (200 mrem/h) at any point on the external surface of the package and 100 Sv/hr (10 mrem/hr) at one meter distance from the external surface of the package. For exceptions to the above where prescribed level is exceeded, the package of the radioactive material shall be transported exclusively with the approval from Competent Authority.
- Permits for importation and re-exportation of radioactive material must be approved by Competent Authority and by Civil Defense. Radioactive Materials shall be transported as per Code of Practice for the Management of Dangerous Goods in the Emirate of Dubai.

Sea transport

- The International Maritime Dangerous Goods Code (IMDG Code) is to be followed for transportation of Radioactive material by Sea. This Code is for the carriage of dangerous goods of any kind by sea. It addresses matters such as packing and container storage, with particular reference to the segregation of incompatible substances.

Air Transport

- The International Air Transport Association (IATA), a trade association representing airlines, publishes annually the Dangerous Goods Regulations (DGR) which is consistent with the ICAO TI as well as the IAEA Regulations. These DGR are to be followed for air transportation of Radioactive material.

26.11 **The IAEA (International Atomic Energy Association) Regulations for the Safe Transportation of Radioactive Material**

The Regulations are based on the fundamental principle that radioactive material being transported should be packaged adequately to provide protection against the various hazards of the material under both normal and potential accident conditions. Safety, therefore, relies primarily on the packaging whatever the transport mode. The prime objective is to protect people, property and the environment against the direct and indirect effects of radiation during transportation. The requirements laid down in the Regulations must ensure the containment of the radioactive contents, the control of the external radiation level, the prevention of a chain reaction and the prevention of damage caused by heat because safety depends primarily on the packaging. The regulations set out several performance standards in this area. They provide for five different primary packages (Excepted, Industrial, Type A, Type B and Type C) and set the criteria for their design according to both the activity and the physical form of the radioactive material they may contain. Land transport Safety Regulations for the Transport of Radioactive Material

The United Nations Economic Commission for Europe (UN/ECE) publishes the European Agreement concerning the International Carriage of Dangerous Goods by Road (known as ADR). It contains requirements for the listing, classification, marking, labeling and packaging of dangerous goods by road. The IAEA Regulations have been adopted to apply to the transport of radioactive material under the ADR.

26.12 **Emergency Procedures:**

The organization should must emergency procedures in the following scenarios involving Radioactive Material

- If splashed with a radioactive solution.
- If cut by glassware, injured by hypodermic needle, splinters, etc.
- In the event of over-exposure to radiation, or the accidental release of radioactive material.

26.13# Radioactive/Radiography work permit (on S3 Form) from EHS-Trakhees-PCFC is required before carrying out radiography work involving radioactive material.

26.14 For import/export of any radioactive sources, obtaining approval from UAE authorities i.e. Federal Authority for Nuclear Regulation (FANR), UAE Shall be mandatory by filling and submitting the relevant forms /details.

26.15 For Importing, Exporting, Storage and handling of radioactive isotopes in the PCFC areas approval from the Authority is required (Refer Occupational Safety Regulations for PCFC EHS-Trakhees of FZIO-Operations). The current IAEA, local rules and regulations shall apply. For import of radioactive isotopes, S1 Form and for Export S2 Form should be filled and submitted to EHS.

26.16 Monthly report for all import and export of Radioactive Isotopes from PCFC areas is to be submitted to EHS-Trakhees-PCFC by 5th of each following month.