SUMMARY

A IONISING RADIATION

Since 1958, all data on environmental radioactivity from measurements performed by authorised laboratories have been published in quarterly reports and, since 1968, in annual reports. In addition to the results from environmental monitoring these reports include data on the population exposure from natural and man-made radiation sources. Data are shown below on exposures due to

- -natural radiation sources
- -technologically enhanced natural radioactivity
- -medical applications
- -nuclear installations
- -the handling of radioactive substances
- -occupational exposure
- -nuclear weapons tests
- -radiation accidents or other emergencies
- -effects from the Chernobyl reactor accident.

The mean radiation exposure to the population in the Federal Republic of Germany during the year 2004 is shown in the following table and classified by various radiation sources. Compared to prior years, the mean effective dose remained unchanged with the exception of the value for diagnostic nuclear medicine.

MEAN EFFECTIVE DOSE TO THE POPULATION IN THE FEDERAL REPUBLIC OF GERMANY DURING THE YEAR 2004

		Mean effective dose mSv/year	
1.	**Exposure from natural radiation sources**		
1.1	cosmic radiation (at sea level)	approx. 0.3	
1.2	external terrestrial radiation	approx. 0.4	
	outdoors (5 h/d)		approx. 0.1
	indoors (19 h/d)		approx. 0.3
1.3	inhalation of radon and its progeny	approx. 1.1	
1.4	ingestion of natural radioactive substances	approx. 0.3	
Total natural radiation exposure		approx. 2.1	
2.	**Exposure from man-made radiation sources**		
2.1	nuclear installations	< 0.01	
2.2	use of radioactive substances and ionising radiation in medicine	approx. 1.9	
	2.2.1 diagnostic nuclear medicine		approx. 0.1
2.3	use of radioactive substances and ionising radiation in research, technology and the home environment	< 0.01	
	2.3.1 industrial products		< 0.01
	2.3.2 industrial radiation sources		< 0.01
	2.3.3 stray radiation		< 0.01
2.4	fallout from nuclear weapons tests	< 0.01	
	2.4.1 external outdoor exposure		< 0.01
	2.4.2 incorporated radioactive substances		< 0.01
2.5	exposure due to the accident in the Chernobyl nuclear power plant	0.015	
Total exposure from man-made sources		approx. 1.9	

Natural radiation sources and technologically enhanced natural radioactivity

Exposure from natural radiation sources consists of both an external and an internal component due to natural radioactive substances in the environment. A major source of external radiation exposure consists of both cosmic and terrestrial radiation from the natural radionuclide potassium-40 together with the radionuclides of the natural decay series of uranium-238 and thorium-232. The internal component of radiation exposure is largely caused by the inhalation of the natural noble gas radon and its daughter nuclides, and partially also by the intake of natural radioactive substances with drinking water and food. Typically, natural radiation sources contribute to the effective dose to the level of 1 to 6 millisievert per year. The nominal mean value is 2.1 millisievert, resulting in particular from exposure to radon in buildings. All individual contributions to the annual mean effective dose are listed in the above table.

Measurements performed during recent years have shown considerable regional variation in natural radiation exposure, due mainly to the significantly different concentrations of natural radioactive substances in soil and air. The construction of houses on land containing increased amounts of uranium and radium, and to a lesser extent, the use of building materials containing increased amounts of radioactive substances are assumed to be responsible for the increase in population exposure from the radioactive decay products of these radionuclides. National and international epidemiological studies are currently underway to further limit the risk to the health of the population from increased exposures to radon daughters. In the last years national and international epidemiological studies were performed in order to be able to narrow the health risk to the population due to enhanced exposure to radon decay products down further. Already at concentrations above 100 Bq/m^3 a significant increase in the lung cancer risk by about 10% per 100 Bq/m^3 shows.

A mining-related increased concentration of radon in air close to ground level is seen only in the immediate vicinity of mining facilities; the concentration decreases with increasing distance from such facilities. The overall results of the measurements show the occurrence of above-average radon concentrations in mining regions of uranium and copper slate mining but, since such concentrations occur also in geologically comparable regions, these are assumed to be partly of natural origin. The discharge of uranium and radium and their respective decay products from mining facilities into drainage areas of the mining regions does not cause an appreciable change of the natural level of these radionuclides.

Man-made sources of radiation

Medical applications

The major part of the mean effective population dose due to man-made radiation exposure to the population is caused by the medical application of radioactive substances and ionising radiation. In 2002, the dose attributable to medical radiation exposure was around 1.9 millisievert (about 0.1 millisievert in nuclear medicine) per inhabitant. Due to a new procedure for the assessment of radiation exposure due to X-ray diagnostics, the value has changed compared with the previous years. The contribution of X-ray diagnostic to the effective dose due to man-made radiation sources has continuously increased in the last years.

Surveys performed by the Federal Office for Radiation Protection (BfS) on exposures in diagnostic radiology, with these representing by far the largest contribution to man-made radiation exposure, yielded a considerable range of dose value scattering for individual examinations over more than two orders of magnitude, which is caused by the different conditions for each individual patient and the different technical standards applied. In spite of the broad use of alternative examination procedures (ultrasound, endoscopy, magnetic resonance tomography) the current survey indicates a largely constant progression of the examination frequencies over the years 1996 to 2002. Corresponding surveys for the updating of the data for frequency and dose have been performed continuously at the Federal Office for Radiation Protection since 1991, supported by the health service organisations.

In nuclear medicine, scintigrams of the thyroid and the skeleton are the most frequently applied methods of examination. Of increasing importance is the use of radioactively labelled monoclonal antibodies, within the framework of the diagnosis of inflammatory processes and tumours and in tumour therapy. An ever increasingly important role is also played by Positron Emission Tomography (PET) applied as a nuclear medicine diagnostic method. The operators of the PET technique assume that the number of PET examinations will considerably increase in the next few years. However, this must not necessarely lead to increased collective dose, because the mean dose per examination is clearly reduced due to the more frequent use of the 3-D-acquisition technique.

In radiotherapy, the use of newly developed exposure techniques and improved exposure planning enables the optimisation of the required therapeutic dose to be administered to the treated body region (tumour dose), while simultaneously limiting the level of radiation exposure to the remaining parts of the body. Increased efforts are needed in the area of follow-up for tumour treatment.

With the amended Radiation Protection Ordinance (StrlSchV) having come into force in 2001 and the amended X-ray Ordinance (RöV) on 21 June 2002, main aspects of radiation protection of the patient have been further improved. Analogously to the Radiation Protection Ordinance, the decision if and in which way X-rays are used in humans is now defined more clearly with the obligation of a justifiable indication laid down in the X-ray Ordinance. Furthermore, the requirements on expertise and knowledge of those persons applying X-radiation or radioactive substances or carry our examinations with these, have been increased. For the optimisation of radiation protection in radiological diagnostics, the diagnostic reference values have to be observed also in X-ray diagnostics. The surveillance of the diagnostic reference values is carried out by the medical services, and the development and up-dating is done by BfS. An additional new task of BfS is the licensing procedure for the use of X-rays in medical research.

Nuclear technology

The emission of radioactive substances from nuclear power facilities and the former Morsleben repository for low and intermediate-level radioactive waste (ERAM) contributes only insignificantly to radiation exposure to the population. The upper values for exposures to individuals, calculated in accordance with the "General Administrative Guideline relating to § 45 of the Radiation Protection Ordinance" of 21.2.1990 are clearly below the limits indicated in the Radiation Protection Ordinance. In general, the calculated radiation exposure values show no essential differences to those reported for 2002. The annual contribution from domestic nuclear installations and other installations located close to the German borders to the mean effective dose to the population of the Federal Republic of Germany remained below 0.01 millisievert, also in the year 2004.

The handling of radioactive substances in research, technology and the home environment

The use of ionising radiation and radioactive substances for technological and research purposes has not changed in comparison to the preceding year. Devices representing relatively weak radiation sources are in use, such as television sets, monitors, smoke alarm systems and anti-static equipment. The radiation exposure to individuals and the population as a whole from mechanical devices is limited by the stipulations of the X-Ray Ordinance and the Radiation Protection Ordinance and this is kept as low as reasonably achievable. The mean contribution to population exposure from the handling of radioactive substances in research, technology and the home environment is less than 0.01 millisievert per year.

Occupational radiation exposure

The mean effective dose from external radiation for all persons (approx. 313,400) controlled using personal dosimeters was about 0.13 millisievert in the year 2004. The effective dose of 0 millisievert was assessed, over the entire year, in about 84% of all controlled persons. In all other cases with an annual dose of 0.1 millisievert or more (approx. 51,500) a mean individual dose of 0,82 millisievert resulted. Since August 1, 2003, aircrews who are in an employment according to German Labour Law and who can receive an effective dose of at least 1 mSv in the calendar year because of the cosmic radiation during the flight, must be monitored. In 2004, about 30,000 persons were concerned who received a mean annual dose of 1.94 millisievert. The distribution of the annual doses corresponds to a normal distribution. The contribution to the total mean effective population dose from occupational exposure is therefore less than 0.01 millisievert in 2004.

Nuclear weapons testing

In the year 2004, no nuclear weapons tests were carried out. The long-lived radioactive substances detectable in the atmosphere and in foodstuffs mainly originate from the above-ground nuclear weapons tests performed during the 1960s. The radionuclides emitted during this period contributed in the year 2004 to a level of less than 0.01 millisievert to the mean effective dose to the population in Germany.

Radiation accidents and unusual events

Due to the strict regulations laid down in the legislation of radiation protection, radiological emergencies with persons handling sources of ionising radiation and radioactive substances are rare events. In the reported year a patient was wrongly irradiated because of a mix-up. The additional dose was about 2.5 Gy.

An overview on radiological emergencies is shown in Part III 3.

Chernobyl reactor accident

Radiation exposure resulting from the Chernobyl reactor accident decreased further in the year 2004; the mean effective dose mainly from caesium-137 was less than 0.015 millisievert. Thus it was less than one percent of the dose from natural sources of exposure and was caused about 90% by external exposure due to caesium-137 deposited on the ground. The mean effective dose from the intake of radiocaesium with foodstuff is estimated to have been less than 0,001 millisievert in the year 2004. In Southern Germany the levels of radiation exposure may be higher by one order of magnitude.

B NON-IONISING RADIATION

The domain of non-ionising radiation (NIR) consists of static and low frequency electric and magnetic fields, high frequency electromagnetic fields as well as optical radiation involving infrared and ultraviolet (UV) radiation, and ultrasound. In view of the growing technical development the general public is increasingly exposed to non-ionising radiation, above all to low frequency fields of energy supply and to high frequency fields of wireless communication networks. The expansion of communication networks in Germany, particularly the introduction of UMTS technology, is the reason for a lively public discussion about possible risks to health from new communication technologies. Today's behaviour in leisure times with long sunbathing and today's "wellness areas" with increasing use of sunbeds cause additional UV exposure. Due to the decrease of ozone layer a further increase of UV exposure to the population is feared. Static fields and ultrasound play particularly a role at some workplaces and in the medical field.

Limit values and recommendations for limit values

In order to protect the population from health effects, the international radiation protection committees give recommendations to limit exposure values. These have been adopted by the Council of the European Community. The currently applied limit values for low and high frequency installations in Germany are based on these recommendations and are stipulated in the 26. BlmSchV, (26th Ordinance on the Implementation of the Federal Immission Control Act; Ordinance on electromagnetic fields, in force since 1 January 1997).

The adherence to the limit values for fixed high frequency installations, used, e.g., in mobile communications, is controlled in a notification procedure on the granting of a site certificate from the regulation office for telecommunication and postal affairs (Regulierungsbehörde für Telekommunikation und Post, Reg TP), now Bundesnetzagentur (BNetzA), in accordance with the legal provisions of telecommunication. Reg TP declares that these limit values were not exceeded in the year 2004, the values observed fell in many cases far below the limit.

Exposure of the general public to low frequency magnetic fields emitted from fixed low frequency installations and from domestic devices lies – according to a Bavarian study – in average far below the legally stipulated limit values.

In 2004, the recommendations on limit values were again continuously checked on the basis of a national and international exchange of scientific knowledge. This evaluation has shown that the existing limit values provide sufficient protection for the population.

Optical radiation

Solar UV radiation near the soil surface is sufficiently high to have a great health effect on humans and on terrestrial and aquatic ecosystems. For the determination of risks to health, UV values are continuously registered by the UV monitoring network existing in Germany, and evaluated in view of radiation hygiene and ecology. Particularly the observed increase of skin cancer diseases is related to increased UV exposure, which can be attributed to a different social behaviour and leisure activities in great parts of the population. A reasonable behaviour with regard to sun is required to avoid acute effects such as sunburn and keratitis as well as chronic effects such as cataract, early ageing and cancer of the skin.

Current topics in the year 2004

Intensive and coordinated research is one of the precautionary measures in the area of high-frequency electromagnetic fields, particularly of modern wireless communication technology. Based on the results of a technical discussion in June 2001, the German Mobile Telecommunication Research Project was elaborated, which is implemented and co-ordinated by BfS. Until probably 2006, research projects in the fields of "biology", "dosimetry", "epidemiology", and "risk communication" will be carried out within the scope of this programme. The investigations associated with the projects are deliberately designed to deal with a broad frequency range, which goes partially beyond currently used mobile telecommunication frequencies. The objective is to prove on a scientifically reliable basis basic biological effects and mechanisms of low high-frequency electromagnetic fields and to assess their relevance to health, taking into account international research results. The aim is to achieve results which are applicable to the whole area of wireless communication technologies and, if possible, make statements on future developments (for a detailed report see Bundestagsdrucksache 15/4604).

In January 2002, BfS has founded the Round Table Solaria (RTS) with participants of scientific and public institutions as well as representatives of solaria and manufacturers of suntanning appliances. RTS aims at stipulating uniform criteria to achieve a minimum standard for the protection of the clients in solaria and offering to the operators a voluntary certification by BfS. In May 2003 agreement could be achieved concerning a catalogue of criteria and the procedure for solaria certification. BfS is the accrediting institution for those institutions who want to have solaria accredited according to the RTS criteria.

Accredited and certified institutions can be found on the BfS websites (http//www.bfs.de/nir/solarien). By the end of 2004, around 30 solaria have applied for a certification.

In mid-June 2002, the Jury on Site Certificates has decided on granting the site certificate ”Blue Angel” for low-radioactive cellular phones. Manufacturers of cellular phones can apply for the ”Blue Angel”, if their mobile phones adhere to the criteria fixed by the Jury. Besides clear consumer information and recycling requirements, this includes, among others, a comparatively low maximum radiation intensity of the appliances, expressed in the SAR unit. The Jury has stipulated in this case a maximum limit value of 0.6 Watt per kilogramme. Although some of the appliances fulfil already the requirements on radiation intensity, also in 2004 no manufacturer has applied for the site certificate.