

Ionizing radiation



Ionizing radiation is radiation that has enough energy to ionize the atoms (or molecules) with which they come into contact. The characteristic of a radiation of being able to ionize an atom, or of penetrating more or less deeply into the matter, depends not only on its energy but also on the type of radiation and the material with which the interaction takes place. Man has always been subject to the action of natural ionizing radiation, which is given the basic name of natural radioactivity. This parameter must be the reference for any radioprotection risk assessments. Ionizing radiation is divided into two main categories: those that produce ions directly (the particles charges α , β^- and β^+ ;) and those that produce ions indirectly (neutrons, γ rays and X-rays).

The exposure limits for the population and for workers are regulated by Legislative Decree 230/95 and as amended. (D.Lgs.241 / 00 and D.Lgs.257 / 01).

TYPOLOGY OF EXPOSURES TO IONIZING RADIATIONS

Exposure to ionizing radiation can originate from:

- External Irradiation - source of radiation external to the subject;
- Internal Irradiation - source of radiation internal to the subject, introduced by ingestion or inhalation.

Ionizing radiation interacts with matter through the transfer of energy through processes of:
Ionization:

**Ionization
Excitement**

EASUREMENTS

External irradiation

1) ABSORBED DOSE (D) in a medium: average energy absorbed per unit mass of the irradiated medium - unit of measure: Gray (Gy, mGy, μ Gy)

- 2) EQUIVALENT DOSE (HT) in tissue T: average dose absorbed in tissue T, weighed by type of radiation R - unit of measurement: Sievert (Sv, mSv, μ Sv)
- 3) EFFECTIVE DOSE (E): takes into account the relative radiosensitivity of the various tissues / organs - unit of measurement: Sievert (Sv, mSv, μ Sv) biological.

Internal irradiation

In the case of irradiation by introduction of radionuclides into the body, the irradiation continues until the radionuclide remains in the body, i.e. until it is totally eliminated by decay or by biological means.

- 1) COMMON EFFECTIVE DOSE: it is the effective dose produced by internal irradiation integrated over 50 years from the moment of introduction - unit of measurement: Sievert (Sv)
- 2) ACTIVITY: number of nuclear transformations of a radionuclide in the unit of time - unit of measurement: Becquerel (Bq) jmn

EXPOSURE FROM NATURAL BACKGROUND

The natural radioactivity background is composed of terrestrial radiation (radiation produced by primordial nuclides or cosmogenic nuclides in radioactive decay) and cosmic (extraterrestrial) radiation. A fundamental component of terrestrial radiation is Radon (Rn-222). It is a natural gas emanated from the earth, radioactive, odorless, tasteless, invisible and 7.5 times heavier than air. It spreads everywhere and its concentration varies from place to place.

Internal irradiation by inhalation of Radon and its derivatives: average dose ~ 1.4 mSv / year

External irradiation due to cosmic radiation: average dose ~ 1.0 mSv / year

Average effective dose of the population due to natural background:

2.4 mSv / year
 ~ 1.0 mSv (external irr.) + 1.4 mSv (internal irr.)

POPULATION EXPOSURE LIMITS

- mSv / year effective dose
- 15 mSv / year dose equivalent to the lens
- 50 mSv / year dose equivalent to skin and extremities

EXPOSURE LIMITS OF WORKERS

- 20 mSv / year effective dose
- 150 mSv / year dose equivalent to the lens
- 500 mSv / year dose equivalent to skin and extremities

Women exposed to childbearing age, apprentices and students

- <13 mSv / year equivalent abdomen dose

Female workers exposed during pregnancy

- <1 mSv / year equivalent abdomen dose

CLASSIFICATION OF WORKERS

Workers at risk of exposure are classified into categories related to the level of exposure:

- UNEXPOSED WORKERS - up to 1 mSv / year (population limit) beyond the natural background
- EXPOSED WORKERS CAT.B - up to 6 mSv / year beyond the natural background
- EXPOSED WORKERS CAT.A - up to 20 mSv / year beyond the natural background

The criteria for classifying workers are:

- Workload
 - Operating working conditions
 - Suitable means of protection
 - Dosimetric area measurements in the work environment
 - Possible anomalies and malfunctions
- The exposed workers are subject to:

1) Individual physical surveillance:

- Individual dosimeter whole body + extremity

2) Individual medical surveillance:

- Preventive physical fitness
- Periodic medical examination: half-yearly Cat.A, annual Cat.B

3) Information / training

CLASSIFICATION OF AREAS

The areas at risk of ionizing radiation are classified according to the level of exposure:

- UNCLASSIFIED AREA - up to 1 mSv / year (population limit) beyond the natural background
- SURVEILLED AREA - up to 6 mSv / year beyond the natural background
- CONTROLLED AREA - up to 20 mSv / year beyond the natural background

The monitored and controlled areas must be:

- Reported
- Bounded
- Controlled and regulated access

BASIC PRINCIPLES OF RADIATION PROTECTION

Justification:

Any practice with radiation must be justified in advance.

Optimization:

Each practice must be carried out in such a way as to keep the exposure as low as reasonably achievable, taking into account economic and social factors.

Compliance with dose limits.

MEANS OF PROTECTION

Physical methods:

- DISTANCE - the exposure level decreases with the inverse of the square of the distance
 - TIME - the exposure level decreases linearly with the exposure time
 - SCREENS - the exposure level decreases according to the characteristics of the screen
- Beta = low atomic number screens (plexiglass)
Gamma = high atomic number (lead) screens

Operating Procedures

- Strict compliance with the operating procedures established by the Internal Radiation Protection Standards in force on the specific work site.

OBLIGATIONS OF WORKERS

- 1) Workers exposed to the risk of ionizing radiation are obliged, in accordance with article 68 of Legislative Decree 230/95 and subsequent amendments, to observe the instructions given by the employer for the purposes of safety and protection from radiation individual, collective and population.
- 2) The means of protection and safety provided by the employer must be used with care and correctly. These means cannot be modified or removed without prior authorization from the employer or the person in charge.
- 3) Any deficiencies in the safety and protection devices or the presence of any dangerous conditions must be promptly communicated by the worker to the employer or the person in charge.
- 4) Female staff are obliged to notify their employer of their pregnancy as soon as they become aware of it.
- 5) Workers classified as "Exposed" are obliged to undergo preventive, periodic and extraordinary medical checks provided for in articles 84 and 85 of Legislative Decree 230/95 and subsequent amendments, according to the employer's provisions.
- 6) Access to controlled and supervised areas is allowed only to authorized persons.

PROCEDURES FOR THE USE OF RADIOACTIVE CALIBRATION SOURCES

- 1) Even if sealed, radioactive sources must always be handled with spring tweezers: never touch the sources with your hands. If possible, use disposable gloves.
- 2) The operator must always keep the radioactive source at the maximum distance from himself and from any other person possibly present in the experimental area. A distance of at least one meter is recommended; shorter distances can be used in exceptional circumstances as long as they are very short.

- 3) The time of use of the sources must always be reduced to the minimum.
- 4) Radioactive sources must always be adequately signaled at the place of use, through the yellow clover plate and an indication of the type and activity of the source concerned.

IMPORTANT!!

**ALL INFN EMPLOYEES AND ASSOCIATES WHO
HAVE TO CARRY OUT ACTIVITIES WITH IONIZING
RADIATIONS
MUST BE PREVENTIVELY AUTHORIZED BY THE
MANAGEMENT AND MUST FILL IN THE
APPLICATION
RADIATION PROTECTION CARD PREPARED BY
INFN.**