Summary

A IONISING RADIATION

On 1 July 2002, the amendment to the X ray Ordinance (RöV) has entered into force (BGBl. I, p.1869). As a result of this the requirements of the Directive 96/29/EURATOM on the basic safety standards and the Medical Exposure Directive 97/43/EURATOM were implemented into German legislation. Analogous to the Radiation Protection Ordinance, the justifying indication for the use of X-rays in humans is now more clearly defined in an individual paragraph. For the optimisation of radiation protection, reference values have now to be applied also in X-ray diagnostics.

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 2002 is shown in the following table and classified by various radiation sources. Compared to prior years, the mean effective dose remained unchanged for most areas.

MEAN EFFECTIVE DOSE TO THE POPULATION IN THE FEDERAL REPUBLIC OF GERMANY DURING THE YEAR 2002

			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	
		outdoors (5 h/d)		approx. 0.2
		in dwellings (19 h/d)		approx. 0.9
	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. 2	
	2.3	use of radioactive substances and ionising radiation in research, technology and the home environment (excluding 2.4)	< 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	occupational radiation exposure (contribution to mean population exposure)	< 0.01	
	2.5	radiological emergencies	0	
	2.6	fallout from nuclear weapons tests	< 0.01	
		2.6.1 external outdoor exposure		< 0.01
		2.6.2 incorporated radioactive substances		< 0.01
	2.7	exposure due to the accident in the Chernobyl nuclear power plant	< 0.015	
Total exposure from man-made sources			**approx. 2**	

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 radioinuclide 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 variations 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.

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 large 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 largest part of the mean effective population dose from man-made exposure sources is due to the use of ionising radiation and radioactive substances in medicine. The dose attributable to medical radiation exposure is estimated to be about 2 millisievert per year.

Surveys performed by the Federal Office for Radiation Protection (BfS) on exposures in diagnostic radiology, with these representing by far the largest contribution, 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) surveys indicate a further slight increase of the examination frequencies, mostly due to the dose-intensive examination procedures of computer tomography and angiography including interventional radiology. The value for the mean effective dose is expected to show a moderate increase over the coming few years only - due to the increasingly successful quality assurance and control measures applied in diagnostic radiology and nuclear medicine. 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 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.

In diagnostic 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.

With the amended X ray Ordinance entering into force on 21 June 2002, main aspects of radiation protection of the patient have been further improved. Analogous to the Radiation Protection Ordinance, the decision if and in which way X-rays are used in humans is defined more clearly with the term of justifying indication. 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 radionuclides identified in the scope of environmental monitoring of the Asse mining facility are of natural origin or, in the case of strontium-90, a consequence of the natural fallout. 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 2001. 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 2002.

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. 314 000) controlled using personal dosimeters was about 0.15 millisievert in the year 2002. The effective dose of 0 millisievert was assessed, over the entire year, in about 85% of all controlled persons. In all other cases with an annual dose of 0.1 millisievert or more (approx. 47 600) a mean individual dose of 1.0 millisievert resulted. The contribution to the total mean effective population dose from occupational exposure is therefore less than 0.01 millisievert in 2002.

Nuclear weapons testing

In the year 2002, 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 2002 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. An overview on radiological emergencies is shown in Part III 4.

Chernobyl reactor accident

After the reactor accident at the Chernobyl nuclear power plant in 1986, all measured data available to the Federal Republic of Germany were documented and evaluated from the point of view of radiation hygiene.

Radiation exposure resulting from this accident decreased further in the year 2002; the mean effective dose from caesium-134 and caesium-137 was less than 0.015 millisievert. Thus it was clearly below one percent of the dose from natural sources of exposure and was caused to a level of 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 2002. In Southern Germany the levels of radiation exposure may be higher by one order of magnitude.

Radioactive waste

By order of the Federal Minister for the Environment, Nature Conservation and Nuclear Safety (BMU), the Federal Office for Radiation Protection (BfS) conducts an annual survey of radioactive residues and nuclear waste in the Federal Republic of Germany. In the process of this an inventory is made of radioactive residues, raw waste and decay waste, and the accumulation and amount of conditioned radioactive waste is determined.

On 31 December 2000, the levels of radioactive wastes in a suitable state for long-term disposal were 67220 m^3 for wastes with negligible heat generation. The amount of heat-generating wastes in Germany was small up to now.

B NON-IONISING RADIATION

The domain of non-ionising radiation (NIR) consists of low frequency electric and magnetic, and high frequency electromagnetic fields as well as optical radiation involving ultraviolet (UV) radiation. 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 planned development of communication networks in Germany, particularly the introduction of UMTS technology, has evoked a public discussion about possible risks to health from new communication tech

nologies. 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.

General mechanism of the effects of electromagnetic fields

The effects of electric, magnetic and electromagnetic fields are manifested in powers exerted to electric charges. This causes currents which dependent on frequency and intensity, may lead to stimulation processes or rising temperatures in biological tissues. Contrary to ionising radiation, the low and high frequency radiation in the frequency field of 0 to 300 GHz has not the energy to produce deleterious radicals in biological systems due to ionising procedures, and thus the potential to permanently damage the genetic structure, i.e. the DNA, as a prerequisite to cause cancer induction, is missing.

Limit values and recommendations for limit values

Based on proved health consequences, 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. BImSchV, (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, RegTP) in accordance with the legal provisions of telecommunication. The RegTP declares that these limit values were not exceeded in the year 2000.

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.

On the basis of a national and international exchange of scientific knowledge, the recommendations on limit values are continuously checked and adapted to the state-of-the-art in science and technology. This evaluation shows that from the scientific viewpoint, there exist possible risks which have to be met with precautionary measures. In particular endeavours are made to ensure and enlarge scientific knowledge by means of specific research.

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 UV monitoring carried out 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.

Actual topics in the year 2002

Intensive and coordinated research is one of the precautionary measures in the area of high-frequency electromagnetic fields, particularly of modern telecommunication. BfS worked out a research programme on the basis of an internal expert discussion in June 2001, considering the actual state of research and the recommendations of national and international expert committees. The first projects started in 2002, and the whole programme runs up to the year 2005.

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 the BfS.

The regulation office for telecommunication and postal affairs (Regulierungsbehörde für Telekommunikation und Post, RegTP) has made available in a central data bank data about the installations of telecommunication to the local authorities.

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, not any manufacturer has applied yet for the site certificate.