Nuclear Science and Technology

Environmental Radioactivity in the European Community

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I. INTRODUCTION

A. General

This report presents a summary of the available data on levels of radioactivity in some environmental media in the European Union (EU) Member States for the years 2002-2003. These data are obtained from official reports published by the responsible authorities and from data transmitted directly to the Commission by the national authorities and from individual laboratories. Member States provide environmental radioactivity data to the EU to comply with Articles 35 and 36 of the Euratom Treaty (see Appendix A). Continuous or semi-continuous monitoring of air and water is undertaken in Member States. Monitoring of food products, such as milk or mixed diet is considered an acceptable surrogate for the Article 35 requirement to monitor soil.

Individual monitoring laboratories tend to retain measurement techniques that have proven reliable over the years and are of sufficient sensitivity for radiological protection purposes. Measurement techniques, and thus measurement sensitivities, may, therefore, vary between laboratories and countries. This can make the interpretation and comparison of data across Europe difficult.

In order to facilitate the presentation of the results, it has been agreed to use uniform reporting levels as a benchmark. If the results for a certain sample type – radionuclide combination are above their corresponding reporting level (RL), then the measured values are stated in this report. Otherwise they are reported as "< RL".

Radiation in the environment comes from space, from the earth, from air, from water, food and other natural sources. It also comes from radioactive waste, consumer products, atmospheric nuclear weapons testing and other artificial sources. Ionising radiation from natural and artificial sources do not differ in kind or effect on humans. The world average effective dose from all sources of radiation is 2.8 millisievert (mSv) per year. Across the Member States of the European Community the annual effective dose for members of the public from natural sources range from just below 2 mSv to above 7 mSv. The reporting levels used in this report were derived such that they would indicate a resultant effective dose value of 1/1000th of a mSv (0.001 mSv).

It must be emphasised that the reporting levels are only meant to be a tool for presenting data and should not be confused with maximum permitted levels of radioactive contamination.

In normal circumstances, variations in time and space for the data from the many sampling locations which are distributed all over the Member States' territories (referred to as the "**dense network**") are gradual. For this reason

daily, weekly or even monthly variations per sample location are not of radiological significance. The data are therefore presented as regional averages (Table 1) except for surface water where on single sample locations is reported.

Although most values are below reporting levels, it is valuable to present the actual concentrations for a small number of locations. This allows any trends in radionuclide concentrations to be monitored over time. To achieve this, a number of representative locations were selected, this is referred to as the "**sparse network**". High sensitivity measurements are performed at these locations and the individual results are presented graphically.

As in the previous report [1], with the exception of caesium-137 (^{137}Cs) in airborne particulates and surface water for the dense network, the following combinations of sample and radionuclide categories are reported:

Sampling media	Radionuclide categories	
	Dense network	Sparse network
airborne particulates	gross ß	^{7}Be ^{137}Cs
surface water	residual ß ^{137}Cs	^{137}Cs
drinking water	^{3}H ^{90}Sr ^{137}Cs	^{3}H ^{90}Sr ^{137}Cs
milk	^{90}Sr ^{137}Cs	^{90}Sr ^{137}Cs
mixed diet	^{90}Sr ^{137}Cs	^{90}Sr ^{137}Cs

However, not all of the above combinations of sample and nuclide type are routinely monitored by each Member State.

Every effort has been made to collect all the available data, thus, most of the blank entries correspond to the absence of measurements. In some cases the available results may have not been received.

All the radionuclides sampled, except strontium-90 (^{90}Sr) and ^{137}Cs, can be of either natural or artificial origin. The two exceptions are of artificial origin, mainly from past atmospheric weapons testing and from radioactive routine or accidental discharges from nuclear facilities.

The sampling locations incorporated in this report are intended to be as representative as possible of regional or national situations. However, while measurements local to and possibly influenced by nuclear installations have been discounted wherever practical, in certain cases national data are strongly dependent on such monitoring programmes.

B. Structure of the report

This report is composed of three main parts:

The **text part** consists of a general introduction followed by one chapter for each medium; this includes general information on the sample type, the occurrence of natural radionuclides therein, a description of sample preparation and analysis and a short discussion of the results.

The **results** are presented by sample and nuclide type, sample types are identified with appropriate symbols. All data from the dense network is presented, followed by that from the sparse network.

- The dense network results are presented graphically (with the exception of surface water as this sample type does not allow for geographical presentation) and in tabular form. The graphical representation illustrates the annual average radioactivity concentrations for each geographical region (see Section C). Four shades are used to indicate the concentrations on a scale ranging from less than the reporting level to ten times the reporting level. In addition, each sampling location is illustrated. Next to the graphical representation the results are presented in tabular form. These results are averaged over geographical regions and over a particular time period (quarter, semester or whole year, depending on the availability of data). The total number of sampling locations and the number of measurements used to calculate the annual averages are given for each geographical region. In addition, the monthly maximum and the month in which this occurred are given for those values above the appropriate reporting level.
- The results for the sparse network are preceded by a map illustrating the sampling locations. The data are presented as time versus activity concentration graphs from 1984 onwards (where the data is available). Between one and three nearby locations are illustrated on each graph. The appropriate reporting level is indicated by a horizontal line. The choice of 1984 as a start date enables the pulse of radioactivity which entered the environment of the EU from the 1986 Chernobyl accident in the Ukraine to be seen clearly.

The **appendices** to this report provide additional information on the Euratom Treaty, the calculation of reporting levels, the averaging procedures used, the data sources, the bibliography and information about the REM data bank. The addresses of the national authorities and laboratories are given in Appendix D, while the national reports of environmental monitoring data are given in Appendix E. All data presented in this report are also stored in the REM data bank, at the JRC-Ispra, Italy, which may be accessed remotely by authorised users (see Appendix F).

Finally, and with the aim of enlarging the readership of this report, a glossary provides background information on frequently used terms in radiation protection.

C. Geographical divisions

For the larger Member States the data is divided according to geographical divisions. The partitioning of Germany, Finland, France, Italy, Spain, Sweden and the United Kingdom has been based on administrative regions (Table 1) and results in a total of 31 geographical divisions of the EU (Figure 1).

II. AIRBORNE PARTICULATES

Airborne radioactive materials may occur in either gaseous or particulate form. In general, the latter is of greater potential radiological significance because it may be deposited and hence remain in the local environment. Consequently, most national routine monitoring networks measure only the particulate component. Atmospheric radioactivity is dominated by the naturally occurring, short-lived particulate decay products of gaseous radon (Rn = 1 to 20 Bq m^{-3} in outdoor air). Measurements of "total beta" radioactivity in airborne particulates must allow for this naturally occurring radioactivity. Other naturally occurring radionuclides measured in airborne particulates include beryllium-7 (^{7}Be) and potassium-40 (^{40}K).

Airborne particulate **sampling** is carried out by pumping air through filters at a flow rate of several hundred cubic meters per day. In most countries filters are changed daily and analysed for total beta activity following the decay of radon decay products. Individual radionuclide analyses are performed weekly, monthly or quarterly. Man-made alpha-emitting aerosols are rarely measured by routine monitoring networks as they are usually undetectable, even close to the nuclear installations where they are produced. Therefore, these measurements are not presented in this report. The sampling locations in the EU for gross beta, ^{7}Be and ^{137}Cs, considered in this report, are illustrated on the maps in figs. A1 and A2, respectively.

Minimal **treatment** of the airfilters is required, on the whole, they are measured directly or they may be ashed or compressed to improve the counting geometry and hence counting efficiency.

III. SURFACE WATER

Surface water is one of the compartments into which authorised discharges of radioactive effluents from nuclear installations are made. Radionuclides in surface waters can be found in the water phase or associated with suspended particles and can eventually become incorporated into sediments and living species. Natural radionuclides in river water include ^{3}H at levels of 0.02 - 0.1 Bq l^{-1}, ^{40}K (0.04 - 2 Bq l^{-1}), radium, radon and their short-lived decay products (< 0.4 - 2 Bq l-1). The main fraction of tritium (^{3}H) in surface water however is due to man's activities.

Samples are either taken continuously and bulked for monthly or quarterly analysis, or alternatively, spot samples are taken periodically several times a year and analysed individually. Some laboratories remove suspended material from the water sample for separate analysis.

Treatment of the water may consist of filtration or evaporation (for direct measurement of the residue), ion-exchange and subsequent washing of the ion exchange column. More elaborate chemical separation techniques are used to determine radionuclides such as strontium-90 (^{90}Sr). To determine ^{3}H concentrations, generally the water is multiple distilled.

IV. DRINKING WATER

Drinking water is monitored because of its vital importance for man, even though a severe radioactive contamination of this medium is rather improbable. The most important natural radionuclides in drinking water are ^{3}H (0.02 - 0.4 Bq l^{-1}), ^{40}K (typically 0.2 Bq l^{-1} but varies greatly), radium, radon and their short-lived decay products (0.4 - 4.0 Bq l^{-1}). Occasionally, the presence of ^{3}H and radium may also be due to man's activities.

Samples may be taken from ground or surface water supplies, from water distribution networks, mineral waters etc. Spot samples are taken a few times a year and analysed individually or samples are taken daily and bulked for monthly or quarterly analysis.

Sample **treatment** usually consists of sample evaporation for direct measurement of the concentrate or separation on ion-exchange columns. More elaborate chemical separations are required for ^{90}Sr determination, whereas ^{3}H is generally measured following multiple distillation of the sample.

V. MILK

Consumption of milk and dairy products has been shown to be one of the most important pathways for uptake of radionuclides from environment to man.

Samples are mostly taken at dairies covering large geographical areas in order to obtain representative samples. They are generally taken on a monthly basis; but sometimes only during the pasture season. The samples may be analysed separately or bulked for regional or national average evaluations.

Treatment usually consists of drying the sample for gamma spectroscopic analysis and chemical separation for ^{90}Sr.

VI. MIXED DIET

The aim of measuring radioactivity in mixed diet is to get "integral" information on the uptake of radionuclides by man via the foodchain. Rather than expressing the radioactivity content of foodstuffs per unit weight, it is more appropriate to estimate the activity consumed per day per person (Bq d^{-1} p^{-1}). An important natural radionuclide is ^{40}K (typically 100 Bq d^{-1} p^{-1}).

Foodstuffs can be measured as separate ingredients. However, due to differences in the composition of national diets, the trend is to sample complete meals to give a representative figure for the contamination of mixed diet. Nevertheless knowledge of the contamination of the individual ingredients together with the composition of the national diet can also lead to a representative figure.

Samples are taken as ingredients or as complete meals, mostly at places where many meals are consumed (i.e. factory restaurants, schools).

Treatment usually consists of mixing the sample prior to gamma spectroscopic measurement of ^{137}Cs and chemical separation to determine the ^{90}Sr activity.

Figure 1: Definition of the geographical regions used to present the dense network results throughout this report.

Table 1: Definition of country partitions. Country codes according to ISO 3166/4217.

Country	Short description	Detailed description
AT	Austria	
BE	Belgium	
DE-N	Germany-North	Bremen, Hamburg, Mecklenburg-Vorpommern, Niedersachsen and Schleswig-Holstein
DE-C	Germany-Central	Hessen, Nordrhein-Westfalen, Rheinland-Pfalz and Saarland
DE-S	Germany-South	Baden-Württemberg and Bayern
DE-E	Germany-East	Berlin, Brandenburg, Sachsen, Sachsen-Anhalt and Thüringen
DK	Denmark	
ES-N	Spain-North	Aragon, Asturias, Cantabria, Galicia, Navarra, Pais Vasco and Rioja
ES-C	Spain-Central	Castilla - La Mancha, Castilla - Leon, Extramadura and Madrid
ES-S	Spain-South	Andalucia, Canarias, Ceuta y Melilla and Murcia
ES-E	Spain-East	Baleares, Cataluña and C. Valenciana
FI-N	Finland-North	Lapland and Oulu
FI-S	Finland-South	Western Finland,Eastern Finland and Southern Finland
FR-NW	France-Northwest	Bretagne, Centre, Ile de France, Nord-Pas-de-Calais, Haute Normandie, Basse Normandie, Pays de la Loire and Picardie
FR-NE	France-Northeast	Alsace, Bourgogne, Champagne-Ardennes, Franche-Comté and Lorraine
FR-SW	France-Southwest	Aquitaine, Languedoc-Roussillon, Limousin, Midi-Pyrénées and Poitou-Charentes
FR-SE	France-Southeast	Auvergne, Corse, Provence-Alpes-Côte-d'Azur and Rhône-Alpes
GB-EN	United Kingdom England	
GB-WL	United Kingdom Wales	
GB-SC	United Kingdom Scotland	
GB-NI	United Kingdom Northern Ireland	
GR	Greece	
IE	Ireland	
IT-N	Italy-North	Emilia-Romagna, Friuli-Venezia-Giulia, Liguria, Lombardia, Piemonte, Trentino-Alto Adige, Val d'Aosta and Veneto
IT-C	Italy-Central	Abruzzi, Lazio, Marche, Molise, Toscana and Umbria
IT-S	Italy-South	Basilicata, Calabria, Campania, Puglia, Sardegna and Sicilia
LU	Luxembourg	
NL	the Netherlands	
PT	Portugal	
SE-N	Sweden-North	Övre Norrland and Mellersta Norrland
SE-S	Sweden-South	Stockholm, Östra Mellansverige, Sydsverige, Norra Mellansverige, Småland med öarna and Västsverige

Annex 1

Origins and contents of Articles 35 and 36

The treaty establishing the European Atomic Energy Community (EURATOM) was signed in Rome on 25 March 1957. Title 2 of the Euratom Treaty sets out provisions for the encouragement of progress in the fields of nuclear energy.

Chapter III of Title 2 deals with Health and Safety matters.

Article 35 states: "Each Member State shall establish the facilities necessary to carry out continuous monitoring of the levels of radioactivity in the air, water and soil and to ensure compliance with the basic standards. The Community shall have the right of access to such facilities so that it may verify their operation and efficiency".

Article 36 states: "The appropriate authorities shall periodically communicate information on the checks referred to in Article 35 to the Community so that it is kept informed of the level of radioactivity to which the public is exposed".

The Commission Recommendations to Article 36 of the Euratom Treaty (2000/473/Euratom)

In addition to articles 35 and 36 of the Euratom Treaty, a Commission Recommendation (2000/473/Euratom) has been published (OJ L191 of 27.7.2000) in view of providing more detailed information on which sample types and radionuclide categories EU Member States should report to the Commission. In addition, more practical information is provided on recommended procedures and the time frame in which this data transfer has to be done.

The Commission Recommendation provides supplementary information on the sampling locations and of the recommended sample types and radionuclide categories on which information should be transmitted. This is summarised in the two tables below.

Sample type	Sampling locations	Additional information requested
Airborne particulates	Vicinity of dense populated areas ensuring adequate geographical coverage	
External ambient gamma dose-rate		
Surface water	Major inland waters at places for which flow rate information is avalable and, if relevant, from coastal waters	Average flow rate during which the sample was taken
Drinking water	Compliant with the drinking water directive (98/83/EC) Major ground or surface water supplies and for water distribution networks	Annual water volume distributed or produced
Milk	Dairies, sufficiently spread to ensure a representative average	Production rate
Mixed diet	Separate ingredients from market places or local distribution centres	Composition of mixed diet
	Complete meals from large consumption centres (canteens, restaurants,...)	

Media	Measurement category	
	Dense network	**Sparse network**
Airborne particulates	^{137}Cs, gross beta	^{137}Cs, ^{7}Be
Air	Ambient gamma dose rate	Ambient gamma dose rate
Surface water	^{137}Cs, residual beta	^{137}Cs
Drinking water	^{3}H, ^{90}Sr, ^{137}Cs Natural radionuclides as monitored in compliance with Council Directive 98/83/EC	^{3}H, ^{90}Sr, ^{137}Cs Natural radionuclides as monitored in compliance with Council Directive 98/83/EC
Milk	^{90}Sr, ^{137}Cs	^{90}Sr, ^{137}Cs, ^{40}K
Mixed diet	^{90}Sr, ^{137}Cs	^{90}Sr, ^{137}Cs, ^{14}C

Annex 2

Method for calculating the reporting levels

Reporting levels were used in the report with the aim to improve transparency when bringing together measurements as significant values and as constraint values. Uniform constraint levels have been defined on the basis of their significance from the health point of view, irrespective of the detection limits applied by the different laboratories. Although the calculation is based on a reference annual dose, it needs to be emphasized that the reporting levels are only meant to be a tool for transparent reporting and should not be confused with maximum permitted levels of radioactive contamination. The reporting level RL is derived as:

$$RL = \frac{DL}{RF \cdot EDC \cdot CF} \qquad (1)$$

where: DL = annual dose limit, taken to be 1 milli-sievert [1]
RF = reduction factor of the dose limit, taken to 1000
EDC = effective dose coefficient in Sv/Bq
CF = annual consumption per person

The basic annual dose limit for the public equals 1 millisievert. This limit, decreased by a factor of thousand, i.e. 1 microsievert, can be regarded as having no radiological significance. Using a nominal probability coefficient of stochastic effects for the whole population of 5.10^{-2} per sievert [1], taking only fatal cancers into consideration, this dose represents a radiological risk of 5.10^{-8} per year.

Reporting levels are introduced only for artificial radionuclides (^{3}H, ^{90}Sr and ^{137}Cs). The actual level for natural radionuclides (^{7}Be) is indicated in the sparse network graphs. The values for the effective dose coefficient (values for adults were considered), the annual consumption and the rounded values of the reporting levels obtained by applying equation 1 are given in the table below.

[1] ICRP publication 60: 1990 Recommendations of the ICRP, Pergamon Press (1991)

[2] Basic Safety Standards (96/29/Euratom, Tables A and B)

[3] ICRP publication 23: Reference man: Anatomical, Physiological and Metabolic Characteristics, Pergamon Press (1975)

[4] Commission of the European Communities, Post-Chernobyl Action 5, Underlying data for Derived Intervention Levels, EUR 12553 (1990)

Sample type	Radionuclide category	EDC [2] (Sv/Bq)	Annual consumption	Reporting level (rounded values)
Air	gross ß (based on ^{90}Sr)	$2.4\ 10^{-8}$	8030 m^3 [3]	5.10^{-3} Bq m^{-3}
	^{137}Cs	$4.6\ 10^{-9}$	8030 m^3 [3]	3.10^{-2} Bq m^{-3}
Surface water	residual ß (based on ^{90}Sr)	$2.8\ 10^{-8}$	60 l *	6.10^{-1} Bq l^{-1}
	^{137}Cs	$1.3\ 10^{-8}$	60 l *	1.10^{0} Bq l^{-1}
Drinking water	^{3}H	$1.8\ 10^{-11}$	600 l [4]	1.10^{+2} Bq l^{-1}
	^{90}Sr	$2.8\ 10^{-8}$	600 l [4]	6.10^{-2} Bq l^{-1}
	^{137}Cs	$1.3\ 10^{-8}$	600 l [4]	1.10^{-1} Bq l^{-1}
Milk	^{90}Sr	$2.8\ 10^{-8}$	200 l [4]	2.10^{-1} Bq l^{-1}
	^{137}Cs	$1.3\ 10^{-8}$	200 l [4]	5.10^{-1} Bq l^{-1}
Mixed diet	^{90}Sr	$2.8\ 10^{-8}$	365 d	1.10^{-1} Bq d^{-1} p^{-1}
	^{137}Cs	$1.3\ 10^{-8}$	365 d	2.10^{-1} Bq d^{-1} p^{-1}

* assumed to 10% of the annual drinking water consumption

Annex 3

Methods for calculating time and geographical averages

Throughout the report average values were calculated as arithmetic averages with the calculating methods described below.

Air [Bq/m^3]

The average concentration A over a period T and within a geographical area G is calculated as follows:

$$\overline{A} = \frac{1}{N_l} \sum_{l=1}^{N_l} \left(\frac{\sum_{i=1}^{N_{ml}} a_{i,l} \Delta t_{i,l}}{\sum_{i=1}^{N_{ml}} \Delta t_{i,l}} \right) \qquad (1)$$

where: $a_{i,l}$ = the value of the i-th measurement with duration $\Delta t_{i,l}$ at location l within G
N_l = the number of locations within G
N_{ml} = number of measurements at location l during T

Surface water [Bq/l]

Only time averages for specific locations over a period T are taken. The following formula is used:

$$\overline{S} = \frac{1}{N_m} \sum_{i=1}^{N_m} s_i \qquad (2)$$

where: s_i = value of the i-th measurement
N_m = number of measurements during T

Drinking water and milk [Bq/l]

The average drinking water concentration W, respectively milk concentration M, over a period of time T and within a geographical area G is calculated as follows:

$$\overline{W} = \frac{1}{N_l} \sum_{l=1}^{N_l} \left(\frac{\sum_{i=1}^{N_{ml}} w_{i,l} \Delta t_{i,l}}{\sum_{i=1}^{N_{ml}} \Delta t_{i,l}} \right) \text{ or } \overline{M} = \frac{1}{N_l} \sum_{l=1}^{N_l} \left(\frac{\sum_{i=1}^{N_{ml}} m_{i,l} \Delta t_{i,l}}{\sum_{i=1}^{N_{ml}} \Delta t_{i,l}} \right) \qquad (3)$$

where $w_{i,l}$ = value of the i-th drinking water measurement performed at location l within G
$m_{i,l}$ = value of the i-th milk measurement performed at location l within G
N_l = number of locations within G
N_{ml} = number of measurements at location l during T

Mixed diet [Bq/d.p]

The average mixed diet concentration D over a period of time T and within a geographical area G is calculated as follows:

$$\overline{D} = \frac{1}{N_l} \sum_{l=1}^{N_l} \left(\frac{\sum_{i=1}^{N_{ml}} d_{i,l} \Delta t_{i,l}}{\sum_{i=1}^{N_{ml}} \Delta t_{i,l}} \right) \qquad (4)$$

where: $d_{i,l}$ = the value of the i-th measurement with duration $\Delta t_{i,l}$ at location l within G
N_l = the number of locations within G
N_{ml} = number of measurements at location l during T

Comments

In this report the basic period T is taken to be one month. Quarterly averages were obtained by averaging the corresponding monthly averages. When the available data do not allow the calculation of quarterly averages, semestrial or annual averages are taken.

In most cases data are taken from national reports where, very often, time or space averages are already given. Hence the quantities a, s, w, m and d are sometimes averages themselves, and the calculated averages A, S, W, M and D may only be an approximation of the true average values.

Since the number of measurements per month or region is not always the same, to avoid untoward biases, quarterly and annual regional averages are taken as the mean of the corresponding monthly and quarterly averages respectively. National averages are obtained in the same way starting from the mean of the corresponding monthly regional averages.

Annex 4

The REM Data bank

After the accident at Chernobyl, a task Force was created by the relevant Directorates of the Commission of the European Commission (CEC) to re-examine all aspects of nuclear safety. The necessity of interpreting a large number of data on environmental radioactivity led to the creation of the REM (Radioactivity Environmental Monitoring) data bank at the CEC Joint Research Centre, Ispra in Italy for holding data on the contamination resulting from the Chernobyl accident.

At a meeting with Member State representatives for the purposes of Articles 35 and 36 of the Euratom Treaty (Luxembourg, October 1987), it was decided to take advantage of the informatic structure of the REM data bank to streamline the various formats adopted in the EU for reporting routine environmental measurements and to prepare the CEC report concerning these data in a more systematic way.

The information in REM largely concerns radioactivity levels in Europe of air, deposition, water, milk, meat, crops and vegetables for the period 1.1.1984 and is continuously being updated. Each data record contains information describing the sample measurement (value, nuclide, etc.), the sample type, location and date of sampling and source of the data.

REM makes use of the relational data base management system Oracle and is implemented on a an Dell PE6600 server at the Environment Institute of the Joint Research Centre at Ispra. The bank currently contains more than 2,000,000 data records.

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Glossary

ABSORBED DOSE The amount of energy imparted by the ionising radiation to unit mass of absorbing material. It is expressed in gray, Gy. (1 Gy = 1 Joule per kilogram).

ACTIVITY The amount of a radionuclide at a given time. It expresses the rate at which radioactive transformations occur. The unit of measurement is the becquerel, Bq. (1 Bq = one transformation per second).

ALPHA PARTICLE A particle, consisting of two protons and two neutrons, which is emitted from the nucleus of certain radionuclides.

ATOM The smallest portion of an element that can combine chemically with other atoms.

BECQUEREL see Activity.

BETA PARTICLE High energy electron which is emitted from the nucleus of certain radionuclides.

COSMIC RAYS High energy ionising radiation from outer space.

DOSE The term used either for individual absorbed dose or effective dose.

DOSE LIMIT Recommended by the ICRP and authorised by regulatory authorities to apply to occupational and public exposure.

EFFECTIVE DOSE Weighted sum of the equivalent doses to the various organs or tissues. The weighing factors are derived from the risk of stochastic effect to the individual tissue or organ. The unit of measurement is the sievert, Sv.

ENVIRONMENTAL MONITORING The application of automatic or mobile equipment to measure the activity in the environment of a release of radioactivity. The parameters usually include the activity of air, ground deposition, river water, drinking water and milk.

EQUIVALENT DOSE The quantity obtained by multiplying the absorbed dose by a factor to take into account the relative harmfulness of the various types of ionising radiations. The unit is the sievert, Sv. One sievert produces the same biological effect irrespective of the type of radiation.

GAMMA RAY A quantity of ionising electromagnetic radiation which is emitted by a certain radionuclide.

GRAY See Absorbed Dose.

GROSS BETA The total measured beta activity in a sample. Depending on the measurement methodology it may exclude tritium and/or radon.

HALF-LIFE The time taken for the activity of a radionuclide to lose half of its value by decay. Also referred to as “physical half-life”.

ICRP The International Commission on Radiological Protection is a non-governmental scientific organisation which publishes recommendations on radiation protection.

IONISING RADIATION Radiation which has sufficient energy to produce ionisation in matter; includes alpha particles, beta particles, gamma rays, X-rays and neutrons (neutrons cause ionisation indirectly).

ISOTOPE Nuclides of the same element but with different number of neutrons.

NATURAL BACKGROUND The radiation field due to naturally occurring radioactivity. It includes radiation arising from the presence of long-lived radionuclides and their daughters in the earth’s crust, atmosphere and cosmic radiation.

NEUTRON An elementary particle with no electric charge which combines with protons to form an atomic nucleus.

PROTON An elementary particle with positive electric charge. The amount of protons in an atomic nucleus determines the chemical element.

RADIOACTIVE CONTAMINATION The undesirable presence of unsealed radioactive materials on surfaces, in air or in water.

RADIOACTIVE DECAY The decay of a radionuclide by the spontaneous transformation of the nuclides, at a rate represented by the half-life. The rate is expressed as the activity in becquerel, Bq, indicating the number of transformations per second.

RADIONUCLIDE A species of atom characterised by the number of protons and neutrons (and sometimes by the energy state of the nucleus), and which emits ionising radiation. It is described by the element and the total amount of protons and neutrons (eg caesium-137).

RADON A naturally occurring radioactive element and the heaviest noble gas. Radon-222 and Radon-220 (also called thoron) are the most important isotopes.

RESIDUAL BETA Gross beta activity minus potassium-40 (^{40}K), which is the major natural beta emitting component in surface water.

SIEVERT See equivalent Dose and Effective Dose.