

# **Regulation on Sanitary Protection against Ionising Radiations Published in the Spanish Official State Gazette number 178, of the 26th of July 2001**

## **Royal Decree 738/2001, of the 6th of July, which approves the Regulation on Sanitary Protection against Ionising Radiations**

Article 2.b), of the Treaty establishing the European Atomic Energy Community (EURATOM) establishes that the Community must put forth uniform norms for the sanitary protection of workers, and of the population, against the risks that may result from ionising radiations, aimed at establishing the maximum acceptable doses that are compatible with an adequate level of security, the maximum acceptable contamination levels, and the fundamental principles for the sanitary monitoring of the workers.

As a result, several successive provisions have emanated from the Council, whose compliance is mandatory for the Member States. Among these we can highlight: Directive 80/836/EURATOM and Directive 84/467/EURATOM, that establish the basic norms for the sanitary protection of the population and workers against the risks derived from ionising radiations. These directives are completed with other accompanying measures included in Directive 84/466/EURATOM, on fundamental protection measures regarding the radiological protection of persons subject to medical treatment and examinations, or in Directive 90/641/EURATOM, relative to the operational protection of external workers, with a risk of exposure to ionising radiations, from their intervention in the controlled area.

In this sense, the actual Royal Decree 53/1992, of the 24th of January, which approves the Regulation for sanitary protection against ionising radiations, operated the transposal of the aforementioned EURATOM Directives, 80/836 and 84/467 in Spain, at the same time it helped to clarify, develop and complete what was established in Chapter Six of Law 25/1964, of the 25th of April, on Nuclear Energy, constituting the basic norm regarding sanitary issues in the sense of Article 149.1.16. of the Spanish Constitution, in application of the exclusive competence of the State to dictate labour legislation according to Article 149.1.7. of our Magna Carta.

Later on, given the considerable development of the scientific knowledge regarding radiological protection, and on the basis of new criteria recommended in publication number 60 of the International Commission on Radiological Protection, Directive 96/29/EURATOM, of the Council, was approved, on the 13th of May 1996, which establishes the basic norms regarding the sanitary protection of workers and the population, against the risks that result from ionising radiations, which supposes a significant revision of the preceding Directives 80/836/EURATOM and 84/467/EURATOM, adopting criteria for the estimation of doses considered to be reasonable for the protection of persons, both in an occupational activity as in other situations of exposure to radiation, including those that suppose exposition to artificial sources of radiation or natural sources of radiation that suppose significant increases in the dose, and

contemplating, specifically, the interventions as a result of a radiological emergency. Furthermore, Directive 84/466/EURATOM has been revised by Directive 97/43/EURATOM, regarding health protection against the dangers derived from ionising radiations in medical exposure.

The commitment to comply with what is established in Article 55 of the aforementioned Directive 96/29/EURATOM, that imposes upon all Member States the obligation to adopt the legislative, regulatory or administrative measures necessary to operate its transposition, before the 13th of May 2000, as well as the need to revise the Regulation on Sanitary Protection of 1992, which had become incomplete, outdated or without a practical application given the time elapsed, have made it necessary to proceed with the approval of a new regulatory text, that together with other provisions that may affect this field, shall contemplate the basic norms on sanitary protection applicable, in a systematic manner and under the principles of justification, optimisation and dose limitation, that are also alluded to in Directive 96/29/EURATOM, and which by repealing the previous Royal Decree 53/1992, of the 24th of January, on Sanitary Protection against ionising radiations, shall constitute, once again, the basic text on sanitary matters and in state regulations responding to the labour rules, and under the aegis of Articles 149.1.16 and 149.1.7., respectively, of the Spanish Constitution.

By means of this new Royal Decree a transposition of Directive 96/29/EURATOM is carried out, although not in its entirety, given that part of it has already been the object of transposition in Royal Decree 1836/1999, of the 3rd of December, which approves the Regulation on nuclear and radioactive installations.

Finally, it is worth pointing out that the draft of this present provision has been reported to the Commission of the European Union, according to the stipulations of Article 33 of the Treaty establishing the European Atomic Energy Community (EURATOM).

By virtue of, and following the proposal of the Ministers of the Economy, the Interior, Health and Consumption, Labour and Social Affairs, and Defence, and according to the Regulation proposed by the Nuclear Safety Council, having heard the National Commission on Safety and Health in the Work Place, and in accordance with the Council of State, and with the prior deliberation of the Council of Ministers in its meeting of the 6th of July 2001,

#### I PROCLAIM:

*Single Article. Regulation on Sanitary Protection against ionising radiations*

The attached Regulation on Sanitary Protection against ionising radiations is hereby approved.

*Single Repeal Provision. Normative Repeal*

Royal Decree 53/1992, of the 24th of January, which approves the Regulation on Sanitary Protection against ionising radiation is hereby repealed.

*First Final Provision. Habilitation of competence*

This present Regulation is dictated under the aegis of what is established in Article 149.1.7. and Article 149.1.16. of the Constitution.

*Second Final Provision. Development of precepts*

The Ministers of the Economy, of Interior, of Health and Consumption, of Labour and Social Affairs, and of Defence, within the scope of their competences, shall be able to dictate the opportune provisions for the development and implementation of this present Regulation.

The Nuclear Safety Council shall be able to dictate the instructions, circulars, and guides or technical standards to facilitate the implementation of this present Regulation.

*Third Final Provision. Entry in force*

This present Royal Decree shall enter into force on the day following its publication in the Spanish "Official State Gazette" (BOE).

Signed in Madrid, on the 6th of July 2001.

JUAN CARLOS R.

The Minister of the Presidency  
JUAN JOSÉ LUCAS GIMÉNEZ

**Regulation on Sanitary Protection against Ionising Radiations**

***Title I. General provisions***

*Chapter One*

Aim and scope of application

**Article 1. Aim**

1. This Regulation has as its aim to establish the norms relative to the protection of workers and members of the population against the risks that can result from ionising radiations, according to Law 25/1964, of the 29th of April, on Nuclear Energy.

2. To the effects of this Regulation, the definitions included in Annex I shall be employed.

**Article 2. Scope of application**

1. This present Regulation shall be applied to all practices that imply a risk deriving from the ionising radiations that proceed from an artificial source, or from a natural radiation source, when the natural radionuclides are, or have been, processed for their radioactive, fissionable, or fertile properties, including:

a) The exploitation of radioactive minerals, their production, treatment, manipulation, use, possession, storage, transportation, import, export, intra-communitary movement and elimination of radioactive substances.

- b) The operation of all electrical equipment that emits ionising radiations, and which contains components that function with a power difference greater than 5 kV.
- c) The commercialisation of radioactive sources, and the technical assistance for equipment that incorporate radioactive sources or that produce ionising radiations.
- d) Any other practice that the competent Authority, considers opportune to define, given the matter, and with the prior report from the Nuclear Safety Council.

Similarly, it shall be applicable to those activities that are developed by external companies, as referred to in Royal Decree 413/1997, of the 21st of March, on the Operational Protection of those External Workers with a Risk of Exposure to Ionising Radiations as a result of their Intervention in the Controlled Area.

- 2. This present Regulation shall be applicable in the terms referred to in Title IV, to all interventions in cases of radiological emergencies, or in cases of lasting exposure.
- 3. This present Regulation shall be applicable in the terms referred to in Title VII to all occupational activities not contemplated within section 1, but which suppose the presence of natural sources of radiation, and which give rise to a significant increase in the exposure of workers or members of the public which cannot be dismissed as insignificant in terms of radiological protection.
- 4. The present Regulation shall not be applicable to the exposure to radon in housing, or to the natural levels of radiation, this is to say, those radionuclides contained in the human body, the cosmic rays at ground level, or to the exposure above ground level due to the radionuclides present in the non altered terrestrial crust.

## *Chapter Two*

Authorities and Administrative organs.

### **Article 3. Authorities and administrative organs.**

Shall correspond to the competent authority, in every case, depending on the issue, and to the Nuclear Safety Council, within the scope of its functions, to ensure the compliance with what is established in this Regulation.

## ***Title II. Justification, optimisation and dose limitation for practices***

### *Chapter One*

General principles

### **Article 4. General principles**

- 1. All new class or type of practice, included within the scope of this present Regulation's application, must be justified by its promoter before the competent authority, which, following the report from the Nuclear Safety Council, shall

decide whether its adoption is advisable, considering the advantages that it may represent in relation to the potential damage that it may cause to health.

The Nuclear Safety Council may propose the revision of the existing classes or types of practices, from the point of view of their justification, whenever new or important evidence appears regarding their efficiency or consequences.

2. The individual doses, the number of exposed persons, and the probability that potential explosions may occur, must be maintained at the lowest reasonably possible levels, taking into account social and economic factors.

3. The sum of the doses received, proceeding from all pertinent practices, shall not exceed the dose limits established in this present title, for exposed workers, persons in training, students, and members of the public, without prejudice to what is established in Article 12 of this Regulation.

4. The principles defined in paragraphs 1 and 2 shall apply to all cases of exposure to ionising radiations that may due to the practices referred to in paragraph 1 of Article 2, including medical exposure. The principle defined in Article 3 shall not apply to any of the following exposures:

a) The exposure of persons in the context of their own medical diagnosis or treatment.

b) The deliberate and voluntary exposure of persons, when this is not an element of their occupation, to help or assist patients during medical diagnosis or treatment.

c) The exposure of volunteers, who participate in medical and biomedical research programs.

#### **Article 5. Special prohibitions and requirements**

1. The addition of radioactive substances in the production of foodstuffs, toys, personal adornments and cosmetics is prohibited, as is the import, export or intra-communitary movement of such products when they have radioactive substances incorporated into them.

2. The deliberate administration of radioactive substances to persons, and to animals, to the extent that it affects the protection of human beings against radiation for the purposes of diagnosis, treatment or medical or veterinary research, can only be carried out in radioactive installations that have been authorised to this end.

3. Regarding medicaments that contain radioactive substances, this case shall be governed by Law 25/1990, of the 20th of December on Medicaments.

#### **Article 6. Dose restrictions**

1. Within the context of the optimisation of radiological protection, when adequate, the title-holder of the practice in question, shall use dose restrictions, which may be based on the guidelines that the Nuclear Safety Council

establishes. Such dose restrictions, shall be evaluated, and if fitting, shall be approved by the Nuclear Safety Council.

2. Dose restrictions must be included in those procedures that must be applied to exposed persons, according to what is determined in paragraphs 4 b) and 4 c) of Article 4, on the basis of the guidelines that the Ministry of Health and Consumption lays down.

#### **Article 7. Responsibility**

The title-holder of the practice shall be responsible for the compliance and application of all the principles herein established, within the scope of the activity and competence.

### *Chapter Two*

#### Dose limitation

#### **Article 8. Application**

The dose limits are applied to the sum of the doses proceeding from external exposure within a specific time period, and the committed doses for fifty years (up to seventy years in the case of children) due to the incorporations that may have taken place in the same period. In this calculation, the dose due to the natural radioactive background shall not be included nor the exposure suffered as a result of medical examinations and treatments.

#### **Article 9. Dose limits for exposed workers**

1. The effective dose limit for exposed workers shall be of 100mSv throughout every official consecutive five-year period, subject to an effective maximum dose of 50 mSv in any single official year.

2. Without prejudice to what is established in paragraph 1:

a) The equivalent dose limit for the crystalline lens shall be of 150 mSv per official year.

b) The equivalent dose limit for the skin shall be 500 mSv per official year. The aforementioned limit shall be applied to the average dose on any surface of 1 cm<sup>2</sup>, independently of the exposed area.

c) The equivalent dose limit for the hands, forearms, feet and ankles shall be of 500 mSv per official year.

#### **Article 10. Special protection during pregnancy and lactation**

1. The moment a pregnant woman informs the title-holder of the practice of her condition, the protection of the foetus must be comparable to that of the members of the public. To this end, the working conditions of the pregnant woman shall be such that the equivalent dose for the foetus be as low as is reasonably possible, in such a manner as to make it unlikely that this dose exceeds 1 mSv, at least from the moment she informs of her condition and until the end of the pregnancy.

2. From the moment a woman, who is in the lactation period, informs of her condition to the title-holder of the practice, she shall not be assigned tasks that suppose a significant risk of radioactive contamination. In such cases adequate monitoring must be ensured in terms of possible radioactive contamination of her organism.

#### **Article 11. Dose limits for persons in training and students**

1. The dose limits for persons in training and for students older than eighteen, who, during their studies, have to handle sources, shall be the same as those of the exposed workers, as established in Article 9.

2. The effective dose limits for persons in training and for students with ages between sixteen and eighteen, that during the course of their studies should have to use sources, shall be of 6 mSv per official year.

Without prejudice to this dose limit:

a) The equivalent dose limit for the crystalline lens shall be of 50 mSv per official year.

b) The equivalent dose limit for the skin shall be 150 mSv per official year. The aforementioned limit shall be applied to the average dose on any surface of 1 cm<sup>2</sup>, independently of the exposed area.

c) The equivalent dose limit for the hands, forearms, feet and ankles shall be of 150 mSv per official year.

3. The dose limits for persons in training and for students that are not subject to the provisions referred to in paragraphs 1 and 2 shall be the same as those established in Article 13 for members of the public.

#### **Article 12. Specially authorised exposure**

1. In exceptional situations, radiological emergencies excluded, the Nuclear Safety Council may authorise, for each specific case, individual occupational exposures beyond the dose limits established in Article 9. The situation that implies this risk shall be considered as a specially authorised exposure.

2. The authorisation referred to in the previous paragraph shall only be granted when the exposures are limited over time, are circumscribed to determined work areas and are comprised within the maximum exposure dose levels, that are defined for this specific case by the Nuclear Safety Council. The following conditions shall be taken into consideration:

a) Only those exposed workers belonging to Category A, as defined in Article 20, shall be authorised into specially authorised exposures.

b) The participation in specially authorised exposures shall not be allowed for:

1°. Pregnant women and those who during the lactation period may suffer corporal contamination.

2°. Those persons in training or students.

c) The title-holder of the practice must justify, in advance, the aforementioned exposures, and inform, with reasons, the involved workers, their representatives, the Prevention Service that carries out the monitoring and control function for the workers' health, the Radiological Protection Service or Technical Unit for Radiological Protection, or in their absence, the Supervisor or person to whom the radiological protection functions are entrusted.

d) Before participating in a specially authorised exposure, the workers must be given adequate information regarding the risks that the operation entails, and the precautions that they must take during the operation. The participation of these workers shall be of a voluntary nature.

3. The surpassing of the dose limits as a result of specially authorised exposures shall not constitute a motive for the exclusion of the worker from the ordinary occupations, or the change of position without the worker's express consent. The conditions of posterior exposure must be submitted to the criteria of the Protection Service that carries out the monitoring and control function of the workers' health.

### **Article 13. Dose limits for members of the public**

1. The effective dose limit for members of the public shall be of 1 mSv per official year. Nonetheless under special circumstances, the Nuclear Safety Council may authorise a greater value for the effective dose for a single official year, as long as the average during five consecutive official years does not exceed 1 mSv per official year.

2. Without prejudice to what is established in paragraph 1:

a) The equivalent dose limit for the crystalline lens shall be of 15 mSv per official year.

b) The equivalent dose limit for the skin shall be of 50 mSv per official year. The aforementioned limit shall be applied to the average dose on any 1 cm<sup>2</sup> skin surface, independently of the exposed area.

## ***Title III. Effective and equivalent doses***

### *Single Chapter*

Estimation of effective and equivalent doses

### **Article 14. Criteria for the estimation of doses**

For the estimation of effective and equivalent doses the values and relations referred to in this present title shall be used, that is:

a) For external radiation, the values and relations contained in Annex II must be used, to estimate the pertinent effective and equivalent doses.



b) For internal radiation, proceeding from a radionuclide or a combination of radionuclides, the values and relations contained in Annex II and III must be used, with the aim of estimating the effective doses.

The Nuclear Safety Council may authorise the use of equivalent methods.

***Title IV. Fundamental principles of operational protection of exposed workers, persons in training and students for the execution of the practices***

*Chapter One*

Operational protection of exposed workers

**Article 15. Principles for the protection of workers**

The operational protection of exposed workers shall be based on the following principles:

- a) Prior evaluation of the working conditions to determine the nature and magnitude of the radiological risk and to ensure the application of the optimisation principle.
- b) Classification of the working places in different areas, taking into account: the evaluation of the expected annual doses, the risk of dispersion of contamination and the probability and magnitude of potential exposures.
- c) Classification of exposed workers into different categories, according to their working conditions.
- d) Application of the standards and the monitoring and control measures related to the different areas and to the different categories of exposed workers, including individual monitoring, when appropriate.
- e) Sanitary monitoring.

*Chapter Two*

Exposure prevention

*Section 1. Classification and delimitation of areas*

**Article 16. Establishment of areas**

To the effects of radiological protection, the title-holder of the practice shall identify and delimit all the work areas in which there may be a possibility of receiving effective doses that exceed 1 mSv per official year, or an equivalent dose greater than 1/10th of the limits for the crystalline lens, the skin, and the extremities referred to in paragraph 2 of Article 9, and shall establish the applicable radiological protection measures. These measures must be adapted to the nature of the installation, the sources, as well as the magnitude and nature of the risks. The scope of the prevention and monitoring measures, as well as their nature and quality, must be based on the risks associated with the tasks that imply exposure to ionising radiations.

**Article 17. Classification of areas**

1. The title-holder of the practice shall classify the work areas, in accordance with the exposure risk and taking into account the probability and magnitude of the potential exposures, in the following areas:

a) Controlled area: is the area in which:

1°. There is the possibility of receiving an effective dose greater than 6 mSv per official year, or an equivalent dose greater than 3/10ths of the equivalent dose limits for the crystalline lens, the skin and extremities, as established in paragraph 2 of Article 9, or

2°. It is necessary to follow work procedures whose aim is to restrict exposure to ionising radiation, to avoid the dispersion of radioactive contamination, or to prevent or limit the probability and magnitude of radiological accidents, or their consequences.

b) Monitored area: is an area in which, although not being a controlled area, there is a possibility of receiving effective doses that exceed 1 mSv per official year, or an equivalent dose greater than 1/10th of the equivalent dose limits for the crystalline lens, the skin and extremities, as established in paragraph 2 of Article 9.

2. Furthermore, the controlled areas may be subdivided as follows:

a) Areas of limited stay: are those in which there is a risk of receiving a dose that exceeds the dose limits set in Article 9.

b) Areas of regulated stay: are those in which there is a risk of receiving for short periods of time a dose that exceeds the dose limits set in Article 9, and which require special prescriptions regarding optimisation.

c) Areas of forbidden access: are those in which there is a risk of receiving, in one single exposure, doses that exceed the dose limits set in Article 9.

3. The classification of the working areas into the established areas must always be updated according to the real existing conditions, to this end the title-holder of the practice shall submit for revision the area classification on the basis of the variations in the working conditions.

#### **Article 18. Area requisites**

1. Taking into account the nature and the importance of radiological risks, radiological monitoring must be carried out on the working environment, of the controlled and monitored areas, according to what is established in Article 26. Furthermore, these areas:

a) Shall be adequately delimited and signalled in a manner that makes the risk of exposure in these areas evident. This signalling shall be carried out according to what is established in Annex IV.

b) The access shall be limited to persons authorised to do so, and who have been given adequate instructions as to the existing risk in these areas. In the controlled areas these instructions shall comply with the working procedures, established in writing by the title-holder of the practice.

2. In those controlled areas where there may be:

a) External exposure risk, the use of individual dosimeters shall be compulsory.

b) Contamination risk, the use of personal protection systems, adapted for the existing risk, shall be compulsory. At the exit points from these areas, there shall be adequate detectors to observe any possible contamination of persons or equipment, and if the case arises to adopt the opportune measures.

3. In the monitored areas, at least an estimation of the potential doses received must be carried out, through area dosimetry.

4. The title-holder of the practice is responsible for complying with what is established in paragraphs 1, 2, and 3 of this article, and to ensure that this is carried out under the supervision of the Radiological Protection Service, or the Radiological Protection Technical Unit, and in their absence by the Supervisor or person to whom the radiological protection duties are entrusted.

### *Section 2. Classification of exposed workers*

#### **Article 19. Age limit for exposed workers**

Without prejudice to what is established in paragraph 2 of Article 11, persons under the age of eighteen must not be allocated duties that could convert them into exposed workers.

#### **Article 20. Classification of exposed workers**

For radiological monitoring and control purposes, the title-holder of the practice, or when applicable, the external company shall be responsible for the classification of the exposed workers into two categories:

Category A: Shall belong to this category those persons who given the conditions in which they perform their job, could receive an effective dose that exceeds 6 mSv per official year, or an equivalent dose that exceeds 3/10ths of the limits for equivalent doses for the crystalline lens, the skin and extremities, as is established in paragraph 2 of Article 9.

Category B: Shall belong to this category those persons who given the conditions in which they perform their job, are very unlikely to receive effective doses that exceed 6 mSv per official year, or 3/10ths of the equivalent dose limits for the crystalline lens, the skin and extremities, as is established in paragraph 2 of Article 9.

### *Section 3. Information and training*

#### **Article 21. Information and training**

1. The title-holder of the practice or, when applicable, the external company, must inform the exposed workers, persons in training and students that during the course of their studies must use sources, before initiating activities, about:

- a) The associated radiological risks and the importance of fulfilling the technical, medical and administrative requirements.
- b) The norms and procedures for radiological protection, as well as the precautions that must be taken, as regards the practice in general, and each type of position or job that may be assigned to them.
- c) In the case of women, the need to inform as soon as possible about the condition of pregnancy and lactation, taking into account the exposure risks for the foetus, as well as the risk of contamination of the child in case of corporal radioactive contamination.

2. The title-holder of the practice or, in its case, the external company, must provide the exposed workers, the persons in training, and the students, before they initiate their activity, and periodically, training in matters of radiological protection, to a level that is adequate with their responsibility and the exposure risk to ionising radiations in their work place.

#### *Section 4. Evaluation and application of radiological protection measures*

##### **Article 22. Application of radiological protection measures for exposed workers**

The title-holder of the practice shall be responsible for ensuring that the examination and control of the protection devices and techniques and for the measuring equipment are carried out according to the established procedures, and supervised by the Radiological Protection Service or the Technical Unit of Radiological Protection, or in its absence by the Supervisor or the person to whom the radiological protection functions are entrusted, and shall specifically include:

- a) The prior critical examination of the installation's projects, from the perspective of radiological protection.
- b) The authorisation for the start-up of new sources or modified sources from the perspective of radiological protection.
- c) The periodic verification of the efficacy of the protection techniques and devices.
- d) The calibration, verification and check-up of the conditions and operation of the measurement instruments.

##### **Article 23. Radiological Protection Services and Technical Units**

The Nuclear Safety Council, taking into account the radiological risk, can demand from the title-holders of the practices included in Article 2, that they provide themselves with a Radiological Protection Service (RPS) or that they hire the services of a Radiological Protection Technical Unit (RPTU), to provide

them with specific advice in matters of radiological protection and to entrust them with the functions that according to this Regulation fall upon them.

#### **Article 24. Authorisation and organisation of Radiological Protection Services and Technical Units**

1. The Radiological Protection Services and Technical Units must be expressly authorised by the Nuclear Safety Council, and shall be composed of a Head of the Radiological Protection Service or Technical Unit, and by expert technicians in the field of radiological protection.

2. The Radiological Protection Services shall be organised and shall act independently from the rest of the functional units, and the Head of this Service shall maintain a direct functional dependence with the title-holder, or when appropriate, with the person who bears the highest degree of responsibility within the installation or centre. Without prejudice to, the necessary coordination with the Prevention Services established in labour law.

3. The Radiological Protection Services and Technical Units may act in more than one installation when they are authorised to do so by the Nuclear Safety Council.

#### **Article 25. Accreditation and obligations of the Head of the Radiological Protection Service or Technical Unit**

1. The Head of the Radiological Protection Service or Technical Unit must hold a diploma, issued by the Nuclear Safety Council, which habilitates the holder to this effect.

2. The Head of the Radiological Protection Service or Technical Unit must ensure the compliance with this Regulation. In case it is not complied with, this must be reported, in writing, to the title-holder of the practice, maintaining the corresponding register at the disposal of the Inspection service. In this same manner it shall request, in writing, the paralysation of operations or the clearing of a specific area, to the title-holder, when it considers that the necessary requirements for radiological protection are not being met.

### *Chapter Three*

#### *Evaluation of the exposure*

##### *Section 1. Monitoring the work environment*

#### **Article 26. Monitoring the work environment**

1. The radiological monitoring of the work environment, referred to in paragraph 1 of Article 18, shall comprise:

a) Measuring the external dose rates, specifying the nature and quality of the radiations in question.

b) Measuring the concentration of activity in the air and ground contamination, specifying the nature of the contaminating radioactive substances, and their physical and chemical state.

2. The documents relative to the registration, evaluation and result of the aforementioned monitoring must be archived by the title-holder of the installation who shall ensure that they are at the disposal of the competent authority.

3. Whenever it is appropriate, the results of these measures shall be used to estimate the individual doses, according to what is established in Article 30.

## *Section 2. Individual monitoring*

### **Article 27. Individual monitoring**

1. The doses received by the exposed workers must be determined according to what is established in Articles 28 and 29, when the operating conditions are normal, and with a periodicity no greater than a month, for external dosimetry, and with the periodicity that is established for each case, for internal dosimetry, for those workers who are exposed to the risks of radionuclides incorporation.

2. Individual dosimetry, be it external or internal, shall be carried out by the Personal Dosimetry Services expressly authorised to do so by the Nuclear Safety Council.

3. The title-holder of the practice, or in its case the external company shall transmit the results of the dosimetric controls to the Prevention Service that carries out the monitoring and control function for the workers' health, and who shall interpret them from a sanitary perspective. In cases of urgency, this aforementioned transmission must be immediate.

### **Article 28. Dose estimation for workers within Category A**

Regarding the exposed workers that belong to Category A, the following shall be compulsory:

a) In case of risk of external exposure, the use of individual dosimeters, that measure the external dose, which represents the dose for the entire organism during a full working day.

b) In case of a partial or non homogenous risk of external exposure of the organism, the use of adequate dosimeters for those parts of the body that are potentially most affected.

c) In the case of a risk of internal contamination, the performance of the pertinent measures or analysis to evaluate the corresponding doses.

### **Article 29. Dose estimation for workers within Category B**

The individual doses received by those exposed workers that belong to Category B may be estimated on the basis of the results of the monitoring carried out in the working environment, as laid out in Article 26, inasmuch as these allow to demonstrate that the aforementioned workers are correctly classified within Category B.

### **Article 30. Special dose estimations**

In those cases where it is impossible, or inappropriate, to carry out individual measurements, the individual monitoring shall be based on an estimation performed on the basis of individual measurements made on other exposed workers, or on the basis of the results of the monitoring of the working environment, as laid out in Article 26, with a specific mention to this fact in the worker's dosimetric record.

**Article 31. System applicable to area dosimetry**

The system for the use of dosimeters or instruments employed for area dosimetry and the associated procedure for the allocation of doses must be included in a written protocol, subject to the evaluation and inspection of the Nuclear Safety Council.

**Article 32. Dose estimation in accidental and emergency exposures**

In case of accidental exposures, the associated doses shall be evaluated as well as their distribution throughout the body. In cases of emergency exposures, an individual monitoring shall be performed or evaluations of the individual doses, depending on the circumstances.

**Article 33. Exceeding the dose limits**

When as a result of a specially authorised exposure, an accidental or emergency exposure, the dose limits, established in Article 9, may have been surpassed, a specific study must be carried out to evaluate, with the greatest possible speed and precision, the dose received by the entire organism or in the affected regions or organs.

These cases, and the results of the studies shall be immediately brought to the attention of the Prevention Service that carries out the monitoring and control functions regarding the workers' health, as well as the Nuclear Safety Council, and the affected worker.

*Section 3. Recording and notifying the results*

**Article 34. Dosimetric record and additional registers**

1. It shall be mandatory to record all the doses received during the working life of the exposed workers in an individual dosimetric record, that shall be kept, duly updated, and which shall at all times be at the worker's disposal.

To these effects, it shall also be obligatory to record, conserve and maintain the following documents at the worker's disposal:

a) In case of the exposures referred to in Articles 32 and 33, the reports regarding the circumstances and the measures adopted.

b) The results of the working area monitoring that may have been used to estimate the individual doses.

2. The dosimetric record of all exposed workers belonging to Category A, must also be incorporated into their respective medical records, referred to in Article 44.

### **Article 35. Contents of the dosimetric record**

In the corresponding dosimetric record for the workers within Category A, the following shall be registered: the monthly doses, the accumulated doses in every official year, and the accumulated doses in every period of five consecutive official years. In the case of workers within Category B, the annual doses, determined or estimated, shall be included.

### **Article 36. Recording doses due to specially authorised, accidental or emergency exposure**

All dose received as a result of a specially authorised exposure must be incorporated as such into the dosimetric record, specifying, when appropriate, the incorporation of radionuclides into the organism. These doses, as well as those received by exposure due to accidents or emergencies, shall be registered in the dosimetric record, separately from those received during work in normal conditions.

### **Article 37. Communication of doses**

1. Those workers who are exposed in more than one activity or installation are obliged to inform of this circumstance to the Head of the Radiological Protection Service or Radiological Protection Technical Unit, or in their absence to the Supervisor or person who has been entrusted with the performance of the radiological protection functions in each one of the centres in which they work, to ensure that in each one of these centres the corresponding individual dosimetric record is kept, updated and complete. To this end, the worker must communicate in each activity the dosimetric results that are provided in the other activities.

2. In case of a change of employer, the worker must provide a certified copy of the corresponding dosimetric record to the title-holder of the new destination.

### **Article 38. Document archive**

1. The dosimetric record of the exposed workers, the documents corresponding to the dose evaluation and the measures taken by the monitoring teams, in those cases referred to in Article 34, and the reports relating to the circumstances and adopted measures, in cases of accidental or emergency exposure, as contemplated in Article 32 of this Regulation, must be filed by the title-holder of the practice, until that time when the worker has, or would have, reached sixty-five years of age, and never for a period of less than thirty years, starting from the date the worker ceases to work in the activities that qualified the worker as an exposed worker.

2. The title-holder of the practice shall make these documents available to the Nuclear Safety Council, and depending on its own competences, to the Public Administrations, in those cases foreseen in the Laws, as well as to the Courts and Tribunals that request them.

3. In case the exposed worker should resign from the position held, the title-holder of the practice must provide the worker with a certified copy of the dosimetric record.



4. Once the practices regulated by this Regulation terminate operations definitively, the title-holders of these must hand over to the Nuclear Safety Council the files referred to in the first paragraph of this article.

5. In the case of external workers, the external company on whom the worker depends, shall have the responsibility to comply with what is established in this present article.

#### *Chapter Four*

#### Sanitary monitoring of exposed workers

##### *Section 1. Sanitary monitoring of exposed workers*

##### **Article 39. Sanitary monitoring of exposed workers**

The sanitary monitoring of exposed workers shall base itself on the general principles of Occupational Medicine and in Law 31/1995, of the 8th of November, on the Prevention of Occupational Hazards and the Regulations that develop it.

##### **Article 40. Medical examinations**

1. All person that is to be classified as an exposed worker within Category A must be subjected to a prior medical examination, that will allow to determine whether the person is incurring, or not, in any of the incompatibilities that are legally defined and to decide on the person's aptitude for the job.

2. The exposed workers within Category A, shall also be subjected to periodic health examinations that will allow to ensure that they are still apt to perform their assigned functions. These examinations shall be carried out every twelve months, and more frequently, if it were to be necessary, upon the doctor's criteria, given the worker's health, working conditions or any incidents that may occur.

##### **Article 41. Prior health examination**

The prior health examination that any person who is to be destined to a working position that implies a risk of exposure that entails their classification as an exposed worker within Category A, shall have as its aim to establish a clinical record that includes the determination of the type of work performed previously, and the risks that the worker has been exposed to as a result, and when relevant, the dosimetric record that must be provided by the worker.

##### **Article 42. Periodic health examinations**

1. The periodic health examinations for exposed workers within Category A shall be adapted to the characteristics of the exposure to ionising radiations or the possible internal or external contamination and shall include a general clinical examination and all those other necessary examinations to determine the condition of the exposed organs and their functions.

2. The Prevention Service that performs the monitoring and control functions for the workers' health may determine the convenience that the sanitary monitoring of workers within Category A, that have subsequently been declared

not apt or who may have resigned from this professional activity, be extended, for as long as it considers necessary.

#### **Article 43. Medical classification**

1. From a medical point of view, and according to the results of the opportune examinations, the exposed workers within Category A shall be classified as:

- a) Apt: those who can perform activities that imply risk of exposure associated to the job.
  - b) Apt, in certain conditions: those who can perform activities that imply exposure risk, associated to the job, as long as the conditions that shall be established to this effect, are fulfilled, on the basis of medical criteria.
  - c) Not apt: those workers who must be kept separated from positions that imply exposure risk.
2. No worker may be employed or classified for a specific position, as a Category A worker, for any period of time, if the medical conclusions do not consider the worker apt for this aforementioned specific position.

#### **Article 44. Medical records**

1. For each exposed worker within Category A, a medical record shall be established, that will be updated throughout the entire period of time that the worker remains in this category, and that must contain, at least, the information regarding the nature of the job, the results of the medical examinations prior to the hiring or classification as a worker in Category A, the periodic and eventual medical examinations, and the dosimetric record of the worker's entire professional life.

2. These medical records shall be filed, until that time when the worker has, or would have, reached the age of sixty-five, and in no case, for a period of less than thirty years, after the end of the activity, in the Prevention Services that perform the monitoring and control of the health of the corresponding workers in the centres in which these persons perform, or have performed, their services, and shall be at the disposal of the competent authority and the worker.

### *Section 2. Special monitoring for exposed workers*

#### **Article 45. Special sanitary monitoring**

In case of exceeding, or grounded suspicion of exceeding, any of the dose limitations established in Article 9, a special sanitary monitoring must be carried out. The subsequent exposure conditions shall be subject to what is established by the Prevention Service that performs the monitoring and control of the workers' health.

#### **Article 46. Additional measures**

1. Beyond the sanitary monitoring, described in the previous articles, other measures shall be applied, when the Prevention Service that performs the monitoring and control of the workers' health, considers it adequate, such as further examinations, urgent decontamination or therapeutic treatment measures,

and when necessary, medical attention and treatment in the assistance Services for those injured and for persons contaminated by radioactive isotopes and ionising radiations, that to this effect have been authorised by the sanitary authority in the respective Autonomous Communities. The authorisations awarded on the basis of this paragraph must be reported to the Nuclear Safety Council and the Ministry of Health and Consumption.

2. The Ministry of Health and Consumption shall keep a catalogue and general register of these Centres to the effects referred to in Articles 15.2 and 40.9 of Law 14/1986, of the 25th of April on General Health.

### *Section 3. Appeals*

#### **Article 47. Appeals**

The declarations regarding the aptitude of workers and the appeals against these same declarations, shall be governed according to what is established in the applicable sanitary and labour legislation.

### *Chapter Five*

Standards for the protection of persons in training and students

#### **Article 48. Standards for the protection of persons in training and students**

1. The exposure and operational protection conditions for persons in training and students, older than eighteen years of age, referred to in paragraph 1 of Article 11, shall, depending on the cases, be equivalent to those of exposed workers of Category A or B, as defined in Article 20.

2. The exposure and operational protection conditions for persons in training and students, between the ages of sixteen and eighteen, referred to in paragraph 2 of Article 11, shall be equivalent to those of exposed workers of Category B, as defined in Article 20.

### ***Title V. Radiological protection of the population under normal circumstances***

#### *Single Chapter*

Fundamental monitoring measures

#### **Article 49. Basic principles**

The protection of members of the public and of the population as a whole shall be carried out through the necessary measures and controls to ensure that the practices operate according to the principles established in Article 4, and with the fundamental principles that govern the protection of the population, as set forth in Article 50.

#### **Article 50. General principles**

1. The protection of the population under normal conditions shall be based on the following principles:

a) The contribution of the practices to the exposure of the population as a whole must be kept at the lowest reasonably possible level, taking into account economic and social factors.

b) The title-holder of the practice shall carry out the adequate studies for each case, to be able to confirm that the exposure risk that could affect the population as a result of its activities is not significant from a radiological protection perspective.

c) The practices must be projected conveniently to avoid, or reduce to the lowest reasonably possible level, the evacuation of radioactive effluents into the environment.

d) On the basis of the mentioned studies, within the corresponding administrative authorisation, shall be specified whether there is a need for a specific monitoring system to evaluate and control, during the operation of the activity, the doses that could be received by the public.

2. The monitoring shall be essentially based on the evaluation of the doses that could be received by the population, and shall be adequate to the risk that the activities imply.

#### **Article 51. Evacuation of effluents and solid waste**

All evacuation of effluents and solid radioactive waste into the environment shall require the express authorisation of the Ministry of the Economy, following the report of the Nuclear Safety Council, and shall be adjusted to the limitations and conditions that are established within this authorisation, taking into account the characteristics of the practice.

To this effect, the party that requests the authorisation shall attach the adequate studies, for each case, relative to the discharge of radioactive effluents into the environment, and the capacity of reception of radioactive contaminants in the area, on the basis of its characteristics,

#### **Article 52. Levels of effluent emission**

The levels of activity for the emission of radioactive effluents into the environment must be such that the activity concentrations of radionuclides that they contain, and the doses that are susceptible of being received by the population, that may potentially be affected, are the lowest possible, taking economic and social factors into account. These levels must always be lesser than the specified limits for members of the public in Article 13 of this Regulation, and when applicable, to those other inferior values that may be established by the Nuclear Safety Council.

#### **Article 53. Estimation of the doses received by the population**

1. The title-holder of each practice shall make estimations, in a regular manner, and in the most realistic way possible, as to the doses received by the population as a whole, and by the reference groups in all those places where such groups may exist. The results of these estimations, which in the case of the reference groups, shall be carried out, at least with a annual periodicity, shall be sent to the Nuclear Safety Council.

2. The dose estimations that are referred to in paragraph 1 of this article, shall include, among other aspects.

a) An evaluation of the external exposures, indicating, depending on the cases, the type and quality of the radiations in question.

b) An evaluation of the incorporation of radionuclides, indicating the nature and the physical and chemical state of the contaminating radioactive substances, as well as the determination of their activity and the concentration of this activity.

c) The specification of the characteristics of the population reference groups, taking into account the effective channels for the transfer of radioactive substances.

#### **Article 54. Archive**

The documents relating to the measurement of external exposure and the estimations on the incorporation of radionuclides, and radioactive contamination, as well as the results of the evaluation of the doses received by the reference groups and by the population must be filed by the title-holder.

#### **Article 55. Equipment regarding effluents and solid waste**

The practices that may give rise to effluents and to solid radioactive waste that may suppose a significant radiological risk must be equipped with all the necessary independent and specific systems for storage, treatment, and when necessary evacuation systems, whose operation shall be the object of adequate revisions to avoid non controlled discharges.

#### **Article 56. Storage of waste**

1. The storage of radioactive waste must be carried out by confining them in containers whose characteristics provide sufficient protection against ionising radiations, taking into account the conditions of the storage site and the possible dispersion or leakage of radioactive material.

2. The containers that contain radioactive waste must be duly signalled.

3. Furthermore, the title-holder must keep a register in which shall be included for each container, the most relevant physical-chemical data regarding its content, and at least, the maximum values of its exposure levels in contact and at a meter's distance from the surface, as well as the date of the last measurement, and if possible, the activity.

#### **Article 57. Responsibilities**

1. The title-holder of the practice shall be responsible to ensure that all the operations are carried out, in accordance with what is established in Article 49, and specifically for carrying out the following tasks within the installations:

a) Reaching and maintaining an optimal level of protection of the environment and the population.

- b) Checking the efficacy of the technical devices for the protection of the environment and the population.
  - c) To put in operation the equipment and measurement procedures necessary to ensure the radiological protection of the population and the environment, and when appropriate, the evaluation of the exposure and the radioactive contamination of the environment and the population.
  - d) The periodic calibration, verification, and checking of the condition and operation of the measurement equipment.
2. The execution of these tasks shall be carried out in compliance with the established procedures and with the supervision of the Radiological Protection Services or Technical Units, foreseen in Articles 23 and 24, or in their absence by the Supervisor or person entrusted with radiological protection functions.

## ***Title VI. Interventions***

### *Chapter One*

#### General principles

##### **Article 58. Application**

1. This present title shall be applicable to all interventions in cases of radiological emergency or in case of lasting exposure.
2. The Nuclear Safety Council shall ensure that the application and the magnitude of the interventions are carried out in compliance with the following principles:
  - a) An intervention shall only be initiated when the reduction of health injury due to radiation is sufficient to justify the negative effects and the costs of the intervention, including social costs.
  - b) The form, magnitude and duration of the intervention must be optimised in a manner so as to ensure the maximum benefit corresponding to the reduction of the health hazard, once the damage associated to the intervention has been reduced.
  - c) The dose limits, according to what is stipulated in Articles 8 to 13, shall not apply in the case of an intervention; nevertheless, in cases of lasting exposure, regulated by Article 61, the dose limits established in Article 9, shall be applicable to those workers who carry out the interventions. The Nuclear Safety Council shall establish intervention levels that shall constitute indications to determine under what situations such an intervention is adequate.

### *Chapter Two*

#### Intervention in case of radiological emergency

##### **Article 59. Application of interventions in case of radiological emergency**

1. The actions that must be taken in cases of radiological emergencies in nuclear power plants shall be established in the in-site emergency plans of these plants, as well as in the corresponding Civil Protection external emergency plans, deriving from the Basic Nuclear Emergency Plan.

2. For the rest of the nuclear and radioactive installations, and for other activities different to these, the actions that must be taken shall be those established both in the in-site emergency plans, or self-protection plans, of each installation or activity, as well as in the radiological emergency plans, derived from the basic planning directives and other norms of Civil Protection that may correspond.

**Article 60. Emergency exposure**

1. The Nuclear Safety Council shall establish the emergency exposure levels taking into account the technical needs and the risks to health.

2. In exceptional cases, exposures beyond these special levels may be admitted, to save human lives and only by volunteer personnel, duly informed of the risks of such an intervention, taking into account what is established in the Council of Ministers Agreement, of the 1st of October 1999, regarding public information on applicable sanitary protection measures and on the behaviour to be followed in cases of radiological emergency.

3. The personnel that participate in an intervention in case of radiological emergency must be subjected to a dosimetric control, and special sanitary monitoring, that shall be developed specifically in the norm quoted in the previous article.

Chapter Three

Intervention in case of lasting exposure

**Article 61. Application of the intervention in case of lasting exposure**

In case of intervention in situations of lasting exposure, and depending on the risks that such exposure may entail, the competent authority, following the report of the Nuclear Safety Council, must:

a) Delimit the affected area.

b) Apply an exposure monitoring system.

c) Perform the opportune interventions, taking into account the situation's characteristics.

d) Regulate the access and use of lands or buildings located within the delimited area.

***Title VII. Natural sources of radiation***

***Single Chapter***

**Significant increase in exposure due to natural radiation sources**

### **Article 62. Application**

1. The competent authority, with the advice of the Nuclear Safety Council, shall require the title-holders of occupational activities, not regulated within paragraph 1 of Article 2, in which natural sources of radiation are present, to carry out the necessary studies to determine whether there is a significant increase in the exposure of workers or of members of the public, which may not be considered as negligible from the perspective of radiological protection.

Among the activities that must be subjected to the aforementioned revision are the following:

- a) Occupational activities in which the workers, when applicable, the members of the public are exposed to the inhalation of decay products of thoron or radon, or to gamma radiation or any other exposure in places of work, such as spas, caves, mines, subterranean, or not subterranean, work places in identified areas.
- b) Occupational activities which imply the storage, or handling of materials that are not ordinarily considered as radioactive, but which contain natural radionuclides that generate a significant increase in the exposure of workers and, in some cases, of members of the public.
- c) Occupational activities that generate waste which is not ordinarily considered radioactive, but which contain natural radionuclides that generate a significant increase in the exposure of workers and, in some cases, of members of the public.
- d) Occupational activities that imply exposure to cosmic radiation during the operation of aircraft.

2. The studies referred to in paragraph 1 shall be carried out according to the instructions laid down by the competent authority, which shall be subject to the guidelines that the Nuclear Safety Council establishes to this effect.

### **Article 63. Terrestrial sources of natural radiation**

1. The competent authority shall present the results of the studies, carried out in accordance with Article 62, to the Nuclear Safety Council. The Nuclear Safety Council, on the basis of these studies, shall identify those occupational activities that warrant special attention and being subject to control. As a result, it shall define those occupational activities that must possess adequate monitoring provisions for the exposures, and when necessary it shall lay down:

- a) The application of corrective actions destined to reduce the exposures, according, totally or partially, with Title VI.
- b) The application of radiological protection measures, according, totally or partially, with Titles II, III, IV and V, and to the regime of declarations or authorisations.



2. The Nuclear Safety Council shall inform the competent authority of the conclusions and necessary measures, as a result of what is indicated in paragraph 1 of this present article, to demand its application by the title-holders.

**Article 64. Aircraft crew**

The airlines must consider a radiological protection programme when the exposure of the crew of its aircraft to cosmic radiation could result in a dose greater than 1 mSv per official year. This program shall consider, specifically:

- a) Evaluating the exposure of the relevant personnel.
- b) Organising the work schedules in order to reduce the exposure in the case of the more exposed crew members.
- c) Informing the relevant workers of the radiological risks associated to their work.
- d) The application of Article 10 to the female crew members.

***Title VIII. Inspection***

***Single Chapter***

Inspection regime and the obligations of the title-holder

**Article 65. Inspection regime**

1. All those practices, activities and entities mentioned in Article 2 of this present Regulation shall be subject to an inspection regime, which will be implemented by the Nuclear Safety Council, from the perspective of protection against ionising radiations.
2. The Radiological Protection Services or Technical Units shall also be inspected by the Nuclear Safety Council, as well as the Personal Dosimetry Systems, with the aim of guaranteeing the maintenance of the conditions in which they were authorised, and the adequateness of their actions.
3. The result of the inspections shall figure in an certificate.
4. The Inspectors shall be given the consideration of agents of authority to the effects referred to in the Penal Code, in all that is relative to the exercise of their duty.

**Article 66. Inspection activities**

The Inspection of the Nuclear Safety Council shall be in charge of verifying the compliance with the legal provisions and all those specifications in the field of radiological protection that have been established in the corresponding regulatory authorisations.

**Article 67. Obligations of the title-holder**

The title-holder of any practice or activity included within the scope of application of this Regulation, as well as those entities referred to in Article 65

shall be obliged to permit or facilitate the work of the Inspection of the Nuclear Safety Council by ensuring:

- a) The access to the sites that the Inspectors consider necessary for the execution of their work.
- b) The installation of the equipment or instruments that are necessary to carry out the tests and necessary check-ups.
- c) The information, documents, equipment and existing elements that may be necessary for the fulfilment of their mission.
- d) Taking sufficient samples to perform the pertinent analysis and check-ups. At the request of the practice's title-holder, a duly sealed and marked contrast sample must be left in possession of the title-holder.

**Article 68. Actions in case of risk**

The Inspectors of the Nuclear Safety Council are capacitated to request the immediate suspension of the practices, that operating without observing the provisions of this Regulation, imply, in their opinion, a manifest hazard for persons or the environment. Such actions must be recorded in the inspection certificates with the necessary details.

***Title IX. Sanction regime***

*Single Chapter*

Sanction regime

**Article 69. Infractions and sanctions**

1. Without prejudice to the civil, penal or other responsibilities that the title-holders of the practices regulated within this Regulation may incur, the non observance of what is established in this Regulation shall constitute an infraction, according to what is established in Chapter XIV of Law 25/1964, of the 29th of April, on Nuclear Energy, modified by the Fifth Additional Provision of Law 54/1997, of the 27th of November, on the Electricity Sector.

2. Furthermore, the non observance of what is laid down in this present Regulation shall constitute the following infractions, classified as minor, serious and very serious:

a) Shall be considered as very serious infractions:

1°. The exercise of any of the practices foreseen in this present Regulation which require a licence or a specific authorisation and which may not be given the consideration of exempted, without the opportune licence or authorisation, as long as it supposes a serious risk for the life or health of persons, or for the environment, or the safety of things.

2°. The deliberate addition of radioactive substances in the production of foodstuffs, toys, personal adornments and cosmetics, when from this a serious risk may be derived for the life or health of persons, or for the environment.

3°. To not dispose of the adequate systems for the storage, treatment, and in their case, the evacuation of effluents and solid waste, or the evacuation of these without authorisation or exceeding the authorised emission levels, as long as from such behaviour a serious risk is derived for persons or the environment.

4°. To not respect the dose limits established in this Regulation for the different cases, when from this a serious risk is derived for the life or health of persons.

b) Shall be considered as serious infractions:

1°. The exercise of any of the practices foreseen in this present Regulation, which require a licence or a specific authorisation, and which may not be given the consideration of exempted, without the opportune licence or authorisation, as long as it does not suppose a very serious, or a minor infraction.

2°. The deliberate addition of radioactive substances in the production of foodstuffs, toys, personal adornments and cosmetics, when it does not constitute a very serious infraction.

3°. To not dispose, in the cases where this present Regulation requires, of a Radiological Protection Service or Technical Unit, when this situation seriously affects the radiological protection of the workers or the members of the public.

4°. To not comply with the criteria for radiological protection established in this present Regulation, in a way that the number of persons exposed, and the doses received by them, are not the minimum possible, as long this situation generates a serious risk for the life or health of persons, or the environment, or the security of things.

5°. To not inform the workers, persons in training and students, before they start their occupational activity in the presence of ionising radiations of the issues highlighted in this present Regulation, or to not comply with the obligation of offering them the necessary training in matters of radiological protection.

6°. To assign a person younger than eighteen years of age to a position that implies the qualification as an exposed worker within Category A.

7°. To not comply with the prescriptions regarding pregnancy and lactation signalled in this Regulation, once the worker has informed the title-holder of the practice of her condition.

8°. To not identify or delimit, according to what is established in Annex IV of this Regulation the working areas in which there is a possibility of exposure to ionising radiations that could produce a dose that exceeds 1 mSv per year, or an equivalent dose greater than 1/10th of the limits for the crystalline lens, the skin and the extremities, as established in this Regulation, and to not implement the measures foreseen in Article 18, as long as from this a serious risk is implied for persons or the environment.

9°. The lack, or not have operational, the adequate measurement devices and instruments, necessary for the correct running of a practice in the presence of ionising radiations.

10°. To not perform a special sanitary monitoring in cases where any of the dose limits established in this present Regulation have been exceeded, or there are grounded suspicions of this.

11°. In the cases of intervention for radiological emergencies, for the titleholder of the practice to not comply with the obligations established in this Regulation, as long as this situation significantly affects the radiological protection of workers or members of the public.

12°. To not have available adequate systems for the storage, treatment and where applicable, the evacuation of effluents and solid waste, or to evacuate these without authorisation, or to exceed the authorised emission levels, as long as from such behaviour no serious risk can be derived for persons or the environment.

13°. To not respect the dose limits established for each case, as specified in this present Regulation, when this does not suppose a very serious, or a minor, infraction.

14°. To not suspend the operations of a practice when the affected party is requested to do so by the competent authorities, according to what is established in this Regulation, when it does not constitute a very serious, or a minor, infraction.

15°. To exceed the established doses for "specially authorised exposures", as a result of an inadequate planning of these, or negligence in their supervision and control.

16°. To not perform with the required urgency, in cases of accidental or emergency exposure, the necessary evaluations to estimate the doses received by a worker, or in its defect, to not adopt the necessary radiological protection measures.

c) Shall be considered minor infractions:

1°. The exercise of any of the practices foreseen in this present Regulation, which require a licence or a specific authorisation, and which may not be given the consideration of exempted, without the opportune licence or authorisation, as long as it does not suppose a very serious, or a serious infraction, and its effects be minor.

2°. To not perform the sanitary monitoring of exposed workers in the terms foreseen in this Regulation or to not dispose of the medical records of the exposed workers of Category A, or to not have them updated, or to not have included in them the details specified in this Regulation.

- 3°. To not dispose of, in the cases required, according to the provisions of this Regulation, of a Radiological Protection Service or Technical Unit, when this does not constitute a serious or very serious infraction.
- 4°. To not comply with the criteria for radiological protection established in this present Regulation, in such a manner that the number of exposed persons and the doses they receive are not the minimum possible, as long as this situation does not significantly affect the radiological protection of workers or of members of the public.
- 5°. To not carry out the dose determinations, according to the terms and the periodicity established in this Regulation, or to not have the individual dosimetric records of the exposed workers available, or to not have them duly updated.
- 6°. To not signal the containers that contain radioactive waste adequately, or to not keep a register with the data, values, measurements and activity of these containers, in the conditions specified in this Regulation.
- 7°. To not comply with the prescriptions established in Title VII, in cases of a significant increase in the exposure, due to natural radiation sources.
- 8°. To not identify or delimit, according to what is stipulated in Annex IV, the work places in which there is a possibility of exposure to ionising radiations that would lead to an annual dose greater than 1mSv, or an equivalent dose that exceeds 1/10th of the limits for the crystalline lens, the skin and the extremities, as established in this Regulation, or to not implement the measures foreseen in Article 18, when this does not suppose a serious risk for persons or the environment.
- 9°. To not apply the requirements, that of a general character, are imposed on a practice by the competent authority according to this present Regulation, or to not comply with the deadlines established for their implementation, or the omission of the corrective measures that are necessary to comply with the legal or regulatory precepts when this does not suppose a serious infraction.
- 10°. To not have the adequate systems for the storage, treatment, and in its case, evacuation of effluents and solid waste, or their evacuation without authorisation, or surpassing the authorised emission levels, as long as such behaviour is not significant for radiological protection.
- 11°. To not respect the dose limits established for each case, in this present Regulation, when this non compliance is not very significant in terms of radiological protection.
- 12°. In the cases of intervention for radiological emergencies, for the title-holder of the practice to not comply with the obligations outlined in this Regulation, although this situation does not significantly affect radiological protection.

13°. To not comply with the terms, requirements, obligations, limits, conditions or prohibitions imposed in the authorisations, when such non compliances do not generate significant radiological protection concerns.

3. For the qualification of the infractions, the circumstances described in Article 92 of Law 25/1964, on Nuclear Energy, modified by Law 54/1997, of the Electricity Sector, shall apply.

4. To the effects of the grading of the sanctions, the following shall be taken into consideration:

a) Minor infractions shall be sanctioned with a fine, whose minimum shall be of up to 500,000 pesetas, between 500,001 and 5,000,000 pesetas for the medium grade, and in their maximum level between 5,000,001 and 10,000,000 pesetas.

b) Serious infractions shall be sanctioned with a fine, whose minimum shall be of up to 10,000,0001 to 25,000,000 pesetas; between 25,000,001 and 50,000,000 pesetas for the medium grade, and in their maximum level between 50,000,001 and 100,000,000 pesetas.

c) Very serious infractions shall be sanctioned with a fine, whose minimum shall be of up to 100,000,0001 to 250,000,000 pesetas; between 250,000,001 and 350,000,000 pesetas for the medium grade, and in their maximum level between 350,000,001 and 500,000,000 pesetas.

5. When the installations in question are second and third category radioactive installations, the economic sanctions referred to in the previous paragraphs shall be reduced by half in all the levels and for all the grades.

6. Regarding procedure, prior measures, and competent authorities to propose and impose the corresponding sanctions, what is established in Article 94 of Law 25/1964, of the 29th of April, on Nuclear Energy, modified by the Fifth Additional Provision of Law 54/1997, of the 27th of November, on the Electricity Sector, shall apply.

*First Additional Provision. Prevention of Occupational Hazards*

In matters of worker protection, the norms contained in Law 31/1995, of the 8th of November, on Prevention of Occupational Hazards, shall apply, without prejudice to the more specific provisions included in this present Regulation.

*Second Additional Provision. Operational protection of external workers*

The application of what is established in this present Regulation is understood, except for what is stipulated in Royal Decree 413/1997, of the 21st of March, on operational protection of external workers with exposure risk to ionising radiations, for intervention in controlled areas.

*Third Additional Provision. Norms applicable to the authorisations*

The practices, referred to in this present Regulation must also comply, as applicable, and specifically in matters of administrative authorisations, with the Law 25/1964, of the 29th of April, on Nuclear Energy; Law 15/1980, of the

22nd of April, on the creation of the Nuclear Safety Council; Royal Decree 1836/1999, of the 3rd of December, which approves the Regulation on Nuclear and Radioactive Installations; and Royal Decree 1891/1991, of the 30th of December, which approves the Regulation on the Installation and Use of X-Ray Equipment for Purposes of Medical Diagnosis.

*Fourth Additional Provision. Transportation of radioactive material*

The transportation of radioactive material, in all that is not expressly regulated by its specific legislation, shall be governed by the precepts of this Regulation, whenever they apply.

*Fifth Additional Provision. Treatment of data of a personal nature*

The treatment of data of a personal nature related to the health of workers, contained in their medical and dosimetric records, shall be carried out by a person subjected to the obligation of secrecy, according to what is established in Law 15/1999, of the 13th of December, on the Protection of Data of a Personal Nature.

*Sixth Additional Provision. Modification of Royal Decree 1836/1999*

Shall be modified: "Table B: list of nuclides in secular equilibrium, referred to in paragraph 2.b) of Annex I of Royal Decree 1836/1999, of the 3rd of December, which approves the Regulation for Nuclear and Radioactive Installations", substituting the daughter products of Ra-223+ and of Ra-224+ by those that are indicated as follows:

<u>Nuclear parent</u>	<u>Daughter products</u>
Ra-223+	Rn-219, Po-215, Pb-211, Bi-211, Tl-207.
Ra-224+	Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212.

*First Transitory Provision. Effectiveness of the authorisation*

The effectiveness of the authorisations, required according to this present Regulation, shall be effective upon the entry in force of the aforementioned Regulation.

*Second Transitory Provision. Adaptation deadlines*

The provisions contained in Chapter Two of Title II of this present Regulation shall enter in force on the 1st of January 2002, until this date the regulations contained in Royal Decree 53/1992, of the 24th of January, which approves the Regulation on Sanitary protection against Ionising Radiations, shall be applied. Nonetheless, a period of six months is established, from the date of the publication of this present Regulation, for the full adaptation of what is stipulated in Title III of this present Regulation.

For the application of the precepts regarding classification, delimitation, and signalling of areas, as well as the classification of exposed workers, as established in Chapter One of Title IV, as well as the related requirements, a six month adaptation period is established, from the date of publication of this present Regulation.

Similarly, a six month period is established, from the date of publication of this present Regulation, for the adaptation of the official documents, corresponding to the practices, activities and services, whose content shall be affected by what is stipulated in this present Regulation.

*Third Transitory Provision. Regime for the authorisations of the Specialised Medical Services*

The Specialised Medical Services authorised according to what is established in Article 40 of Royal Decree 53/1992, of the 24th of January, which approves the Regulation on Sanitary Protection against Ionising Radiations, may continue to perform the duties of sanitary monitoring of workers exposed to ionising radiations.

The authorisation proceedings for Specialised Medical Services that may have been initiated before the entry in force of this present Regulation shall be governed by what is established in Article 40 of Royal Decree 53/1992, of the 24th of January. To these effects, they shall be considered initiated once the interested party has presented the corresponding request before the Register of the competent Administration for the resolution of the aforementioned authorisations.

## ANNEX I

### Definitions

*Activity (A)*: the activity A of a quantity of a radionuclide in a determined energetic state at a specific moment is the coefficient between dN and dt where dN is the expected value of the number of spontaneous nuclear transformations that take place from this given energetic state in the time interval dt

$$A = \frac{dN}{dt}$$

The unit of the activity is the Becquerel (Bq). One Becquerel is equal to one transformation per second

$$1\text{Bq} = 1 \text{ s}^{-1}$$

*Official year*: twelve month period, starting from the 1st of January, until the 31st of December, both included.

*Competent authority*: official body in charge, within the exercise of the functions that are attributed to it, to award authorisations, dictate provisions or resolutions and to ensure their compliance.

*Authorisation*: permit awarded by the competent authority in a documental form, following its request, or established by Spanish legislation, for the exercise of a practice or whatever other action within the scope of this Regulation's application.



*Calibration*: group of operations carried out by duly qualified laboratories, through which it is possible to establish, in specific conditions, the relation between the values indicated by an instrument or a measurement system, or the values represented by a material measure, and the corresponding known values of a measure.

*Radioactive contamination*: undesirable presence of radioactive substances in a matter, a surface, any means or a person. In the specific case of the human organism this contamination can be external or cutaneous, when it has been deposited on the external or internal, surface, when the radionuclides have penetrated into the organism through any of the possible channels (inhalation, ingestion, percutaneous, etc.).

*Non altered terrestrial crust*: any part of the terrestrial crust in which quarries, or subterranean or opencast mines are not exploited (the surface of a uranium deposit that has never been exploited shall be considered as non altered terrestrial crust). The ploughing, excavation or levelling of terrains, derived from agricultural or construction activities shall not be considered to "alter" the terrestrial crust, except when such operations take place in the framework of the restoration work of contaminated terrains.

*Declaration*: obligation to present a document to the competent authority to notify the intention to carry out a practice, or any other action, within the scope of this Regulation's application.

*Health hazard*: estimation of the risk of a reduction in the duration, or the quality of life, of a segment of the population, having been exposed to ionising radiations. Are included all the losses due to somatic effects, cancer and serious genetic alterations.

*Absorbed dose (D)*: the energy absorbed per unit of mass

$$D = \frac{d\varepsilon}{dm}$$

where,  $d\varepsilon$ , is the average energy imparted by the ionising radiation to the matter in an element of volume, and  $dm$  is the mass of the matter contained in the aforementioned volume element.

In this present Regulation, the absorbed dose indicates the average dose on a tissue or organ.

The unit of absorbed dose is the Gray (Gy).

*Effective dose (E)*: sum of the weighted equivalent doses in all the tissues and organs of the body which are specified in Annex II due to internal and external radiations. It is estimated through the following formula

$$E = \sum W_T H_T = \sum W_T \sum W_R D_{T,R}$$

T            T            R

where,  $D_{T,R}$  is the average absorbed dose by the tissue or organ T proceeding from the radiation R;  $W_R$  is the radiation weighting factor, and  $W_T$  is main weighting factor for the tissue or organ T.

The adequate values for  $W_T$  and  $W_R$  are specified in Annex II.

*Equivalent dose ( $H_T$ ):* absorbed dose, in a tissue or organ T, weighted in function of the type and quality of radiation R. Is given by the formula

$$H_{T,R} = W_R D_{T,R}$$

where,  $D_{T,R}$  is the average absorbed dose on the tissue or organ T, proceeding from radiation R, and  $W_R$  is the radiation weighting factor.

When the radiation field is composed of types and energies with different  $W_R$  values, the equivalent dose total  $H_T$  shall be given by the formula

$$H_T = \sum_R W_R D_{T,R}$$

The appropriate values for  $W_R$  are specified in Annex II.

The unit for the equivalent dose is the Sievert.

*Effective committed dose [ $E(\tau)$ ]:* sum of the equivalent committed doses in a tissue or organ  $H_T(\tau)$  as a result of an incorporation, multiplying each one of them by the corresponding tissue weighting factor  $W_T$ . As defined by the following formula

$$E(\tau) = \sum_T W_T H_T(\tau)$$

By specifying  $E(\tau)$ ,  $\tau$  is given in years. When value  $\tau$  is not specified, it shall be understood to be a fifty year period for adults, and a maximum of seventy years for children.

The unit for the effective committed dose is the Sievert.

*Equivalent committed dose [ $H_T(\tau)$ ]:* Integral with respect to time  $\tau$ ; of the rate of the equivalent dose in a tissue or organ T that a person may receive as a result of an incorporation. As defined by the formula

$$H_T(\tau) = \int_{t_0}^{t_0 + \tau} \dot{H}_T(t) dt$$

for an incorporation over time  $t_0$ , with  $H_T(t)$  as the corresponding equivalent dose in the organ or tissue T, in time t and with  $\tau$  as the period of time during which the integration takes place.

By specifying  $H_T(\tau)$ ,  $\tau$  is given in years. When the value  $\tau$  is not specified, it shall be understood to be a fifty year period for adults, and a maximum of seventy years for children.

The unit for the equivalent committed dose is the Sievert.

*Radioactive effluents*: residual radioactive products in a liquid or gaseous form.

*Elimination*: location of waste in a specific site when there is no intention of recovering them. The elimination also includes the direct evacuation of waste into the environment, with the prior authorisation, and its consequent dispersion.

*Radiological emergency*: situation that requires urgent measures to protect workers, members of the public or the population, in part or as a whole.

*External company*: any legal entity or person, different to the title-holder of the installation, who must carry out activities of any kind in a controlled area of a nuclear or radioactive installation.

*Exposure*: action and effect of subjecting persons to ionising radiations.

*Accidental exposure*: exposure of persons as a result of an accident, although it may not give rise to the surpassing of any of the established dose limits. It does not include emergency exposure.

*Emergency exposure*: voluntary exposure by persons who carry out an urgent action that is necessary to offer help to persons in danger, to avoid the exposure of a large number of persons, or to save an installation or valuable goods, that could imply exceeding some of the individual dose limits established for exposed workers.

*External exposure*: exposure of the organism to sources external to it.

*Internal exposure*: exposure of the organism to sources internal to it.

*Occupational exposure*: the exposure of workers during the performance of their work, with the exception of the exposures that are excluded from the scope of this Regulation, and those proceeding from sources and practices exempted from declaration and authorisation according to the applicable legislation.

*Partial exposure*: exposure that is located essentially on one part of the organism or on one or more organs or tissues, or the exposure of the entire body that is considered to be not homogenous.

*Lasting exposure*: exposure that results from the residual effects of a radiological emergency or from a past practice or occupational activity.

*Potential exposure*: exposure whose occurrence is not definitely expected, but with a probability of occurrence that can be estimated beforehand.

*Natural radioactive background:* collection of ionising radiations that proceed from natural terrestrial or cosmic sources (to the extent that the exposure that results from them is not increased significantly by human actions).

*Source:* apparatus, radioactive substance or installation capable of emitting ionising radiations or radioactive substances.

*Artificial sources:* sources of radiation different from the natural sources of radiation.

*Natural sources of radiation:* sources of ionising radiation of a natural, terrestrial or cosmic origin.

*Gray (Gy):* special name for the unit of absorbed dose. A gray is equal to a joule per kilogram:

$$1\text{Gy} = 1 \text{ J kg}^{-1}$$

*Population reference group:* group that includes persons whose exposure to a source is reasonably homogenous and representative of the most exposed members of the population, to the aforementioned source.

*Incorporation:* activity of radionuclides that proceeding from the outside world introduce themselves inside the organism.

*Intervention:* human activity that avoids or reduces the exposure of persons to radiation proceeding from sources that are not part of a practice or which are out of control, acting on the sources, the transference channels and the persons themselves.

*Head of a Radiological Protection Service or Technical Unit:* person responsible, or who is at the head of a Radiological Protection Service or Technical Unit, that shall be accredited to this effect by means of a diploma awarded by the Nuclear Safety Council.

*Dose limits:* maximum values set in Title II for the doses that result from the exposure of workers, persons in training, students, and members of the public, to the ionising radiations contemplated in this present Regulation.

*Members of the public:* members of the population, with the exception of exposed workers, persons in training and students, during their working hours, as well as persons during the exposure mentioned in paragraphs a), b), and c) of section 4 of Article 4.

*Intervention level:* value of the avoidable equivalent dose, the effective avoidable dose or the derived value, on the basis of which the adoption of intervention measures must be considered. The value of the avoidable or derived dose is solely that related to the channel of exposure to which the intervention measures must be applied.

*Person in training or students:* to the effects of this Regulation, all persons who, without being workers, should receive training or instruction within, or outside, a company, to perform a trade or profession, directly, or indirectly, related to activities that could imply exposure to ionising radiations.

*Population as a whole:* the entire population comprising exposed workers, persons in training, students, and members of the public.

*Practice:* human activity that can increase the exposure of persons to the radiation that proceeds from an artificial source, or a natural source of radiation, when the natural radionuclides are processed by their radioactive, fissionable, or fertile properties, except in the case of emergency exposure.

*Promoter:* person or legal entity that wishes to carry out a new practice in the country for the first time.

*Ionising radiation:* transfer of energy in the shape of particles, or electromagnetic waves, of a wave length lower or equal to 100 nanometres, or with a frequency greater than or equal to  $3 \times 10^{15}$  hertz, capable of producing ions directly, or indirectly.

*Radioactive waste:* any material or waste product, for which there is no expected use, which contains, or is contaminated with radionuclides in concentrations, or with levels of activity, that are greater than those set by the Ministry of the Economy, following a favourable report from the Nuclear Safety Council.

*Dose restriction:* restriction of the values of expected individual doses that may be derived from a specific source, for their use in the planning stage of radiological protection, in any circumstance where optimisation must be considered.

*Personal Dosimetry Service:* entity responsible for the reading or interpretation of individual monitoring apparatus, or for measuring radioactivity in the human body or in biological samples, or for the evaluation of doses, whose capacity to act in these respects shall be recognised by the Nuclear Safety Council.

*Radiological Protection Service and Technical Unit:* entity expressly authorised by the Nuclear Safety Council for the performance of functions established in the present Regulation. The Radiological Protection Service is an entity owned by a title-holder or jointly by several title-holders, whilst the Radiological Protection Technical Unit is an external entity hired by the title-holder.

*Sievert (Sv):* special name for the unit of effective and equivalent dose. One Sievert is equal to one joule per kilogram

$$1\text{Sv} = 1 \text{ Jkg}^{-1}$$

*Supervisor:* person who holds a specific licence awarded by the Nuclear Safety Council, which capacitates the holder to direct the operation of a nuclear or

radioactive installation, as well as those activities regarding the manipulation of the control and protection mechanisms of the installation. All of this according to what is established in Royal Decree 1836/1999, of the 3rd of December, which approves the Regulation on Nuclear and Radioactive Installations.

*Radioactive substance*: substance that contains one or more radionuclides, and whose activity or concentration cannot be considered insignificant from the perspective of radiological protection.

*Technical expert in Radiological Protection*: a duly qualified person, who is part of a Radiological Protection Service or Technical Unit, and who under the direction of a Head of Service or Technical Unit of Radiological Protection carries out activities that particular to such Services or Units.

*Title-holder*: person or legal entity who bears, according to national law, the responsibility and authority regarding the exercise of any of the practices or occupational activities foreseen in Article 2 of this present Regulation.

*Exposed workers*: those persons subject to exposure due to their work, deriving from the practices referred to in this present Regulation, which could entail doses greater than any of the dose limits for members of the public.

*External workers*: any worker classified as an exposed worker, who carries out activities of any kind in the controlled area of a nuclear or radioactive installation, and who is employed, either temporarily or permanently, by an external company, including those workers during their professional apprenticeship, persons in training or students, or those who offer their services as self-employed workers.

*Controlled area*: area subject to special regulations to the effects of protection against ionising radiations.

*Monitored area*: area subject to adequate monitoring to the effects of protection against ionising radiations.

## ANNEX II

### Dose estimations for external exposure

#### A) Definition of the terms used in this present annex

*Equivalent environmental dose  $H^*$  (d)*: equivalent dose at a specific point of a radiation field that would be produced by the corresponding expanded and aligned field in the ICRU sphere, at a depth "d", over the opposite radius to the direction of the aligned field. The special name of the unit of the equivalent environmental dose is the Sievert (Sv).

*Equivalent directional dose  $H'$  (d,  $\Omega$ )*: equivalent dose at a specific point of a radiation field that would be produced by the corresponding expanded field in

the ICRU sphere, at a depth "d", over a radius in a specific direction,  $\Omega$ . The specific name of the unit of the equivalent directional dose is the Sievert (Sv).

*Expanded and aligned field*: radiation field in which the fluence and its directional and energetic distributions are the same as in an expanded field, but where the fluence is unidirectional.

*Expanded field*: radiation field which is derived from the actual field in which the fluence and its directional and energetic distributions possess the same value throughout the entire volume of interest as the real radiation field at the point of reference.

*Fluence  $\Phi$* : is the quotient between dN and da, where dN is the number of particles that enter into a sphere of a normal section da:

$$\Phi = \frac{dN}{da}$$

*Average quality factor ( $\bar{Q}$ )*: average value of the quality factor in a point of a tissue in which the absorbed dose is transmitted by particles with values different to L. It is calculated by means of the following expression:

$$\bar{Q} = 1 / \bar{D} \int_0^{\infty} Q(L) D(L) dL$$

where  $D(L)dL$  is the absorbed dose at 10 mm between the linear energy transferences L and L + dL; and Q(L) is the corresponding quality factor at the point of interest. The Q-L relations are indicated in section C).

*Equivalent personal dose  $H_p(d)$* : equivalent dose in soft tissues at an adequate depth "d", beneath a specific point of the body. The special name given to the unit of equivalent personal dose is the Sievert (Sv).

*Quality factor (Q)*: is a function of the linear transfer of energy (L) that is used to weigh the absorbed dose in one point, in such a manner as to be able to take into account the quality of the radiation.

*Radiation weighting factor ( $w_R$ )*: adimensional factor that is used to weigh the dose absorbed by a tissue or organ. The appropriate values of  $w_R$  are specified in section B.

*Absorbed dose in an organ or tissue ( $D_T$ )*: is the quotient between the total energy communicated to an organ or tissue (T) and the mass of the aforementioned organ or tissue.

*Weighting factor for tissues ( $w_T$ )*: adimensional factor that is used to weigh the equivalent dose in a tissue or organ (T). The appropriate values of  $w_T$ , are specified in section D).

*Linear transfer of non restricted energy ( $L_\infty$ ):* is a magnitude that is defined as:

$$L_\infty = \frac{dE}{dL}$$

where  $dE$  is the average energy loss of a particle charged with energy  $E$ , when travelling a distance  $dL$  in water. In the Regulation it shall be denominated  $L$  to  $L_\infty$ .

*ICRU Sphere:* body introduced by the International Commission on Radiological Units and Measures (ICRU) to approximate the human body as regards the absorption of energy from ionising radiations. It consists of a sphere of 30cm in diameter of a material that is equivalent to tissue, with a density of  $1\text{ g cm}^{-3}$  and a mass composed of 76.2% of oxygen, 11.1% of carbon, 10.1% of hydrogen and 2.6% of nitrogen.

## B) Values of the radiation weighting factor of radiation $w_R$

The values of the radiation weighting factor  $w_R$  depend on the type and the quality of the external radiation field or the type and quality of the radiation emitted by a radionuclide that has been deposited internally.

When the radiation field is composed of types and energies with different values of  $w_R$ , the absorbed dose shall be subdivided into blocks, each one of them having its own value of  $w_R$  that shall be added up to obtain the total equivalent dose. Alternatively, the equivalent dose may be expressed as a continuous distribution of energy in which each element of absorbed dose by the element of energy between  $E$  and  $E + dE$  shall be multiplied by the corresponding value of  $w_R$  according to the following table.

Type and rank of energy	Radiation weighting factor, $w_R$
Photons, all energies	1
Electrons and muons, all energies	1
Neutrons, energy < 10 keV	5
> 10 keV to 100 keV	10
> 100 keV to 2 MeV	20
> 2 MeV to 20 MeV	10
> 20 MeV	5
Protons, except those of energy recoil > 2 MeV	5
Alpha particles, fission fragments, heavy nuclei	20

In the calculations regarding neutrons, problems may arise from the application of values to the step function. In these cases, it may be preferable to use the continuous function that is defined in the following mathematical relationship:

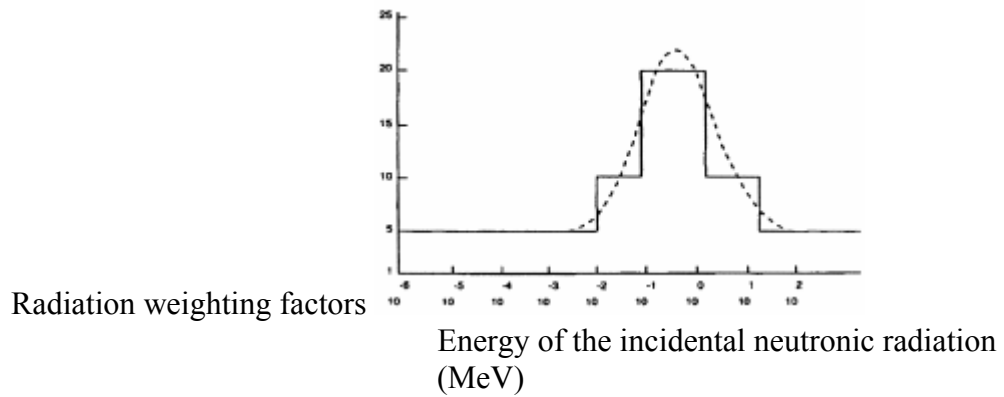
$$w_R = 5 + 17e^{-(\ln(2E))^{2/6}}$$

where  $E$  is the energy of the neutron in MeV.



Figure 1 shows a comparison between both approaches.

Figure 1



Weighting factor of radiation for neutrons  
The dotted line must be treated as an approximation.

For types and energies of radiation that are not included in the table, an approximate value of  $w_R$  can be obtained by calculating the average quality factor  $Q$  at a depth of 10mm in the ICRU sphere.

**C) Relationship between the quality factor  $Q(L)$  and the linear transfer of non restricted energy,  $L$**

Linear transfer of non restricted energy,  
 $L$ , in water ( $\text{keV } \mu\text{m}^{-1}$ )

$L$ , in water ( $\text{keV } \mu\text{m}^{-1}$ )	$Q(L)$
<10	1
10-100	$0.32L^{-2.2}$
>100	$300/\sqrt{L}$

**D) Values of the weighting factor for tissues,  $w_T$  (\*)**

The values of the weighting factor for tissues  $w_T$ , are listed as follows:

Tissue or organ	Weighting factors for tissues, $w_T$
Gonads.....	0.20
Bone marrow (red).....	0.12
Colon .....	0.12
Lung.....	0.12
Stomach.....	0.12
Bladder.....	0.05

\* The values have been calculated on the basis of a population with an equal number of persons of both sexes and with a wide variety of ages. In the definition of effective dose, these values are applied to workers, to the entire population and to both sexes.

Breast.....	0.05
Liver.....	0.05
Oesophagus.....	0.05
Thyroids.....	0.05
Skin.....	0.01
Bone surface.....	0.01
Rest of the body.....	0.05 (**)(***)

**E) Operative magnitudes for external radiation**

The operative magnitudes for external radiation shall be used in radiological protection for individual monitoring.

1. Individual monitoring:

equivalent personal dose  $H_p(d)$ ,  
d: depth within the body in mm.

2. Aerial monitoring:

equivalent environmental dose  $H^*(d)$ ,  
equivalent directional dose  $H'(d, \Omega)$ ,  
d: depth in mm under the surface of the ICRU sphere.  
 $\Omega$ : angle of incidence

3. For very penetrating radiation, a depth of 10mm is recommended, whilst for weakly penetrating radiation a depth of 0.07mm is recommended for the skin and of 3mm for the crystalline lens of the eyes.

**F) Effective dose relative to the exposure of adults (workers or members of the public) to inert gases**

Nuclide	$T_{1/2}$	Effective dose per unit of integrated concentration of air ( $Sv\ d^{-1}/Bq\ m^{-3}$ )
Argon		
Ar-37	35.0 d	$4.1\ 10^{-15}$
Ar-49	269 a	$1.1\ 10^{-11}$
Ar-41	1.83 h	$5.3\ 10^{-9}$
Krypton		
Kr-74	11.5 m	$4.5\ 10^{-9}$

\*\* To the effects of these calculations, the rest of the body is composed of the following tissues and organs: suprarenal glands, brain, superior large intestine, small intestine, kidney, muscles, pancreas, spleen, thymus and uterus. In the list, some organs are included, which may be irradiated in a selective manner. It is known that some of the organs in this list are susceptible of cancer induction. If subsequently, other tissues and organs are identified as having a significant risk of cancer induction, they shall be included in the table with a specific  $w_T$ , or in this additional list that includes the rest of the body. This list may also include other tissues or organs that are selectively irradiated.

\*\*\* In those exceptional cases where any one of the tissues or organs of the rest of the body should receive an equivalent dose greater than the highest dose of any of the twelve listed organs for which there is a specific weighting factor, a weighting factor of 0.025 shall be applied to such organs or tissues, and a weighting factor of 0.025 to the average dose in the remaining tissues and organs of the rest of the body, as defined previously.

Kr-76	14.8 h	$1.6 \cdot 10^{-9}$
Kr-77	74.7 m	$3.9 \cdot 10^{-9}$
Kr-79	1.46 d	$9.7 \cdot 10^{-10}$
Kr-81	$2.10 \cdot 10^5$ a	$2.1 \cdot 10^{-11}$
Kr-83m	1.83 h	$2.1 \cdot 10^{-13}$
Kr-85	10.7 a	$2.2 \cdot 10^{-11}$
Kr-85m	4.48 h	$5.9 \cdot 10^{-10}$
Kr-87	1.27 h	$3.4 \cdot 10^{-9}$
Kr-88	2.84 h	$8.4 \cdot 10^{-9}$
Xenon		
Xe-120	40.0 m	$1.5 \cdot 10^{-9}$
Xe-121	40.1 m	$7,5 \cdot 10^{-9}$
Xe-122	20.1 h	$1.9 \cdot 10^{-10}$
Xe-123	2.08 h	$2.4 \cdot 10^{-9}$
Xe-125	17.0 h	$9.3 \cdot 10^{-10}$
Xe-127	36.4 d	$9.7 \cdot 10^{-10}$
Xe-129m	8.0 d	$8.1 \cdot 10^{-11}$
Xe-131m	11.9 d	$3.2 \cdot 10^{-11}$
Xe-133m	2.19 d	$1.1 \cdot 10^{-10}$
Xe-133	5.24 d	$1.2 \cdot 10^{-10}$
Xe-135m	15.3 m	$1.6 \cdot 10^{-9}$
Xe-135	9.10 h	$9.6 \cdot 10^{-10}$
Xe-138	14.2 m	$4.7 \cdot 10^{-9}$

## ANNEX III

### Dose estimation for internal exposure

A) Unless otherwise provided, in all the Regulation the dose limits shall apply to the sum of the corresponding doses derived from external exposure in a determined period, and the corresponding dose commitment for fifty years (and up to seventy years for children) derived from the incorporations that have taken place in the same period. The specified period is indicated in Article 9 and 13, regarding dose limits.

In general, the effective dose  $E$  to which a person belonging to age group  $g$  shall be determined according to the following formula:

$$E = E_{\text{external}} + \sum_j h(g)_{j,\text{ing}} J_{j,\text{ing}} + \sum_j h(g)_{j,\text{inh}} J_{j,\text{inh}}$$

where  $E_{\text{external}}$  is the corresponding effective dose derived from external exposure;  $h(g)_{j,\text{ing}}$  and  $h(g)_{j,\text{inh}}$  represent the effective dose committed per unit of incorporation per radionuclide  $j$  (Sv/Bq) ingested or inhaled by a person belonging to age group  $g$ ;  $J_{j,\text{ing}}$  and  $J_{j,\text{inh}}$  respectively, represent the corresponding incorporation by ingestion or inhalation of the radionuclide  $j$ (Bq).

B) Excepting the daughter-products of radon and thoron, the values of the effective dose commitment per unit of incorporation by means of ingestion and inhalation regarding the public as a whole, as well as the persons in training and

students with ages comprised between sixteen and eighteen, are indicated in Tables A and B of this present Annex.

Except for the daughter-products of radon and thoron, the values of the effective dose commitment per unit of incorporation by means of ingestion and inhalation regarding exposed workers, persons in training and students older than eighteen years of age, are indicated in Table C of this present Annex.

Regarding the exposure of the public as a whole, Table A, includes for ingestion, values that correspond to different  $f_1$  factors, for small children and old people. Furthermore, as regards the exposure of the public as a whole, Table B includes, for inhalation, the relative values for different types of pulmonary retention with the corresponding  $f_1$  values for the component of the incorporation deposited in the gastro-intestinal tract. If data is available for the aforementioned parameters, the pertinent value shall be used, if not, the most restrictive value shall apply. As regards occupational exposure, Table C includes, for ingestion, the corresponding values to various  $f_1$  factors of intestinal transit, and for inhalation, the relative values for different types of pulmonary retention, with the pertinent  $f_1$  values, for the component of the incorporation deposited in the gastro-intestinal tract.

Table D presents  $f_1$  factors of intestinal transit per element and per compound, relative to workers, and when appropriate to the public in general, in cases of incorporation by means of ingestion. Table E presents  $f_1$  factors of intestinal transit, per element and per compound, regarding exposed workers, as well as persons in training and students older than eighteen years of age, for incorporation by means of inhalation.

For the public as a whole, the types of pulmonary absorption and the  $f_1$  factors of intestinal transit, shall include the chemical form of the element, according to the international guidelines that are applicable. In general, when there is no information available on these parameters, the most restrictive value shall apply.

C) Regarding the daughter-products of radon and thoron, the following effective dose per unit of potential alpha energy exposure (Sv per  $\text{Jhm}^{-3}$ ) conventional conversion factors shall apply:

Radon in the home: 1.1.

Radon in the workplace: 1.4.

Thoron in the workplace: 0.5.

Potential alpha energy (of the daughter-products of radon, and thoron): the total alpha energy finally emitted during the disintegration of the daughter-products of radon and thoron through the disintegration chain up to a  $^{210}\text{Pb}$  of the daughter-product of  $^{222}\text{Rn}$ , not inclusive, and a stable  $^{208}\text{Pb}$  of the daughter-product of  $^{220}\text{Rn}$ . The unit is the joule (J). In case of exposures to a specific concentration during a determined period, the unit is the  $\text{Jhm}^{-3}$ .

D) Tables:

- a) Coefficients of the ingestion dose for the public as a whole.
- b) Coefficients of the inhalation dose for the public as a whole.
- c) Coefficients of the ingestion and inhalation dose for workers.
- d)  $f_1$  values  $f_1$  for the calculation of the coefficients of the ingestion dose.
- e) Types of pulmonary absorption and of  $f_1$  values for the chemical forms of the elements in relation to the calculation of the coefficients of the inhalation dose.
- f) Effective dose commitment per unit of incorporation by inhalation ( $\text{Sv Bq}^{-1}$ ) of soluble or reactive gases and vapours.

TABLE A

Effective dose commitment per unit of incorporation by ingestion ( $\text{Sv Bq}^{-1}$ ) for members of the public

Nuclide/ Semi disintegration period/ Age ( $f_1$  for g)/ Age

"OBT": stands for, Organically Bound Tritium

Hydrogen  
 Tritiated water  
 OBT  
 Beryllium  
 Carbon  
 Fluorine  
 Sodium  
 Magnesium  
 Aluminium  
 Silicon  
 Phosphorus  
 Sulphur (inorganic/organic)  
 Chlorine  
 Potassium  
 Calcium [The value of  $f_1$  for persons between 1 and 15 years of age is of 0.4.]  
 Scandium  
 Titanium  
 Vanadium  
 Chromium  
 Manganese  
 Iron [The value of  $f_1$  for persons between 1 and 15 years of age is of 0.2.]  
 Cobalt [The value of  $f_1$  for persons between 1 and 15 years of age is of 0.3.]  
 Nickel  
 Copper  
 Zinc  
 Gallium  
 Germanium

Arsenic  
Selenium  
Bromine  
Rubidium  
Strontium [The value of  $f_1$  for persons between 1 and 15 years of age is of 0.4.]  
Yttrium  
Zirconium  
Niobium  
Molybdenum  
Technetium  
Ruthenium  
Rhodium  
Palladium  
Silver  
Cadmium  
Indium  
Tin  
Antimony  
Tellurium  
Iodine  
Caesium  
Barium [The value of  $f_1$  for persons between 1 and 15 years of age is of 0.3.]  
Lanthanum  
Cerium  
Praseodymium  
Neodymium  
Promethium  
Samarium  
Europium  
Gadolinium  
Terbium  
Dysprosium  
Holmium  
Erbium  
Thulium  
Ytterbium  
Lutetium  
Hafnium  
Tantalum  
Tungsten  
Rhenium  
Osmium  
Iridium  
Platinum  
Gold  
Mercury (organic/inorganic)  
Thallium  
Lead [The value of  $f_1$  for persons between 1 and 15 years of age is of 0.4.]  
Bismuth  
Polonium

Astatine  
 Francium  
 Radium [The value of  $f_1$  for persons between 1 and 15 years of age is of 0.3.]  
 Actinium  
 Thorium  
 Protactinium  
 Uranium  
 Neptunium  
 Plutonium  
 Americium  
 Curium  
 Berkelium  
 Californium  
 Einsteinium  
 Fermium  
 Mendeleevium

TABLE B

Effective dose commitment per unit of incorporation by inhalation ( $\text{Sv Bq}^{-1}$ ) for members of the public

Nuclide/ Semi disintegration period/ Age/ Age

"F" stands for rapid pulmonary exit

"M" stands for moderate pulmonary exit

"S" stands for slow pulmonary exit

Hydrogen  
 Tritiated water  
 Beryllium  
 Carbon  
 Fluorine  
 Sodium  
 Magnesium  
 Aluminium  
 Silicon  
 Phosphorus  
 Sulphur (inorganic)  
 Chlorine  
 Potassium  
 Calcium [The value of  $f_1$  for persons between 1 and 15 years of age, in type "F" is of 0.4.]  
 Scandium  
 Titanium  
 Vanadium  
 Chromium  
 Manganese  
 Iron [The value of  $f_1$  for persons between 1 and 15 years of age, in type "F" is of 0.2.]

Cobalt [The value of  $f_1$  for persons between 1 and 15 years of age, in type "F" is of 0.3.]

Nickel

Copper

Zinc

Gallium

Germanium

Arsenic

Selenium

Bromine

Rubidium

Strontium [The value of  $f_1$  for persons between 1 and 15 years of age, in type "F" is of 0.4.]

Yttrium

Zirconium

Niobium

Molybdenum

Technetium

Ruthenium

Rhodium

Palladium

Silver

Cadmium

Indium

Tin

Antimony

Tellurium

Iodine

Caesium

Barium [The value of  $f_1$  for persons between 1 and 15 years of age, in type "F" is of 0.3.]

Lanthanum

Cerium

Praseodymium

Neodymium

Promethium

Samarium

Europium

Gadolinium

Terbium

Dysprosium

Holmium

Erbium

Thulium

Ytterbium

Lutetium

Hafnium

Tantalum

Tungsten

Rhenium



Osmium  
 Iridium  
 Platinum  
 Gold  
 Mercury (organic/inorganic)  
 Thallium  
 Lead [The value of  $f_1$  for persons between 1 and 15 years of age, in type "F" is of 0.4.]  
 Bismuth  
 Polonium  
 Astatine  
 Francium  
 Radium [The value of  $f_1$  for persons between 1 and 15 years of age, in type "F" is of 0.3.]  
 Actinium  
 Thorium  
 Protactinium  
 Uranium  
 Neptunium  
 Plutonium  
 Americium  
 Curium  
 Berkelium  
 Californium  
 Einsteinium  
 Fermium  
 Mendeleevium

TABLE C.1  
 Effective dose coefficients ( $\text{Sv Bq}^{-1}$ )  
 Nuclide/ Semi disintegration period/ Installation (Type)/ Ingestion

"F" stands for rapid pulmonary exit  
 "M" stands for moderate pulmonary exit  
 "S" stands for slow pulmonary exit  
 "OBT": stands for, Organically Bound Tritium

Hydrogen  
 Tritiated water [Refer to the inhalation dose in Table C.2]  
 OBT [Refer to the inhalation dose in Table C.2]  
 Beryllium  
 Carbon [Refer to the inhalation dose in Table C.2]  
 Fluorine  
 Sodium  
 Magnesium  
 Aluminium  
 Silicon  
 Phosphorus  
 Sulphur (inorganic/organic) [Refer to the inhalation dose in Table C.2]  
 Chlorine

Potassium  
Calcium  
Scandium  
Titanium  
Vanadium  
Chromium  
Manganese  
Iron  
Cobalt  
Nickel  
Copper  
Zinc  
Gallium  
Germanium  
Arsenic  
Selenium  
Bromine  
Rubidium  
Strontium  
Yttrium  
Zirconium  
Niobium  
Molybdenum  
Technetium  
Ruthenium  
Rhodium  
Palladium  
Silver  
Cadmium  
Indium  
Tin  
Antimony  
Tellurium  
Iodine  
Caesium  
Barium  
Lanthanum  
Cerium  
Praseodymium  
Neodymium  
Promethium  
Samarium  
Europium  
Gadolinium  
Terbium  
Dysprosium  
Holmium  
Erbium  
Thulium  
Ytterbium

Lutetium  
Hafnium  
Tantalum  
Tungsten  
Rhenium  
Osmium  
Iridium  
Platinum  
Gold  
Mercury (organic/inorganic)  
Thallium  
Lead  
Bismuth  
Polonium  
Astatine  
Francium  
Radium  
Actinium  
Thorium  
Protactinium  
Uranium  
Neptunium  
Plutonium  
Americium  
Curium  
Berkelium  
Californium  
Einsteinium  
Fermium  
Mendelevium

TABLE C.2  
Effective dose coefficients of reactive or soluble gases

Nuclide/Chemical form  
Tritium gas  
Tritiated water  
Organically Bound Tritium  
Carbon vapour 11  
Carbon dioxide 11  
Carbon monoxide 11  
Carbon vapour 14  
Carbon dioxide 14  
Carbon monoxide 14  
Sulphur vapour 35  
Nickel carbonyl 56  
Nickel carbonyl 57  
Nickel carbonyl 59  
Nickel carbonyl 63

Nickel carbonyl 65  
 Nickel carbonyl 66  
 Iodine vapour 120  
 Iodine vapour 120m  
 Iodine vapour 121  
 Iodine vapour 123  
 Iodine vapour 124  
 Iodine vapour 125  
 Iodine vapour 126  
 Iodine vapour 128  
 Iodine vapour 129  
 Iodine vapour 130  
 Iodine vapour 131  
 Iodine vapour 132  
 Iodine vapour 132m  
 Iodine vapour 133  
 Iodine vapour 134  
 Iodine vapour 135  
 Mercury vapour 193  
 Mercury vapour 193m  
 Mercury vapour 194  
 Mercury vapour 195  
 Mercury vapour 195m  
 Mercury vapour 197  
 Mercury vapour 197m  
 Mercury vapour 199m  
 Mercury vapour 203

TABLE D

Compounds and  $f_1$  values used to calculate the ingestion dose coefficients

Element/  $f_1$ / Compounds

Hydrogen	Ingestion of tritiated water Organically Bound Tritium
Beryllium	All compounds
Carbon	Organically marked compounds
Fluorine	All compounds
Sodium	All compounds
Magnesium	All compounds
Aluminium	All compounds
Silicon	All compounds
Phosphorus	All compounds
Sulphur	Inorganic compounds Elemental sulphur Organic sulphur
Chlorine	All compounds
Potassium	All compounds
Calcium	All compounds
Scandium	All compounds
Titanium	All compounds

Vanadium	All compounds
Chromium	Hexavalent compounds Trivalent compounds
Manganese	All compounds
Iron	All compounds
Cobalt	Non specified compounds Oxides, hydroxides and inorganic compounds
Nickel	All compounds
Copper	All compounds
Zinc	All compounds
Gallium	All compounds
Germanium	All compounds
Arsenic	All compounds
Selenium	Non specified compounds Elemental selenium and selenides
Bromine	All compounds
Rubidium	All compounds
Strontium	Non specified compounds Strontium titanate (SrTiO <sub>3</sub> )
Yttrium	All compounds
Zirconium	All compounds
Niobium	All compounds
Molybdenum	Non specified compounds Molybdenum sulphide
Technetium	All compounds
Ruthenium	All compounds
Rhodium	All compounds
Palladium	All compounds
Silver	All compounds
Cadmium	All inorganic compounds
Indium	All compounds
Tin	All compounds
Antimony	All compounds
Tellurium	All compounds
Iodine	All compounds
Caesium	All compounds
Barium	All compounds
Lanthanum	All compounds
Cerium	All compounds
Praseodymium	All compounds
Neodymium	All compounds
Promethium	All compounds
Samarium	All compounds
Europium	All compounds
Gadolinium	All compounds
Terbium	All compounds
Dysprosium	All compounds
Holmium	All compounds
Erbium	All compounds
Thulium	All compounds

Ytterbium	All compounds
Lutetium	All compounds
Hafnium	All compounds
Tantalum	All compounds
Tungsten	Non specified compounds Tungstic acid
Rhenium	All compounds
Osmium	All compounds
Iridium	All compounds
Platinum	All compounds
Gold	All compounds
Mercury	All inorganic compounds
Mercury	Methylmercury Non specified organic compounds
Thallium	All compounds
Lead	All compounds
Bismuth	All compounds
Polonium	All compounds
Astatine	All compounds
Francium	All compounds
Radium	All compounds
Actinium	All compounds
Thorium	Non specified compounds Oxides and hydroxides
Protactinium	All compounds
Uranium	Non specified components The majority of tetravalent compounds, for example: $\text{UO}_2$ , $\text{U}_3\text{O}_8$ (⚠️), $\text{UF}_4$
Neptunium	All compounds
Plutonium	Non specified compounds Nitrates Insoluble oxides
Americium	All compounds
Curium	All compounds
Berkelium	All compounds
Californium	All compounds
Einsteinium	All compounds
Fermium	All compounds
Mendelevium	All compounds

TABLE E

Compounds, types of pulmonary absorption and  $f_1$  values used to calculate the coefficients of the inhalation dose

Element/ Type of absorption/  $f_1$ / Compounds

Beryllium	Non specific compounds Oxides, halogenides and nitrates
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Fluorine	Determined by means of combination cation Determined by means of combination cation Determined by means of combination cation
Sodium	All compounds
Magnesium	Non specific compounds Oxides, hydroxides, carbides, halogenides, and nitrates
Aluminium	Non specific compounds Oxides, hydroxides, carbides, halogenides, nitrates and metallic aluminium
Silicon	Non specific compounds Oxides, hydroxides, carbides, halogenides, and nitrates Silicium-alumina glass aerosol
Phosphorus	Non specific compounds Some phosphates: determined by means of combination cation
Sulphur	Sulphides and sulphates: determined by means of combination cation Elemental sulphur. Sulphides and sulphates: determined by means of combination cation
Chlorine	Determined by means of combination cation Determined by means of combination cation
Potassium	All compounds
Calcium	All compounds
Scandium	All compounds
Titanium	Non specific compounds Oxides, hydroxides, carbides, halogenides, and nitrates Strontium titanate (SrTiO <sub>3</sub> )
Vanadium	Non specific compounds Oxides, hydroxides, carbides, and halogenides
Chromium	Non specific compounds Halogenides and nitrates Oxides and hydroxides
Manganese	Non specific compounds Oxides, hydroxides, halogenides, and nitrates
Iron	Non specific compounds Oxides, hydroxides, and halogenides
Cobalt	Non specific compounds Oxides, hydroxides, carbides, and halogenides
Nickel	Non specific compounds Oxides, hydroxides, and carbides
Copper	Non specific inorganic compounds Sulphides, halogenides and nitrates Oxides and hydroxides
Zinc	All compounds
Gallium	Non specific compounds Oxides, hydroxides, carbides, halogenides, and nitrates
Germanium	Non specific compounds Oxides, sulphides and halogenides
Arsenic	All compounds
Selenium	Non specific inorganic compounds

Bromine	Elemental selenium, oxides, hydroxides and carbides Determined by means of combination cation Determined by means of combination cation
Rubidium	All compounds
Strontium	Non specific compounds Strontium titanate (SrTiO <sub>3</sub> )
Yttrium	Non specific compounds Oxides and hydroxides
Zirconium	Non specific compounds Oxides, hydroxides, halogenides, and nitrates Zirconium carbide
Niobium	Non specific compounds Oxides and hydroxides
Molybdenum	Non specific compounds Molybdenum sulphide, oxides and hydroxides
Technetium	Non specific compounds Oxides, hydroxides, halogenides, and nitrates
Ruthenium	Non specific compounds Halogenides Oxides and hydroxides
Rhodium	Non specific compounds Halogenides Oxides and hydroxides
Palladium	Non specific compounds Nitrates and halogenides Oxides and hydroxides
Silver	Non specific compounds and metallic silver Nitrates and sulphides Oxides, hydroxides and carbides
Cadmium	Non specific compounds Sulphides, halogenides and nitrates Oxides and hydroxides
Indium	Non specific compounds Oxides, hydroxides, halogenides and nitrates
Tin	Non specific compounds Tin phosphate, sulphides, oxides, hydroxides, halogenides and nitrates
Antimony	Non specific compounds Oxides, hydroxides, halogenides, sulphides, sulphates and nitrates
Tellurium	Non specific compounds Oxides, hydroxides and nitrates
Iodine	All compounds
Caesium	All compounds
Barium	All compounds
Lanthanum	Non specific compounds Oxides and hydroxides
Cerium	Non specific compounds Oxides, hydroxides and fluorides
Praseodymium	Non specific compounds



	Oxides, hydroxides, carbides and fluorides
Neodymium	Non specific compounds
	Oxides, hydroxides, carbides and fluorides
Promethium	Non specific compounds
	Oxides, hydroxides, carbides and fluorides
Samarium	All compounds
Europium	All compounds
Gadolinium	Non specific compounds
	Oxides, hydroxides and fluorides
Terbium	All compounds
Dysprosium	All compounds
Holmium	Non specific compounds
Erbium	All compounds
Thulium	All compounds
Ytterbium	Non specific compounds
	Oxides, hydroxides and fluorides
Lutetium	Non specific compounds
	Oxides, hydroxides and fluorides
Hafnium	Non specific compounds
	Oxides, hydroxides, halogenides, carbides and nitrates
Tantalum	Non specific compounds
	Elemental tantalum, oxides, hydroxides, halogenides, carbides and nitrates
Tungsten	All compounds
Rhenium	Non specific compounds
	Oxides, hydroxides, halogenides, and nitrates
Osmium	Non specific compounds
	Halogenides and nitrates
	Oxides and hydroxides
Iridium	Non specific compounds
	Metallic iridium, halogenides and nitrates
	Oxides and hydroxides
Platinum	All compounds
Gold	Non specific compounds
	Halogenides and nitrates
	Oxides and hydroxides
Mercury	Sulphates
	Oxides, hydroxides, halogenides, nitrates and sulphides
Mercury	All organic compounds
Thallium	All compounds
Lead	All compounds
Bismuth	Bismuth nitrate
	Non specific compounds
Polonium	Non specific compounds
	Oxides, hydroxides and nitrates
Astatine	Determined by means of combination cation
	Determined by means of combination cation
Francium	All compounds
Radium	All compounds
Actinium	Non specific compounds

	Halogenides and nitrates
	Oxides and hydroxides
Thorium	Non specific compounds
	Oxides and hydroxides
Protactinium	Non specific compounds
	Oxides and hydroxides
Uranium	The majority of hexavalent compounds, for example: UF <sub>6</sub> , UO <sub>2</sub> F <sub>2</sub> and UO <sub>2</sub> (NO <sub>3</sub> ) <sub>2</sub>
	Less soluble compounds, for example: UO <sub>3</sub> , UF <sub>2</sub> , UCl <sub>4</sub> and the majority of other hexavalent compounds
	Highly insoluble compounds, for example: UO <sub>2</sub> and U <sub>3</sub> O <sub>8</sub>
Neptunium	All compounds
Plutonium	Non specific compounds
	Insoluble compounds
Americium	All compounds
Curium	All compounds
Berkelium	All compounds
Californium	All compounds
Einsteinium	All compounds
Fermium	All compounds
Mendelevium	All compounds

TABLE F

Effective dose commitment per unit of incorporation by inhalation (Sv Bq<sup>-1</sup>) of soluble or reactive gases and vapours

Nuclide/ Semi disintegration period/ Absorption/ % of deposit/ Age

Tritiated water  
Elemental hydrogen  
Tritiated methane  
Organically Bound Tritium  
Carbon vapour - 11  
Carbon dioxide - 11  
Carbon monoxide - 11  
Carbon vapour - 14  
Carbon dioxide - 14  
Carbon monoxide - 14  
Carbon disulphide - 35  
Sulphur dioxide - 35  
Nickel carbonyl - 56  
Nickel carbonyl - 57  
Nickel carbonyl - 59  
Nickel carbonyl - 63  
Nickel carbonyl - 65  
Nickel carbonyl - 66  
Ruthenium tetroxide - 94  
Ruthenium tetroxide - 97  
Ruthenium tetroxide - 103

Ruthenium tetroxide - 105  
Ruthenium tetroxide - 106  
Tellurium vapour - 116  
Tellurium vapour - 121  
Tellurium vapour - 121m  
Tellurium vapour - 123  
Tellurium vapour - 123m  
Tellurium vapour - 125m  
Tellurium vapour - 127  
Tellurium vapour - 127m  
Tellurium vapour - 129  
Tellurium vapour - 129m  
Tellurium vapour - 131  
Tellurium vapour - 131m  
Tellurium vapour - 132  
Tellurium vapour - 133  
Tellurium vapour - 133m  
Tellurium vapour - 134  
Elemental iodine - 120  
Elemental iodine - 120m  
Elemental iodine - 121  
Elemental iodine - 123  
Elemental iodine - 124  
Elemental iodine - 125  
Elemental iodine - 126  
Elemental iodine - 128  
Elemental iodine - 129  
Elemental iodine - 130  
Elemental iodine - 131  
Elemental iodine - 132  
Elemental iodine - 132m  
Elemental iodine - 133  
Elemental iodine - 134  
Elemental iodine - 135  
Methyl iodide - 120  
Methyl iodide - 120m  
Methyl iodide - 121  
Methyl iodide - 123  
Methyl iodide - 124  
Methyl iodide - 125  
Methyl iodide - 126  
Methyl iodide - 128  
Methyl iodide - 129  
Methyl iodide - 130  
Methyl iodide - 131  
Methyl iodide - 132  
Methyl iodide - 132m  
Methyl iodide - 133  
Methyl iodide - 134  
Methyl iodide - 135

Mercury vapour - 193  
Mercury vapour - 193m  
Mercury vapour - 194  
Mercury vapour - 195  
Mercury vapour - 195m  
Mercury vapour - 197  
Mercury vapour - 197m  
Mercury vapour - 199m  
Mercury vapour - 203

- (1) V: Very rapid absorption.
- (2) Reference to section 5.6 of publication number 71 of the ICPR.
- (3) Deposit: 10%, 20%, 40% (bronchial, bronchiolar and alveolar-interstitial); average retention life: 1.7 days (publication number 68 of the ICPR).
- (4) Is applied both to workers as well as to adult members of the public.

## ANNEX IV

### Area signalling

1. The signalling of controlled areas and monitored areas shall be carried out according to what is established in norm UNE-73-302, and according to what is stipulated in this Annex.
2. The exposure risk shall be signalled by its international symbol, a "clover" surrounded by a rectangular border of the same colour as the symbol, and of the same width as the diameter of the inside circumference of the aforementioned symbol.
- 3) **Controlled areas:** In the controlled areas the aforementioned clover shall be green on a white background.
  - a) **Areas of limited stay:** In these areas the clover shall be yellow on a white background.
  - b) **Areas of regulated stay:** In these areas the clover shall be orange on a white background.
  - c) **Areas of forbidden access:** In these areas the clover shall be red on a white background.
4. **Monitored areas:** In the monitored areas the clover shall be blue-gray on a white background.
5. If in any of the areas there should only be external exposure risk, the general clover for the area shall be used surrounded by radial dots; if there is danger of contamination and the risk of external exposure were to be minor, the general clover for the area shall be used on a dotted background; if there were to be a

joint risk of contamination and exposure, the general clover for the area shall be used with a border of radial dots on a dotted background.

6. All the signs that correspond to controlled areas, areas of limited stay, areas of regulated stay, and areas of forbidden access, as well as the monitored areas shall be placed in a very visible manner at their entrance and in the significant sites of the areas.

7. For all types of zones, the aforementioned signals shall be complemented by text that indicates the type of area in question, which shall be placed above the sign, whereas underneath the sign, the type of risk shall be indicated.

8. When the outer limits of an area must be signalled temporarily, fences, articulated metal bars or supports through which ropes, chains, tape, etc. may be attached, shall be placed, in the colour that corresponds to the area in question.

9. In the access areas to contiguous areas of different characteristics, the corresponding limits may be signalled on the floor by means of clearly visible lines in the colours that correspond to the areas in question. This aforementioned signalling may be complemented with lighting effects in the appropriate colours for each area.

10. Within the controlled areas and the monitored areas the sources must be signalled.