Environmental Radioactivity in the European Community 1995

DG ENV: Environment and Health, Radiation Protection (Luxembourg)
DG JRC, Institute for Environment and Sustainability (Ispra)
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PREFACE

Under the terms of Article 36 of the Euratom Treaty, Member States shall periodically communicate to the Commission information on environmental radioactivity levels. Compilations of the information received have been published by the Commission as a series of reports beginning in the early 1960s; the current report is the 29th in the series and covers the year 1995.

This report continues the attempt to improve the clarity of presentation of information on low levels of radioactivity in the European environment by making use of standardised reporting levels, updated for the latest Basic Safety Standard values. These reporting levels are supported by presenting more detailed values of radioactivity levels from a limited number of stations that provide high sensitivity measurements.

All of the environmental radioactivity results received from the Member States have been introduced into the REM data-bank by the Environment Institute of the EC Joint Research Centre (JRC) at Ispra (Italy) as part of its DG ENV support programme. The JRC collated, checked and loaded the data, prepared the tabulations and figures as appropriate and provided the draft of the report. I would like to express my gratitude for the JRC's assistance and also for the co-operation provided by the national authorities who supplied the original data.

This report is addressed to all who are concerned with environmental radiation protection.

S. Kaiser
Acting Director
Environment and Health
DG ENV.C
En vertu des dispositions de l’article 36 du Traité Euratom, les Etats Membres sont tenus de communiquer périodiquement à la Commission des informations sur la radioactivité dans l’environnement. La compilation de l’information obtenue a été publiée par la Commission sous forme d’une série de rapports dont le premier date du début des années 60. Le présent rapport est le 29ème et traite de l’année 1995.

Comme précédemment ce rapport vise à améliorer la clarté de la présentation des informations relatives aux faibles niveaux de radioactivité dans l’environnement Européen en employant des niveaux de notification généraux. Ceux-ci sont confirmés et complétés par la présentation de valeurs d'activité plus détaillées provenant d'un nombre limité de stations de mesures réa-lisant des mesures de sensibilité élevée.

Tous les résultats de mesures de la radioactivité dans l’environnement, reçus des Etats Membres, ont été introduits dans la banque de données REM par l’Institut de l’Environnement du Centre Commun de Recherche (CCR) de l'UE à Ispra (Italie) dans le cadre du programme de support à la DG ENV. Le CCR a collecté, comparé et introduit les données, préparé les tableaux et figu-res et édité le projet du rapport. Je souhaite exprimer toute ma reconnaissance envers le CCR pour l’assistance apportée ainsi qu’envers les autorités nationales ayant coopéré à l’ap- port des données.

Le présent rapport est adressé à toutes les personnes concernées par les aspects environnementaux de la radioprotection.

S. Kaiser
Directeur f.f.
Environnement et Santé
DG ENV.C

Auch in diesem Bericht werden zwecks größere Klarheit bei der Darstellung der niedrigen Umwelt-Radioaktivitätswerte in Europa einheitliche Berichtsgrenzen (reporting levels) verwendet. Detaillierte Aktivitätswerte von ausgewählten Meßstationen, bei denen hochempfindliche Messungen durchgeführt werden, dienen als Ergänzung und Bestätigung.

Alle aus den Mitgliedstaaten eingegangenen Umweltradioaktivitätswerte wurden durch das Umweltinstitut der Gemeinsamen Forschungsstelle der Europäischen Union (GFS, JRC) in Ispra im Rahmen ihres Unterstützungsprogramms für die GD ENV in die REM-Datenbank aufgenommen. Die GFS hat die Daten zueinander gestellt, geprüft und eingegeben, die Tabellen und Abbildungen aufbereitet sowie den Entwurf zu diesem Bericht erstellt. Ich danke der GFS für ihre Unterstützung und den nationalen Behörden, die Originaldaten geliefert haben, für ihre Mitarbeit.

Der Bericht richtet sich an alle, die sich mit Umweltaspekten im Strahlenschutz befassen.

S. Kaiser
Direktor a.i.
Umwelt und Gesundheit
GD ENV,C
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I. INTRODUCTION

A. General

This report presents a summary of the available data on levels of radioactivity in the European Union (EU) Member States for the year 1995. 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”. The reporting levels were derived on the basis of an effective dose: values below reporting level are considered to lead to an annual dose less than 1/2,000th of the natural background (see Appendix B for the calculation of the reporting levels).

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 quarterly regional averages (for the averaging procedure see Appendix C).

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], the following combinations of sample and radionuclide categories are reported:

<table>
<thead>
<tr>
<th>Sampling media</th>
<th>Radionuclide categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>airborne particulates</td>
<td>gross beta, 7Be, 137Cs</td>
</tr>
<tr>
<td>surface water</td>
<td>residual beta, 137Cs</td>
</tr>
<tr>
<td>drinking water</td>
<td>3H, 90Sr, 137Cs</td>
</tr>
<tr>
<td>milk</td>
<td>90Sr, 137Cs</td>
</tr>
<tr>
<td>mixed diet</td>
<td>90Sr, 137Cs</td>
</tr>
</tbody>
</table>

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.

However, it may be that in certain cases the available results have not been received. 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 divided into 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. A more detailed description of monitoring procedures carried out in EU Member States can be found elsewhere [2].

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.
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 (⁷Be) and potassium-40 (⁴⁰K).

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, ⁷Be and caesium-137 (¹³⁷Cs), considered in this report, are illustrated on the maps in figures 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.

Measurements: Most Member States have provided gross beta data (Table A1) for the dense network. All quarterly averages are less than the reporting level. For the sparse network those stations were selected to provide a good coverage of the European territory and for which measurable concentrations were reported. The results for the naturally occurring ⁷Be and artificial radionuclide ¹³⁷Cs are given in Figures A3 to A7 and Figures A8 to A13, respectively. The ¹³⁷Cs activity concentration trends clearly show the ‘Chernobyl peak’ (26 April - 10 May 1986), followed by a return to pre-Chernobyl concentration values. The Chernobyl-peak values may differ by several orders of magnitude at different locations, due to differences in the airborne activity and also differences in the sampling time used (ranging from hours to weeks).

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).
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 tritium (3H) at levels of 0.02 - 0.1 Bq l⁻¹, ⁴₀K (0.04 - 2 Bq l⁻¹), radium, radon and their short-lived decay products (< 0.4 - 2 Bq l⁻¹). The main fraction of ³H 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 (⁹⁰Sr). To determine ³H concentrations, generally the water is multiple distilled.

Measurements: Most of the sampling locations considered (Fig. S1 and S2) lie on rivers into which authorised discharges of radioactive effluents are made. Surface water samples may, therefore, contain detectable radioactive contaminants traceable to installations appreciable distances upstream from the sampling locations and this appears to be reflected in some cases in the results obtained. Furthermore, this has the effect of clouding the usual distinction made between sampling carried out for the purposes of general environmental monitoring and that for the surveillance of nuclear power plants. Nevertheless, since the rivers in question are all water courses of major significance, the results have been considered to be nationally representative.

The results on beta activity given here (Tables S1 and S2) refer to residual beta (total beta less natural ⁴₀K activity). For France, the national reports indicate total beta for the water phase and for suspended matter, and the potassium content separately; the residual beta activity was calculated using a conversion factor of 27.6 Bq g⁻¹ potassium.

For the sparse network those stations were selected for which measurable concentrations of ¹³⁷Cs were reported and which provided a good coverage of the European territory on major rivers and in the sea (Fig. S3). The results are presented in Fig. S4 to S9.

It should be noted that while some above average values appear to be associated with discharges from nuclear installations the results are still well below levels which might be considered of any significance in terms of health.

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 ³H (0.02 - 0.4 Bq l⁻¹), ⁴₀K (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 ³H 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 ⁹⁰Sr determination, whereas ³H is generally measured following multiple distillation of the sample.

Measurements: ³H values (Table W1) range from a few Bq l⁻¹ to a few tens of Bq l⁻¹ throughout the period and thus are less than the reporting level. For the sparse network, only six stations reporting measured concentrations could be selected (Fig. W5 and W6). For ⁹⁰Sr the levels, as shown in Table W2, are generally of the order of 10 mBq l⁻¹ (or less), leading to dense network values less than the reporting level, which is confirmed in the figures with concentration trends (Fig. W7 and W8). For ¹³⁷Cs (Table W3) all values are less than or equal to the reporting level, which is also confirmed by the sparse network data (Fig. W9 and W10).

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 ⁹⁰Sr.

Measurements: Generally the concentrations of the stable elements calcium (Ca) and potassium (K) are determined
I. INTRODUCTION

A. Généralités


Les laboratoires de contrôle ont tendance à continuer à utiliser des méthodes qui se sont avérées fiables au cours des années et qui sont suffisamment sensibles pour être utilisées aux fins de la radioprotection. Les techniques de mesure, et donc la précision, peuvent en conséquence varier d’un laboratoire et d’un pays à l’autre. Ceci peut rendre difficile l’interprétation et la comparaison des données à travers toute l’Europe.

Pour faciliter la présentation des résultats il a été décidé d’utiliser comme repères des niveaux de notification uniformes. Si les résultats des mesures pour un certain type d’échantillon ou une certaine combinaison de radionucléides sont supérieurs au niveau de notification (RL), la valeur transcrite dans le rapport est la valeur mesurée. Sinon le rapport indique seulement “<RL”. Les niveaux de notification sont dérivés d’une dose effective; les valeurs inférieures au niveau de notification ne peuvent générer qu’une dose moindre que le 1/2000° de celle résultant du bruit de fond naturel. (voir l’annexe B pour le calcul de ces niveaux de notification).

Il faut souligner que les niveaux de notification ne sont qu’un moyen de présentation des données et ne doivent en aucun cas être confondus avec des limites maximales permises de contamination radioactive.

En conditions normales, les variations dans le temps et dans l’espace des données provenant des nombreux points d’échantillonnage répartis sur l’ensemble des territoires des États Membres (nommés “réseau dense”), sont graduelles. Pour cette raison, des varia-tions journalières, hebdomadaires ou même mensuelles ne sont du point de vue radiologique, pas significatives. Les données sont dès lors présentées sous forme de moyennes régionales trimestrielles (pour la procédure de calcul de la moyenne, voir l’annexe C).

Bien que la majeure partie des données soient inférieures aux niveaux de notification, il est intéressant de montrer, pour un nombre réduit de points d’échantillonnage représentatifs, la valeur des concentrations réelles. Cela permet de contrôler leur évolution éventuelle au fil du temps. Dans ce but un certain nombre de points d’échantillonnage (nommés “réseau espacé”) a été choisi. Des mesures d’une grande sensibilité sont effectuées sur les échantillons prélevés en ces points et les résultats individuels sont représentés graphiquement.

Comme le précédent [1], le présent rapport couvre les combinaisons de types d’échantillons et de catégories de nucléides suivantes:

<table>
<thead>
<tr>
<th>Types d’échantillons</th>
<th>Catégories de nucléides</th>
</tr>
</thead>
<tbody>
<tr>
<td>aérosols</td>
<td>bêta total, 7Be, 137Cs</td>
</tr>
<tr>
<td>eau de surface</td>
<td>bêta résiduel, 137Cs</td>
</tr>
<tr>
<td>eau potable</td>
<td>3H, 90Sr, 137Cs</td>
</tr>
<tr>
<td>lait</td>
<td>90Sr, 137Cs</td>
</tr>
<tr>
<td>régime mixte</td>
<td>90Sr, 137Cs</td>
</tr>
</tbody>
</table>

Quoiqu’il en soit, il est clair que tous les types d’échantillons décrits ci-dessus ne sont pas mesurés en routine dans chacun des États Membres. Tous les efforts possibles ont été faits pour rassembler toutes les données disponibles et, par conséquent, la majorité des blancs correspondent à l’absence de mesures. Toutefois, il est possible que dans certains cas, des mesures disponibles n’aient pas été reçues.

Les emplacements d’échantillonnage correspondant aux mesures incorporées dans ce rapport sont aussi représentatifs que possible de la situation régionale ou nationale. Les mesures pouvant être influencées par la proximité d’installations nucléaires, ont été retirées dans la mesure du possible. Néanmoins, dans certains cas, les données nationales sont très dépendantes de tels programmes de contrôle.

B. Structure du rapport

Ce rapport est divisé en trois parties principales:
un texte consistant en une introduction générale suivie d’un chapitre pour chaque milieu considéré: des informations générales, relatives aux types d’échantillons, et à la présence
Les résultats sont présentés par type d’échantillon et par type de nucléide, les différents types d’échantillons sont identifiés chacun par un logo approprié. Toutes les données du réseau dense sont présentées, suivies par celles relatives au réseau espacé:

• Les résultats du réseau dense sont pré-sentés sous forme de cartes et de tableaux (à l’exception de ceux de l’eau de surface ce type de prélèvement ne permettant pas une représentation géographique simple). La carte montre la concentration radioactive moyenne annuelle, pour chaque zone géographique (voir la section C). La concentration est représentée par quatre intensités de couleur utilisées pour définir des valeurs comprises entre “inférieure à la limite de notification” et dix fois la limite de notification. Les points d’échantillonnage sont également mentionnés. À côté des cartes les résultats sont repris sous forme de tableaux. Les valeurs sont des moyennes de concentrations pour une région géographique et une période définie (trimestre, semestre ou l’année entière, selon la disponibilité des données). Pour chaque division géographique, le nombre total de points de mesures et le nombre correspondant de mesures pris en compte pour calculer la moyenne annuelle, sont donnés. En outre, pour les valeurs qui dépassent le niveau de notification correspondant, on précise la valeur mensuelle maximale et le mois pendant lequel cela s’est passé.

• Les résultats du réseau espacé sont précédés par une carte sur laquelle sont représentées les localités où sont effectuées les prises d’échantillons. Les résultats sont représentés sous forme de graphiques donnant l’activité en fonction du temps; si possible depuis 1984 (dans la mesure où les données sont disponibles). De une à trois localités figurent sur chaque graphique. Le niveau de notification y est indiqué par une ligne horizontale. Le choix de 1984 permet de voir clairement le pic de radioactivité dû à l’accident de Tchernobyl.

Les appendices de ce rapport donnent des informations supplémentaires en ce qui concerne le traité Euratom, le calcul des niveaux de notification, les façons de calculer les moyennes, les sources de données, la bibliographie et la banque de données REM. Les adresses des autorités et des laboratoires nationaux figurent à l’annexe D, tandis que les références des rapports nationaux sur la radioactivité dans l’environnement sont données en annexe E. Toutes les données utilisées pour préparer ce rapport sont conservées dans la banque de données REM, accessible aux utilisateurs autorisés (voir annexe F).

Finalement, dans le but d’augmenter le lectorat de ce rapport, un glossaire fournit la définition des termes les plus fréquemment utilisés en radioprotection.

C. Subdivisions géographiques

Pour les pays les plus étendus, les données ont été ventilées en fonction de subdivisions géographiques. La division de l’Allemagne, de la Finlande, de la France, de l’Italie, de l’Espagne, de la Suède et du Royaume Uni est basée sur des entités administratives (Tableau 1), résultant en un total de 31 subdivisions géographiques indiquées sur la figure 1.

II. LES PARTICULES EN SUSPENSION DANS L’AIR

Les substances radioactives dans l’air peuvent se présenter sous la forme de gaz ou de particules, cette dernière forme ayant, en général, une importance radiologique potentielle plus grande car elle peut être à l’origine de dépôts persistants. La plupart des réseaux nationaux assurant les contrôles de routine mesurent par conséquent, uniquement la composante “particules”. Les mesures de l’activité bêta totale doivent tenir compte de la présence des produits de décroissance à courte période du radon, produits qui sont d’origine naturelle et qui prédominent dans la radioactivité de l’atmosphère (Radon = 1 à 20 Bq m⁻³ en plein air). D’autres radionucléides naturels présents dans les aérosols sont le bérylium-7 (⁷Be), le potassium-40 (⁴⁰K) et le plomb-210 (²¹⁰Pb).

Le prélèvement des échantillons de particules en suspension dans l’air s’effectue par des techniques de filtration impliquant un débit de plusieurs centaines de mètres cubes d’air par jour. Dans la plupart des pays, les filtres sont changés tous les jours et analysés en vue de doser l’activité bêta totale après décroissance des produits fils du radon. Les analyses de nucléides spécifiques sont réalisées hebdomadairement, mensuellement ou trimestriellement. Les aérosols artificiels à activité alpha sont rarement mesurés par les réseaux de contrôle de routine puisqu’ils sont généralement non décelables, même à proximité des installations nucléaires où ils sont produits. Ces mesures ne sont dès lors pas incorporées dans le présent rapport. Les points de prélèvement des échantillons, dans l’Union Européenne, pour le contrôle du bêta total, du ⁷Be et du ¹³⁷Cs, pris en compte dans le présent rapport, sont représentés respectivement sur les cartes des figures A1 et A2.

Un traitement minimum des filtres est requis, en général les filtres sont directement mesurés, ou peuvent être réduits en cendres ou encore comprimés afin d’améliorer la géométrie de comptage et par là le rendement.
Mesures: La plupart des États Membres ont fourni pour le réseau dense des données relatives au bèta total (Tableau A1). Toutes les moyennes trimestrielles sont endossées du niveau de notification. Pour le réseau espacé, les stations ont été sélectionnées pour, d’une part, couvrir l’ensemble de la surface de l’Europe et parce que, d’autre part, des concentrations mesurables y sont données. Les résultats pour le béryllium-7 (radioélément naturel) et le césium-137 (radioélément artificiel) sont représentés respectivement dans les figures A3 à A7 et A8 à A13. L’évolution de l’activité du $^{137}$Cs met clairement en évidence le “pic Tchernobyl” (26 avril - 10 mai 1986), suivi d’un retour aux valeurs de concentration pré-Tchernobyl. Les valeurs relatives au pic Tchernobyl, considérées à des stations différentes, peuvent varier de plusieurs ordres de grandeur, non seulement à cause des différences liées à l’activité des particules dans l’air mais aussi parce qu’il peut y avoir des différences dans les temps d’échantillonnage (de quelques heures à plusieurs semaines).

III. L’EAU DE SURFACE

Les eaux de surface peuvent recevoir des rejets autorisés d’effluents radioactifs provenant d’installations nucléaires. On peut y trouver des radionucléides en solution ou associés à des particules en suspension; ils pourront finalement être incorporés dans les sédiments et les espèces vivantes. Les radionucléides naturels présents dans les cours d’eau comprennent le tritium ($^3$H) à des niveaux de 0.02 à 0.1 Bq l$^{-1}$ le potassium-40 ($^{40}$K) (0.04 à 2 Bq l$^{-1}$) le radium, le radon et leurs produits de filiation à courte période ($<0.4$ à 2 Bq l$^{-1}$). Toutefois l’essentiel du tritium présent dans les eaux de surface est d’origine artificielle.

Les échantillons peuvent être prélevés en permanence et accumulés en vue d’une analyse mensuelle ou trimestrielle, ou ponctuellement plusieurs fois par an et analysé individuellement. Certains laboratoires séparent les matières en suspension et, séparément, le contenu en potassium; l’activité du bèta résiduel est calculée sur base d’un facteur de conversion de 27.6 Bq g$^{-1}$ de potassium. Il convient de noter que, si certaines valeurs, supérieures à la moyenne, paraissent associées à des rejets d’effluents d’installations nucléaires, ces résultats sont encore bien inférieurs aux niveaux qui pourraient être considérés comme ayant une importance quelconque du point de vue de la santé.

IV. L’EAU POTABLE

La radioactivité présente dans l’eau potable est contrôlée, même si une contamination importante de ce milieu est très improbable, à cause de son importance vitale pour l’homme. Les radionucléides naturels les plus importants dans l’eau destinée à la boisson sont le tritium (0.02 à 0.4 Bq l$^{-1}$), le potassium-40 (typiquement 0.2 Bq l$^{-1}$ mais peut varier notable-ment), le radium, le radon et leurs produits de filiation de courte période (0.4 – 4 Bq l$^{-1}$). Occasionnellement la présence de tritium et de radium peut aussi être due aux activités humaines. Les échantillons peuvent être prélevés dans des nappes d’approvisionnement, souterraines ou de surface, les réseaux de distribution d’eau, les eaux minérales, etc. Des échantillons ponctuels sont prélevés plusieurs fois par an et analysés individuellement ou bien des échantillons quotidiens sont accumulés pour réaliser des analyses mensuelles ou trimestrielles.
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\(^{-1}\) person\(^{-1}\)). An important natural radionuclide is \(^{40}\)K (typically 100 Bq d\(^{-1}\) person\(^{-1}\)).

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.

**Measurements:** Generally the concentrations of the stable isotopes of calcium (Ca) and potassium (K) are determined because of the similarity of their metabolic behaviour with strontium (Sr) and caesium (Cs), respectively. Typical values in milk are 1 to 2 g l\(^{-1}\) for calcium and potassium. The average radioactive concentration reported in the tables were mainly calculated from data which were themselves averages in time (daily, weekly or monthly) and space. For \(^{90}\)Sr the quarterly averages are less than the reporting level (0.2 Bq l\(^{-1}\)) (Table M1). \(^{137}\)Cs quarterly averages range from below the reporting level (0.5 Bq l\(^{-1}\)) up to 3.6 Bq l\(^{-1}\) (Table M2).
Le traitement de l’eau consiste surtout en une évaporation de l’échantillon en vue de mesurer directement le résidu ou en une séparation au moyen d’une colonne échangeur d’ions. Des procédés chimiques de séparation plus sophistiqués sont requis pour doser le strontium-90 ($^{90}$Sr). Pour doser le tritium, l’eau est généralement mesurée après des distillations multiples.

Mesures: Les résultats relatifs au tritium (Tableau W1) varient entre quelques Bq l$^{-1}$ et quelques dixièmes de Bq l$^{-1}$ pendant la période considérée et sont donc en dessous du niveau de notification. Pour le réseau espacé, six stations seulement fournissent des valeurs non majorées pouvant être sélectionnées (Fig. W5 et W6). En ce qui concerne les niveaux en strontium-90, indiqués au tableau W2, ceux-ci sont généralement de l’ordre de 10 nBq l$^{-1}$ (ou moins) ce qui mène à des valeurs, pour le réseau dense, inférieures au niveau de notification, ce qui est confirmé dans les figures donnant les tendances d’évolution des concentrations (Fig. W7 et W8). Toutes les données relatives au césium-137 ($^{137}$Cs) (Tableau W3) sont inférieures ou égales aux niveaux de notification, ce qui est également confirmé par les données du réseau espacé (Fig. W9 et W10).

V. LE LAIT

La consommation de lait et de produits laitiers est une des plus importantes voies de transfert de radionucléides de l’environnement vers l’homme.


Le traitement consiste habituellement en une dessiccation de l’échantillon en vue d’une spectrométrie gamma; on réalise une séparation chimique pour déterminer le strontium-90 ($^{90}$Sr).

Mesures: Généralement les concentrations en éléments stables, tels que le calcium (Ca) et le potassium (K) sont mesurées, étant donné leur similitude de comportement dans le métabolisme avec respectivement le strontium et le césium. Les valeurs types dans le lait sont de 1 à 2 g l$^{-1}$ pour le calcium et le potassium. Les concentrations moyennes de radionucléides dans le lait indiquées dans les tableaux ont pour l’essentiel, été calculées à l’aide de données qui étaient, elles-mêmes des moyennes dans le temps (quotidiennes, hebdomadaires ou mensuelles) et dans l’espace. Les moyennes trimestrielles pour le strontium-90 sont “inférieure au seuil de notification” (0.2 Bq l$^{-1}$) (Tableau M1). Les moyennes trimestrielles pour le césium-137 varient de “inférieure au seuil de notification” (0.5 Bq l$^{-1}$) à 3.6 Bq l$^{-1}$ (Tableau M2).

VI. LE RÉGIME MIXTE

Le contrôle de la radioactivité dans “le régime mixte” vise à obtenir une information globale sur l’ingestion de radioactivité, par l’homme, au travers de la chaîne alimentaire. Plutôt que d’exprimer la radioactivité contenue dans la nourriture par unité de poids, il est plus indiqué de faire l’estimation de l’activité ingérée par jour et par personne (Bq j$^{-1}$ p$^{-1}$). Un isotope important est le potassium-40 (typiquement 100 Bq par jour et par personne (Bq j$^{-1}$ p$^{-1}$)). Les aliments peuvent être mesurés sous forme d’ingrédients isolés. Toutefois étant donné les différences de composition des régimes alimentaires nationaux, la tendance est de prélever comme échantillon un repas complet afin d’obtenir une valeur de contamination représentative d’un “régime mixte”. La connaissance de la contamination des différents composants ainsi que la composition du régime alimentaire national peut néanmoins mener également à des valeurs représentatives.

Les échantillons sont soit un plat soit un repas complet, prélevés généralement en des endroits de grande consommation (restaurants d’usines, écoles).

Le traitement consiste le plus souvent à mélanger l’échantillon préalablement à une mesure du césium-137 par spectroscopie gamma et à une séparation chimique pour permettre de déterminer le strontium-90 ($^{90}$Sr). Généralement les concentrations en isotopes stables, tels que le calcium (Ca) et le potassium (K) sont déterminées, vu leur similitude de comportement dans le métabolisme avec le strontium et le césium, respectivement. Les valeurs types pour le régime mixte varient de 0.7 à 1.5 g j$^{-1}$ p$^{-1}$ pour le calcium et de 3 à 4 g j$^{-1}$ p$^{-1}$ pour le potassium. Pour le strontium-90, la moyenne trimestrielle varie entre “inférieure au seuil de notification” (0.1 Bq j$^{-1}$ p$^{-1}$) et 0.39 Bq j$^{-1}$ p$^{-1}$ (Tableau D1). Les résultats représentés pour le réseau espacé (Fig. D4 et D5) indiquent un niveau de contamination à peu près constant dans le temps. La moyenne trimestrielle pour le césium-137 varie entre, “inférieure au seuil de notification” (0.2 Bq j$^{-1}$ p$^{-1}$) et 0.53 Bq j$^{-1}$ p$^{-1}$ (Tableau D2). Les valeurs pour la Belgique, le Luxembourg et le Portugal ont été obtenues en pondérant les mesures des ingrédients individuels par rapport à leur contribution au régime national. Les mesures fournies par les stations du réseau es-pacé montrent clairement une tendance à la réduction, en ce qui concerne la contamination en césium du régime mixte, depuis l’accident de Tchernobyl (Fig. D6 et D7).
I. EINLEITUNG

A. Allgemeines


Es muß betont werden, daß die Berichtsgrenzen nur als Werkzeug zur Darstellung der Daten gedacht sind und nicht mit maximal erlaubten Radioaktivitätskonzentrationen verwechselt werden dürfen. Unter normalen Umständen gibt es nur geringe und allmähliche Änderungen der Meßwerte an den zahlreichen Probennahmestellen, die über das gesamte Gebiet der Mitgliedstaaten verteilt sind und die im folgenden als das „engmaschige Netz“ bezeichnet werden. Tägliche, wöchentliche oder sogar monatliche Schwankungen an einer Probennahmestelle sind aus diesem Grund nicht von radiologischer Bedeutung. Die Daten werden deshalb als vierteljährliche regionale Durchschnittswerte darge stellt (Zum Verfahren der Mittelwertbildung siehe Anhang C).

Obwohl die meisten Meßergebnisse unterhalb der Berichtsgrenzen liegen, ist es von Interesse, für einige Probennahmestellen die tatsächlichen Aktivitätskonzentrationen anzugeben, weil dabei zeitliche Veränderungen der Radionuklidkonzentrationen sichtbar werden. Dafür wurden einige repräsentative Probennahmestellen ausgewählt, die in der Folge als „weitmaschiges Netz“ bezeichnet werden. Die Einzelergebnisse der dort durchgeführten hochempfindlichen Messungen werden in diesem Bericht als Zeitverläufe graphisch dargestellt.

In diesem Bericht werden die selben Kombinationen von Probennahmen und Nuklidkategorien wie für 1994 präsentiert:

<table>
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<tr>
<th>Probenmedium</th>
<th>Nuklidkategorie</th>
<th>engmaschiges Netz</th>
<th>weitmaschiges Netz</th>
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<tr>
<td>luftgetragene Teilchen</td>
<td>Gesamt-Beta</td>
<td></td>
<td>$^7$Be $^{137}$Cs</td>
</tr>
<tr>
<td>Oberflächenwasser</td>
<td>Rest-Beta</td>
<td>$^3$H</td>
<td>$^{90}$Sr $^{137}$Cs</td>
</tr>
<tr>
<td>Trinkwasser</td>
<td>$^9$Sr $^{137}$Cs</td>
<td>$^{137}$Cs</td>
<td>$^{90}$Sr $^{137}$Cs</td>
</tr>
<tr>
<td>Milch</td>
<td>$^{137}$Cs</td>
<td>$^{137}$Cs</td>
<td>$^{90}$Sr $^{137}$Cs</td>
</tr>
<tr>
<td>Gesamtnahrung</td>
<td>$^{137}$Cs</td>
<td>$^{137}$Cs</td>
<td>$^{90}$Sr $^{137}$Cs</td>
</tr>
</tbody>
</table>


Alle für diesen Bericht verwendeten Daten sind in der REM-Datenbank des GSF in Ispra gespeichert, zu der entsprechend berechtigte Benutzer Zugang haben (siehe Anhang F).
B. Aufbau des Berichtes


Im Ergebnisteil werden die Resultate für jedes Probenmedium präsentiert; jeder Probentyp hat zwecks Übersichtlichkeit ein Symbol. Es werden zuerst alle Daten aus dem „weitmaschigen Netz“ präsentiert, danach die aus dem „weitmaschigen Netz“ in Tabellenform wiedergegeben.

Die Graphiken zeigen die Jahresmittelwerte der Aktivitätskonzentrationen aus jeder geographischen Einheit (siehe Abschnitt C) in vier Schattierungsstufen von „unter der Berichtsgrenze“ bis „mehr als das 10fache der Berichtsgrenze“. Zusätzlich sind alle Probennahmestellen eingzeichnet. Neben jeder Abbildung befindet sich die Tabelle mit den Werten der Aktivitätskonzentrationen, gemittelt über die jeweilige geographische Einheit und einen bestimmten Zeitraum (Vierteljahr, Halbjahr oder Jahr, je nach Verfügbarkeit der Daten). Weiters enthält die Tabelle für jede geographische Einheit die Anzahl der Probennahmestellen und der Messungen, die für die Berechnung der jährlichen Durchschnittswerte herangezogen wurden, sowie für Werte über der Berichtsgrenze den höchsten Monatswert und den zugehörigen Monat.

C. Geographische Unterteilungen

Die Daten aus den größeren Mitgliedstaaten werden nach kleineren geographischen Einheiten aufgeschlüsselt. Die Unterteilung für Deutschland, Finnland, Frankreich, Italien, Spanien, Schweden und das Vereinigte Königreich beruht auf Verwaltungseinheiten (vgl. Tabelle 1). Es ergeben sich insgesamt 31 geographische Bereiche (Abbildung 1).

II. LUFTGETRAGENE TEILCHEN


Die atmosphärische Radioaktivität ist gewöhnlich von den natürlichen kurzlebigen Zerfallsprodukten des Edelgases Radon dominiert (Die Radonkonzentration in der Außenluft beträgt typisch 1 bis 20 Bq m⁻³). Bei Messungen der „Gesamt-Beta-Aktivität“ muß die Anwesenheit dieser Radonzerfallsprodukte berücksichtigt werden. Andere in Aerosolen vorkommende natürliche Radionuklide sind Beryllium-7 (⁷Be), Kalium-40 (⁴⁰K) und Blei-210 (²¹⁰Pb).


Die Probenvorbereitung ist bei Luftfiltern in der Regel minimal: sie werden direkt ausgemessen oder sie werden zur Volumenreduktion verascht oder gepreßt, um so die Zählrausbeute zu erhöhen.

III. OBERFLÄCHENWASSER

In Oberflächengewässer kann fallweise eine kontrollierte Abgabe von radioaktiven Stoffen z.B. aus kerntechnischen Anlagen erfolgen. Die Radionuklide können in der wäßrigen Phase oder in Schwebstoffen auftreten, und eventuell an Sedimente gebunden oder in Lebewesen inkorporiert werden. Zu den natürlichen Radionukliden, die im Oberflächenwasser vorkommen, gehören Tritium (3H, 0.02 - 0.1 Bq l⁻¹), Kalium-40 (40K, 0.04 - 2.0 Bq l⁻¹) sowie Radium, Radon und ihre kurzlebigen Zerfallsprodukte (< 0.4 - 2.0 Bq l⁻¹). Die Hauptmenge des Tritiums in Oberflächenwasser ist allerdings auf menschlichen Einfluß zurückzuführen.

Proben werden entweder kontinuierlich entnommen und als monatliche oder vierteljährliche Mischproben analysiert, oder es werden regelmäßig mehrmals pro Jahr Stichproben entnommen und einzeln untersucht. Manche Laboratorien trennen die Schwebstoffe vom Wasser ab und analysieren sie getrennt.


Die Ergebnisse der Beta-Messungen, die hier aufgeführt sind (Tabellen S1 und S2), sind Rest-Beta-Aktivitäten (Gesamt-Beta abzüglich 40K-Aktivität). Die nationalen Berichte von Frankreich führen Gesamt-Beta-Werte für Radionuklide in wäßriger Phase und für Schwebstoffe sowie separat den Kaliumgehalt an; daraus wurde die Rest-Beta-Aktivität mittels eines Umrechnungsfaktors von 27.6 Bq 40K pro Gramm Kalium berechnet.

Für das weitmaschige Netz wurden Meßstationen ausgewählt, für die tatsächlich gemessene Werte für Cäsium-137 (137Cs) vorlagen und die eine gute Abdeckung des europäischen Gebietes an den Hauptflüssen und im Meer erlaubten (Abb. S3). Die Ergebnisse sind in den Abb. S4 bis S9 dargestellt.

Es sei angemerkt, daß zwar einige Meßwerte offenbar wegen Ableitungen aus kerntechnischen Anlagen erhöht sind, diese Werte aber trotzdem immer noch weit unterhalb des Bereiches liegen, der gesundheitlich relevant ist.

IV. TRINKWASSER

Trinkwasser wird wegen seiner grundlegenden Bedeutung für die Menschen überwacht, obwohl eine wesentliche radioaktive Kontamination dieses Mediums sehr unwahrscheinlich ist. Die wichtigsten natürlichen Radionuklide in Trinkwasser sind Tritium (Tritium) sind Tritium (0.02 - 0.4 Bq l⁻¹), Kalium-40 (typisch 0.2 Bq l⁻¹, aber sehr unterschiedlich) sowie Radium, Radon und ihre kurzlebigen Zerfallsprodukte (0.4 - 4.0 Bq l⁻¹). Fallweise können Tritium und Radium allerdings auch auf menschlichen Einfluß zurückzuführen sein.

Proben können vom Grund- oder Oberflächenwasserversorgung aus Wasserleitungssnetzen, von Mineralwässern usw. entnommen werden. Stichproben werden entweder mehrmals pro Jahr entnommen und einzeln analysiert oder
es werden tägliche Stichproben zu Monats- oder Quartalsproben vereinigt.

Die **Probevorbereitung** besteht für Trinkwasser meist aus Eindampfen der Probe zur direkten Ausmessung der Rückstands- oder in einer Trennung an Ionenaustauschersäulen. Für Strontium-90-Bestimmungen ist eine komplizierte chemische Aufarbeitung nötig. Für die Bestimmung von Tritium wird die Probe in der Regel mehrfach destilliert.

**Ergebnisse:** Die Konzentrationen für Tritium reichen im Bezugszeitraum von wenigen Bq l⁻¹ bis zu einigen Zehn Bq l⁻¹ (Tabelle W1) und liegen damit unterhalb der Berichtsgrenze. In das weitmaschige Netz wurden nur sechs Meßstationen aufgenommen, die Werte über der Nachweigrenze geliefert haben (Abb. W5 und W6). Für Strontium-90 liegen die Aktivitätskonzentrationen normalerweise im Bereich von 10 nBq l⁻¹ oder darunter, wodurch die Ergebnisse des engmaschigen Netzes sämtlich unterhalb der Berichtsgrenze sind (Tabelle W2). Dies wird in den Konzentrationsverläufen aus dem weitmaschigen Netz bestätigt (Abb. W7 und W8). Auch für Cäsium-137 (Tabelle W3) sind alle Ergebnisse unter der Berichtsgrenze, was ebenfalls durch die Daten des weitmaschigen Netzes bestätigt wird (Abb. W9 und W10).

**V. MILCH**

Der Konsum von Milch und Milchprodukten ist einer der wichtigsten Pfade für die Aufnahme von Radionukliden aus der Umwelt durch den Menschen.

Die **Proben** werden vorwiegend bei Molkereien mit einem breiten geographischen Einzugsgebiet entnommen, um möglichst repräsentative Proben zu erhalten. Die Probenahme erfolgt normalerweise monatlich, mitunter auch nur während der Weidezeit. Die Proben können separat oder als Sammelproben zur Ermittlung regionaler bzw. nationaler Mittelwerte untersucht werden.

Die **Probevorbereitung** besteht normalerweise aus Trocknen der Proben für die gammaspektrometrische Analyse bzw. chemischer Trennung für Strontium-90.

**Ergebnisse:** Im allgemeinen werden auch die Konzentrationen der Elemente Calcium und Kalium (K) gemessen. Dabei werden die Stoffwechselverhältnisse von der nationalen Mitte wie bei den anderen Elementen untersucht. Die nationalen Zentren von unterhalb der Berichtsgrenze: 0.2 Bq l⁻¹) (Tabelle M2). Die Vierteljahresmittelwerte für Cäsium-137 reichen von „unter der Berichtsgrenze“ (0.5 Bq l⁻¹) bis 3.6 Bq l⁻¹ (Tabelle M3).

**VI. GESAMTNAHRUNG**

Die Bestimmung der Radioaktivität der Gesamtnahrung dient dazu, eine „integrale“ Information über die Aufnahme von Radionukliden durch die Menschen über die Nahrungskette zu erhalten. Anstelle einer Angabe des massbezogenen Radionuklidgehalts (Bq kg⁻¹) der Lebensmittel ist dabei eine Abschätzung der pro Person täglich aufgenommenen Aktivität (Bq d⁻¹ Person⁻¹) zweckmäßiger. Ein wichtiges natürliches Radionuklid ist Kalium-40 (typische Aufnahme 100 Bq d⁻¹ Person⁻¹).


Die **Proben** werden in Form von einzelnen Lebensmitteln gezogen oder als vollständige Menüs, meistens an Stellen mit großem Konsum (z.B. Fabrikskantinen, Schulen).

Die **Probevorbereitung** besteht normalerweise aus Mischen der Probe für die gammaspektrometrische Messung von Cäsium-137 und in einer chemischen Aufarbeitung für die Strontium-90-Bestimmung.

**Ergebnisse:** Im allgemeinen werden auch die Konzentrationen der Elemente Calcium und Kalium ermittelt, da ihr Stoffwechselverhalten mit dem von Strontium bzw. Cäsium vergleichbar ist. Typische Werte in der Gesamtnahrung sind für Calcium 0.7 bis 1.5 g d⁻¹ Person⁻¹ und 3 bis 4 g d⁻¹ Person⁻¹ für Kalium. Für Strontium-90 reichen die Vierteljahresmittelwerte von unterhalb der Berichtsgrenze (0.1 Bq d⁻¹ Person⁻¹) bis 0.39 Bq d⁻¹ Person⁻¹ (Tabelle D1). Die Ergebnisse aus dem weitmaschigen Netz zeigen zeitlich fast konstante Kontaminationswerte (Abb. D4 und D5). Die Vierteljahresmittelwerte für Cäsium-137 reichen von unterhalb der Berichtsgrenze (0.2 Bq d⁻¹ Person⁻¹) bis 0.53 Bq d⁻¹ Person⁻¹ (Tabelle D2). Die Werte für Belgien, Luxemburg und Portugal wurden durch Gewichtung der Werte der einzelnen Zutaten entsprechend der Zuzuwandsetzung der nationalen Nahrung erhalten. Die Messungen, die von
Meßstationen aus dem weitmaschigen Netz berichtet wurden, zeigen klar eine abnehmende Tendenz der Cäsiumkontamination in der Gesamtnahrung nach dem Tschernobyl-Unfall (Abb. D6 und D7).

References

Fig. 1
Definition of the geographical regions used in the data tables and figures
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<th>Country</th>
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<td>Hessen, Rheinland-Pfalz and Saarland</td>
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<td>Baden-Württemberg and Bayern</td>
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Fig. A1
Sampling locations and geographical averages by year for gross-beta in airborne particulates
### Geographical and time averages

**YEAR:** 1995  
**SAMPLE TYPE:** airborne particulates (Bq m\(^{-3}\))  
**NUCLIDE CATEGORY:** gross-\(\beta\)

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**Notes:**  
- RL: reporting level for gross-\(\beta\) in air, i.e. 5.0E-03 Bq m\(^{-3}\) (see Appendix B)  
- \(\Delta\): only constraint values above the reporting level were reported  
- N: number of measurements considered in calculating the annual concentration.  
- L: number of sampling locations considered in calculating the annual concentration.  
- Monthly max: maximum monthly average in the year.  
- M: month during which the maximum occurred.
Fig. S1
Sampling locations for residual-beta in surface water considered in Tables S1 - S2
Fig. S2
Sampling locations for residual-beta in surface water considered in Table S2
### Table S1

**Time averages**

**YEAR:** 1995  
**SAMPLE TYPE:** surface water (Bq l⁻¹)  
**NUCLIDE CATEGORY:** residual-β

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**RL:** reporting level for residual-β in surface water, i.e. 6.0E-01 Bq l⁻¹ (See Appendix B)  
* : sampling location downstream of a nuclear power plant

- **N:** number of measurements considered in calculating the annual concentration.  
- **Monthly max:** maximum monthly average in the year.  
- **M:** month during which the maximum occurred.
### Table S2
Time averages

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**RL**: reporting level for residual-β in surface water, i.e. 6.0E-01 Bq l⁻¹ (see Appendix B)

***: sampling location downstream of a nuclear power plant

**N**: number of measurements considered in calculating the annual concentration.

**Monthly max**: maximum monthly average in the year.

**M**: month during which the maximum occurred.
Fig. W1
Sampling locations and geographical averages by year for tritium in drinking water
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Geographical and time averages

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**Notes:**
- RL: Reporting level for H-3 in drinking water, i.e. 1.00E+02 Bq/l (see Appendix B)
- N: Number of measurements considered in calculating the annual concentration.
- L: Number of sampling locations considered in calculating the annual concentration.
- Monthly max: Maximum monthly average in the year.
- M: Month during which the maximum occurred.
Fig. W2
Sampling locations and geographical averages by year for strontium-90 in drinking water
### Table W2
Geographical and time averages

**YEAR**: 1995  
**SAMPLE TYPE**: drinking water (Bq l⁻¹)  
**NUCLIDE CATEGORY**: strontium-90 (⁹⁰Sr)

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**RL**: reporting level for Sr-90 in drinking water, i.e. 6.0E-02 Bq l⁻¹ (see Appendix B)

**N**: number of measurements considered in calculating the annual concentration.

**L**: number of sampling locations considered in calculating the annual concentration.

**Monthly max**: maximum monthly average in the year.

**M**: month during which the maximum occurred.
Fig. W3
Sampling locations and geographical averages by year for caesium-137 in drinking water
## Table W3
Geographical and time averages

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**SAMPLE TYPE:** drinking water (Bq l\(^{-1}\))  
**NUCLIDE CATEGORY:** caesium-137 (\(^{137}\)Cs)

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**Bold:** reporting level for Cs-137 in drinking water, i.e. 1.0E-01 Bq l\(^{-1}\) (see Appendix B)

- **N:** number of measurements considered in calculating the annual concentration.
- **L:** number of sampling locations considered in calculating the annual concentration.
- **Monthly max:** maximum monthly average in the year.
- **M:** month during which the maximum occurred.

---

**Note:** This table provides data on caesium-137 concentrations in drinking water for various countries, with reporting levels, monthly maxima, and the month they occurred in.
Fig. M1
Sampling locations and geographical averages by year for strontium-90 in milk
Table M1
Geographical and time averages

YEAR : 1995
SAMPLE TYPE : milk (Bq l\(^{-1}\))
NUCLIDE CATEGORY : strontium-90 (\(^{90}\)Sr)

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RL : reporting level for Sr-90 in milk, i.e. 2.0E-01 Bq l\(^{-1}\) (see Appendix B)

N : number of measurements considered in calculating the annual concentration.
L : number of sampling locations considered in calculating the annual concentration.
Monthly max : maximum monthly average in the year.
M : month during which the maximum occurred.
Fig. M2
Sampling locations and geographical averages by year for caesium-137 in milk
Table M2
Geographical and time averages

YEAR : 1995
SAMPLE TYPE : milk (Bq l⁻¹)
NUCLIDE CATEGORY : caesium-137 (¹³⁷Cs)

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RL : reporting level for Cs-137 in milk, i.e. 5.0E-01 Bq l⁻¹ (see Appendix B)

N : number of measurements considered in calculating the annual concentration.
L : number of sampling locations considered in calculating the annual concentration.
Monthly max : maximum monthly average in the year.
M : month during which the maximum occurred.
Fig. D1
Sampling locations and geographical averages by year for strontium-90 in mixed diet
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Note:
- **N**: number of measurements considered in calculating the annual concentration.
- **L**: number of sampling locations considered in calculating the annual concentration.
- **Monthly max**: maximum monthly average in the year.
- **M**: month during which the maximum occurred.

RL: reporting level for Sr-90 in mixed diet, i.e. 1.0E-01 Bq d^-1 p^-1 (see Appendix B)

- **+** : calculated from the national diet constituents
- **∆** : only constraint values above the reporting level were reported
Fig. D2
Sampling locations and geographical averages by year for caesium-137 in mixed diet
Table D2
Geographical and time averages

YEAR: 1995
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NUCLIDE CATEGORY: caesium-137 (¹³⁷Cs)

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<td></td>
</tr>
</tbody>
</table>

RL: reporting level for Cs-137 in mixed diet, i.e. 2.0E-01 Bq d⁻¹ person⁻¹ (see Appendix B)
Δ: only constraint values above the reporting level were reported
+: calculated from the national diet constituents
N: number of measurements considered in calculating the annual concentration.
L: number of sampling locations considered in calculating the annual concentration.
Monthly max: maximum monthly average in the year.
M: month during which the maximum occurred.
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Activity trends for strontium-90 in milk (Hjørring, Rovaniemi and Lycksele)

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Fig. M6
Activity trends for strontium-90 in milk (Cléville and Méaudre)
**Fig. M7**
Activity trends for caesium-137 in milk (Hjørring, Rovaniemi and Lycksele)

**Fig. M8**
Activity trends for caesium-137 in milk (Burmerange, Berlin and Helsinki)
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Appendix A

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”.

Appendix B

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:

\[
RL = \frac{DL}{RF \cdot EDC \cdot CF}
\]

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\(^{-1}\)
- \( CF \) = 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 \( 5 \times 10^{-2} \) per sievert [1], taking only fatal cancers into consideration, this dose represents a radiological risk of \( 5 \times 10^{-8} \) per year.

Reporting levels are introduced only for artificial radionuclides (H-3, Sr-90 and Cs-137). The actual level for natural radionuclides (Be-7) 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.

<table>
<thead>
<tr>
<th>Sample type</th>
<th>Radionuclide category</th>
<th>EDC [2] (Sv Bq(^{-1}))</th>
<th>Annual consumption</th>
<th>Reporting level (rounded values)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>gross beta (based on 90Sr)</td>
<td>2.4 ( 10^{-6} )</td>
<td>8030 m(^3)</td>
<td>5.10(^{-3}) Bq m(^{-3})</td>
</tr>
<tr>
<td></td>
<td>137Cs</td>
<td>4.6 ( 10^{-9} )</td>
<td>8030 m(^3)</td>
<td>3.10(^{-2}) Bq m(^{-3})</td>
</tr>
<tr>
<td>Surface water</td>
<td>residual beta (based on 90Sr)</td>
<td>2.8 ( 10^{-6} )</td>
<td>60 l</td>
<td>6.10(^{-3}) Bq l(^{-1})</td>
</tr>
<tr>
<td></td>
<td>137Cs</td>
<td>1.3 ( 10^{-6} )</td>
<td>60 l</td>
<td>1.10(^{-3}) Bq l(^{-1})</td>
</tr>
<tr>
<td>Drinking water</td>
<td>3H</td>
<td>1.8 ( 10^{-11} )</td>
<td>600 l</td>
<td>1.10(^{-4}) Bq l(^{-1})</td>
</tr>
<tr>
<td></td>
<td>90Sr</td>
<td>2.8 ( 10^{-6} )</td>
<td>600 l</td>
<td>6.10(^{-2}) Bq l(^{-1})</td>
</tr>
<tr>
<td></td>
<td>137Cs</td>
<td>1.3 ( 10^{-6} )</td>
<td>600 l</td>
<td>1.10(^{-1}) Bq l(^{-1})</td>
</tr>
<tr>
<td>Milk</td>
<td>90Sr</td>
<td>2.8 ( 10^{-8} )</td>
<td>200 l</td>
<td>2.10(^{-1}) Bq l(^{-1})</td>
</tr>
<tr>
<td></td>
<td>137Cs</td>
<td>1.3 ( 10^{-8} )</td>
<td>200 l</td>
<td>5.10(^{-3}) Bq l(^{-1})</td>
</tr>
<tr>
<td>Mixed diet</td>
<td>90Sr</td>
<td>2.8 ( 10^{-8} )</td>
<td>365 d</td>
<td>1.10(^{-1}) Bq d(^{-1}) p(^{-1})</td>
</tr>
<tr>
<td></td>
<td>137Cs</td>
<td>1.3 ( 10^{-8} )</td>
<td>365 d</td>
<td>2.10(^{-1}) Bq d(^{-1}) p(^{-1})</td>
</tr>
</tbody>
</table>

* assumed to 10% of the annual drinking water consumption

Appendix C

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:

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

(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\(^{-1}\)]

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

\[
\bar{S} = \frac{1}{N_m} \sum_{i=1}^{N_m} s_i
\]  

(2)

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

Drinking water and milk [Bq l\(^{-1}\)]

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:

\[
W = \frac{1}{N_l} \sum_{l=1}^{N_l} \left( \frac{\sum_{i=1}^{N_{ml}} w_{i,l} \Delta t_{i,l}}{\sum_{i=1}^{N_{ml}} \Delta t_{i,l}} \right)
\]  

or \[
M = \frac{1}{N_l} \sum_{l=1}^{N_l} \left( \frac{\sum_{i=1}^{N_{ml}} m_{i,l} \Delta t_{i,l}}{\sum_{i=1}^{N_{ml}} \Delta t_{i,l}} \right)
\]  

(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\(^{-1}\) p\(^{-1}\)]

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

\[
D = \frac{1}{N_l} \sum_{l=1}^{N_l} \left( \frac{\sum_{i=1}^{N_{ml}} d_{i,l} \Delta t_{i,l}}{\sum_{i=1}^{N_{ml}} \Delta t_{i,l}} \right)
\]  

(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.
Appendix D

Addresses of national competent authorities and laboratories

Austria
Bundeskanzleramt
Abt. Strahlenschutz
Radetzkystraße 2
A - 1031 Wien

Bundesanstalt für Lebensmitteluntersuchung und -forschung
Abteilung Strahlenschutz
Berggasse 11
A - 1090 Wien

Belgium
Agence Fédérale de Contrôle Nucléaire (AFNC)
Rue Ravenstein 36B
B - 1000 Bruxelles

Institut Scientifique de la Santé Publique – Louis Pasteur
rue Juliette Wytsman 14
B - 1040 Bruxelles

S.C.K./C.E.N.
Boeretang 200
B - 2400 Mol
IRE
Zoning Industriel
B - 6220 Fleurus

Denmark
National Institute of Radiation Hygiene
378 Frederikssundsvej
DK - 2700 Bronshoj

Risø National Laboratory
Postbox 49
DK - 4000 Roskilde

Finland
Radiation and Nuclear Safety Authority
Research and Environmental Surveillance
P.O. Box 14
FIN - 00881 Helsinki

France
Office de Protection contre les Rayonnements Ionisants
31, rue de l’Ecluse
B.P. 35
F - 78116 Le Vesinet (Cedex)

IPSN/DPRE/SERE
Commissariat à l’Energie Atomique
Laboratoire de mesure de la radioactivité de l’environnement
Bâtiment 501
Bois de rames
B.P. 6
F - 91400 Orsay (Cedex)

Germany
Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit
Postfach 120 629
D - 53048 Bonn

Zentralamt des Deutschen Wetterdienstes
Frankfurter Straße 135
D - 63067 Offenbach am Main

Bundesamt für Strahlenschutz
Institut für Strahlenhygiene
Zentralstelle des Bundes für die Überwachung der Umweltradioaktivität
Ingolstädter Landstraße 1
D - 85764 Neuherberg-München

Greece
Greek Atomic Energy Commission
PO Box 60092
GR - 15310 Aghia Paraskevi, Attiki

Environment Radioactivity Laboratory
Institute of Nuclear Technology - Radiation Protection
NCSR “Demokritos”
GR - 15310 Aghia Paraskevi, Attiki

Ireland
Radiological Protection Institute of Ireland
3 Clonskeagh Square
Clonskeagh Road
IRE - Dublin 14

Italy
Agenzia Nazionale per la Protezione dell’Ambiente
Via Vitaliano Brancati 48
I - 00144 Roma-EUR

Luxembourg
Direction de la Santé
Division de la Radioprotection
Villa Louvigny
Allée Marconi
L - 2120 Luxembourg
the Netherlands
Ministerie van Landbouw en Visserij
Landelijk Meetnet Radioactiviteit in Voedsel
Postbus 48
NL - 6700 Wageningen
Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer
Directoraat-Generaal Milieubeheer
Postbus 450
NL - 2260 MB Leidschendam
National Institute of Public Health and the Environment
Laboratory for Radiation Research
P.O.Box 1
NL - 3720 Bilthoven

Portugal
Direcção-geral do Ambiente
Departamento de Protecção e Segurança Radiológica
Estrada Nacional 10
P - 2686 Sacavém Codex

Spain
Consejo de Seguridad Nuclear
Justo Dorado, 11
E - 28040 Madrid
Ministerio de Fomento
Centro de Estudios y Experimentación de Obras Públicas (CEDEX)
Alfonso XII, 3
E - 28014 Madrid

Sweden
National Defense Research Establishment
S - 172 90 Stockholm
Swedish Radiation Protection Institute
S - 171 16 Stockholm

United Kingdom
Department of the Environment, Transport and the Regions
Ashdown House
123, Victoria Street
UK - London SW1E 6DE
Food Standards Agency
Aviation House
125 Kingsway
UK - London WC2B 6NH
Scottish Environmental Protection Agency
Erskine Court
The Castle Business Park
UK - Steirling FK9 4TR
AEA Technology plc
Harwell
UK - Oxfordshire OX11 0RA
National Radiological Protection Board
Chilton, Didcot
UK - Oxon OX11 ORQ
Appendix E

Bibliography - data sources (for 1995)

**Austria**
- V. Karg Bundesanstalt für Lebensmitteluntersuchung und – forschung, Abt. Strahlenschutz, Wien (personal communications)

**Belgium**
- J.-M. Lambotte, L. Sombré – Agence Fédérale de Contrôle Nucléaire (AFNC), Bruxelles (personal communications)

**Denmark**
- S.P. Nielsen - Risø National Laboratory (personal communications)

**Germany**
- L. Kammerer - Bundesamt für Strahlenschutz, Institut für Strahlenhygiene, Neuherberg, (personal communications)

**Finland**
- M. Moring and R. Mustonen, Radiation and Nuclear Safety Authority, Research and Environmental Surveillance, Helsinki (personal communications)

**France**
- Office de Protection contre les Rayonnements Ionisants (OPRI) - Tableaux Mensuels des Mesures (1995)
- G. Linden, Office de Protection contre les Rayonnemets Ionisants, Le Vesinet; D. Robeau and D. Calmet, Institut de Protection et de Sûreté Nucléaire, Fontenay-aux-Roses (personal communications)

**Greece**
- A. Maltezos, P. Kritidis - Greek Atomic Energy Commission, Athens (personal communications)

**Ireland**
- S. Long and D. Pollard - Radiation Protection Institute of Ireland, Dublin (personal communications)

**Italy**
- M. Belli - ANPA, Rome (personal communications)

**Luxembourg**
- Direction de la Santé, Division de la Radioprotection, Luxembourg - Rapports mensuels des résultats de la surveillance de la radioactivité (1995)
- M. Feider and P. Breuskin, Direction de la Santé, Division de la Radioprotection, Luxembourg (personal communications)

**the Netherlands**
- P. Kwakman, Rijksinstituut voor Volksgezondheid en Milieuhygiëne, Bilthoven (personal communications)

**Portugal**
- M.D.T. Elias and G. Ferrador, LNETI, Lisboa (personal communications)

**Spain**
- I. Marugán, C. Rey and R. Salas, Consejo de Seguridad Nuclear, Madrid (Personal communications)

**Sweden**
- C.-M. Larsson, Swedish Radiation Protection Institute, Stockholm; L-E. De Geer, Nuclear Detection Group, National Defense Research Establishment, Stockholm (personal communications)

**United Kingdom**
APPENDIX F

The REM Data bank

After the accident at Chernobyl, a task Force was created by the relevant Directorates of the European Commission (EC) 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 Environment Institute of the EC 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 EC 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 till present 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 an IBM Risc 6000 server at the Environment Institute of the Joint Research Centre at Ispra. The bank currently contains more than 1,500,000 data records and is accessible in an interactive way to external users via internet. (http://java.ei.jrc.it)

For further information please contact:

ir. M. De Cort
European Commission, DG JRC
Institute for Environment and Sustainability
T.P. 321
I - 21020 Ispra (VA)

Easy-Proteo

To harmonize the data format and thus accelerate the data input into the REM data bank, a special data input processor called Easy-Proteo was developed at JRC-Ispra. The programme is written in the Microsoft Foxpro© 2.5 language and uses the standard dBASE III database format. Its most important characteristics are:

– almost no typing is needed: most fields are compiled by point and click
– non procedural: no need to type commands, all actions are triggered by clicking menu options or by using function keys
– context sensitive help: using the Help key popups Help that relates to the current action. From there one can move inside the Help system, that includes some hyper-text elements to join related items.
– Output formats: besides the REM standard data format, the user can also export his data for further use into several other formats as DIF, MOD, SYLK, WK1, WKS, WRK, XLS and ASCII.

The software runs on IBM PC’s or compatibles and is available in two versions. The first can be executed on any IBM-PC or compatibles with 540 kByte of free conventional memory and 1.5 Mbyte of free disk space. The second (faster) version uses an extended memory manager and is therefore only suited for PC’s with a 386 or better processor and 1.8 Mbyte of free disk space.

To obtain further information or a copy of the software, please contact:

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European Commission, DG JRC
Institute for Environment and Sustainability
T.P. 321
I - 21020 Ispra (VA)
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Fig. D3  Sampling locations for strontium-90 and caesium-137 in mixed diet considered in Figures D4 - D7; page 67

Fig. D4  Activity trends for strontium-90 in mixed diet (Copenhagen and Berlin); page 68

Fig. D5  Activity trends for strontium-90 in mixed diet (Le Vesinet and Avignon); page 68

Fig. D6  Activity trends for caesium-137 in mixed diet (Copenhagen and Berlin); page 69

Fig. D7  Activity trends for caesium-137 in mixed diet (Le Vesinet and Avignon); page 69
**ABSORBED DOSE**
The amount of energy imparted by the ionising radiation to unit mass of absorbing material. The unit of measurement is the gray, Gy. (1 Gy = 1 Joule per kilogram).

**ACTIVITY**
The attribute of the amount of a radionuclide. 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 a radionuclide.

**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 a radionuclide.

**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 environmental impact 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 of measurement 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, without mass or charge which is emitted by a radionuclide.

**GRAY**
See Absorbed Dose.

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

**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 with the same number of protons but different number of neutrons.

**NATURAL BACKGROUND**
The radiation field due to naturally occurring radioactivity. It includes radiation arising from the presence of long live radionuclides in the earth’s crust 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, which number 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 amount of protons and neutrons (e.g. caesium-137).

**RADON**
The 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 (40K), being the major natural beta emitting component in surface water.

**SIEVERT**
See Equivalent Dose and Effective Dose.
Quarterly average values of radioactivity levels in airborne particulates, surface water, drinking water, milk and mixed diet are reported for the fifteen countries of the European Union (sparse and dense network) for the year 1995.
The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies.

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