SAFETY PROCEDURE FOR THE USE OF RADIOACTIVE SOURCE

Viareggio, July 28 – August 01, 2025

INTERNATIONAL SUMMER SCHOOL 2025

During the week you will be asked to use radioactive laboratory sources to perfor measurements

Here the CAEN safety procedure to follow and information regarding a safe use of the items

Ionizing radiations

- **Ionizing radiation** is radiation that has enough energy to ionize atoms (or molecules) with which it comes into contact.
- The ability of radiation to ionize an atom, or to penetrate more or less deeply into matter, depends not only on its energy but also on the type of radiation and the material with which the interaction occurs.
- Ionizing radiation is divided into two main categories:
  - those that produce ions **directly** (charged particles such as α, β^-, and β^+ particles)
  - those that produce ions **indirectly** (neutrons, gamma rays, and X-rays).

Exposure to ionizing radiation can originate from:

- **External Irradiation** – the radiation source is located outside the body;
- **Internal Irradiation** – the radiation source is inside the body, introduced through ingestion or inhalation.

The Italian Exposure limits for the general population and for workers are regulated by the Legislative Decree DLGS.101/2020.

The dose

- **Absorbed Dose (D)** in a medium: average energy absorbed per unit mass of the irradiated medium
  - **unit of measurement**: Gray (Gy, mGy, µGy)
- **Equivalent Dose (H_t)** in tissue T: average absorbed dose in tissue T, weighted by the type of radiation R
  - **unit of measurement**: Sievert (Sv, mSv, µSv)
- **Effective Dose (E)**: takes into account the relative radiosensitivity of different tissues/organs
  - **unit of measurement**: Sievert (Sv, mSv, µSv)

EXPOSURE FROM NATURAL BACKGROUND RADIATION

- Humans have always been exposed to natural ionizing radiation: **natural background radiation**
- The natural background radiation consists of **terrestrial radiation** (produced by primordial or cosmogenic radionuclides undergoing radioactive decay) and **cosmic radiation** (of extraterrestrial origin).
- A key component of terrestrial radiation is **Radon (Rn-222)**. It is a naturally occurring radioactive gas, odorless, tasteless, invisible, and 7.5 times heavier than air. It spreads everywhere, and its concentration varies from place to place.

The Italian statistics:

- **Internal exposure from inhalation of Radon and its decay products**: Average dose ~1.4 mSv/year
- **External exposure from cosmic radiation**: Average dose ~1.0 mSv/year
- **Average effective dose to the population from natural background radiation**:
  2.4 mSv/year (approximately 1.0 mSv from external exposure + 1.4 mSv from internal exposure)

EXPOSURE LIMITS FOR THE GENERAL POPULATION

From not natural background

- **1 mSv/year** effective dose
- **15 mSv/year** equivalent dose to the lens of the eye
- **50 mSv/year** equivalent dose to the skin and extremities

Foundamentals

… OF RADIATION PROTECTION

- **Justification**: Any practice involving radiation must be justified in advance.
- **Optimization**: Each practice must be carried out so as to keep exposure ***as low as reasonably achievable*** (**ALARA**), taking economic and social factors into account.
- **Compliance with dose limits**: All exposures must remain within the established dose limits.

PROTECTIVE MEASURES

Physical Methods:

- **DISTANCE** – the level of exposure decreases with the inverse square of the distance.
- **TIME** – the level of exposure decreases linearly with reduced exposure time.
- **SHIELDING** – the level of exposure decreases depending on the shielding material:
  - ***Beta radiation***: low atomic number shields (e.g., plexiglass)
  - ***Gamma radiation***: high atomic number shields (e.g., lead)
  - ***Neutrons***: low atomic numbers (e.g. plexiglass)

Operational Procedures

Strict adherence to operational procedures established by the **Internal Radiation Protection Regulations** in force

PROCEDURES FOR THE USE OF CALIBRATION RADIOACTIVE SOURCES

- Sealed sources
- Must be handled with **disposable gloves**– never touch the sources with bare hands
- The operator must always keep the radioactive source at the **maximum possible distance** from themselves and from any other person who may be present in the experimental area.
- The **time of use** of radioactive sources must always be kept to the **strict minimum necessary**.
- Radioactive sources must always be **clearly marked** at the point of use, with a **yellow trefoil warning sign** indicating the **type and activity** of the source.
- One of the operators must wear the active dosimeter to monitor the dose

THANK YOU!

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