



Strahlenschutzkommission

Geschäftsstelle der
Strahlenschutzkommission
Postfach 12 06 29
D-53048 Bonn

<http://www.ssk.de>

**Recommendation for the continued development
of the Radiation Protection Research Programme
of the Federal Minister for the Environment, Nature
Conservation and Nuclear Safety (BMU)**

Statement of the German Commission on Radiological Protection

Adopted at the 107th session of the Commission on Radiological Protection
on December 12/13, 1991

The German original of this English translation was published in Volume 24
of the series "Publications by the Commission on Radiological Protection"
under the title:

**Vorschlag zur Weiterentwicklung des
Strahlenschutz-Forschungsprogramms des BMU**

Stellungnahme der Strahlenschutzkommission

**In the event of any doubts about the meaning,
the German original as published shall prevail.**

Contents

I	Introduction	4
II	Recommended areas of concentration in the radiological protection research programme.....	5
III	Currently promoted projects and proposals for future research topics	9

I Introduction

The performance of governmental tasks in radiation protection, in particular the recommendation of appropriate radiation protection regulations and supervision of their implementation, is achievable only on a broad basis of scientific and technological data. Research within a wide topical spectrum, reaching from the determination of the exposure of man from natural and man-made sources and the analysis of biomedical radiation effects on exposed individuals and their progeny to the technological aspects of radiation protection, the removal of radioactive waste and the precautionary measures to be taken in case of an incident or accident, has so far produced results from which the most important approaches to radiation protection measures can clearly and distinctly be seen.

Nevertheless, an even deeper and broader science- and technology related foundation through research is needed in view of the many practice-oriented questions concerning standardization and its implementation. Man's exposure from industrial radiation sources may involve doses ranging between often immeasurably low doses – normally far below those from natural radiation sources – and very high life-threatening doses in severe accidental situations. There is likewise a multitude of physical, chemical and biological factors influencing the mechanisms of radiation exposure and the biological radiation effects. New techniques in the industrial maintenance of radiation and radioactive substances and, ultimately, the principle statutory task of continuous optimization of man's protection against radiation will not allow research in this field to come to rest.

The Commission on Radiological Protection (SSK), on the basis of many years of previous research in radiation protection and in consideration of current research needs, has submitted detailed proposals for future radiation protection research programmes to the Federal Minister for the Environment (BMU) (see recommendations of the Commission on Radiological Protection of 1985/86, SSK-publications, volume 6, p. 65). During the last 5 years, this catalogue of topics served as a reference source for promoting research topics in radiation protection. The topics receiving support are listed in this report. During the time between 1986 and 1990, a total of 222 projects have been supported at an overall expense of about 160 million DM. Research results show that considerable progress has been made in population protection and that of occupationally exposed individuals.

During the past five years, new topics have emerged in radiation protection, including among others mainly radioecological problems connected with the widespread contamination of terrain, biological investigations of low dose effects, epidemiological investigations of health effects from uranium mining, protective measures in the demolition of nuclear power plants as well as the protection from non-ionizing radiation. Also, in previously emphasized areas of research, e.g. mechanical and organisational radiation protection techniques in medicine and technology, protection in emergency situations, removal of radioactive waste material, additional research is needed in the interest of gaining a deeper knowledge and achieving a wider basis for action to be taken in radiation protection.

For such reasons, SSK is herewith submitting a request for radiation protection research programs to be supported by the Federal Minister for the Environment (BMU). All major previously and supplementary recommended research topics can be divided into 10 subject areas. A brief survey of supplementary recommended topics is given in paragraph II of this recommendation. A detailed description of all so far supported research topics and of those to

be promoted in future are listed in paragraph III together with respective substantiations. The proposals for new research topics – as far as they lie within the authority of BMU – were formulated by the Commission on Radiological Protection (SSK) and its committees.

The SSK feels that the list of proposed research topics may provide fresh impetus to the selection of topics for which research support is requested and might be of technical aid in the expert assessment of such requests. The Commission, of course, is aware of the fact that the demand on financial resources must also be taken into account when selecting topics for research support. The, in part, identical coverage of proposed research topics by the radiation protection research programme of the EC reflects the existing need of such research in the interest of the protection of occupationally exposed workers and the population at large. However, due to the fact that only multi-national research programmes can be funded by the EC, these can only be regarded as supplementary to nationally promoted radiation protection research projects.

II Recommended areas of concentration in the radiological protection research programme

1 Analysis of natural and industrial (man-made) radiation exposures

- 1.1 Radon in houses in uranium mining regions
- 1.2 Radiation exposure in mines
- 1.3 Medical radiation exposure (patients)
- 1.4 Medical radiation exposure (staff)
- 1.5 Population radiation exposure from medical facilities
- 1.6 Radiation exposure of aircraft personnel

2 Measurement techniques and dose assessment

- 2.1 Realisation of new measurement units in radiation protection
- 2.2 Special developments in the field of radioactivity measurement
- 2.3 Special developments in the field of person dosimetry
- 2.4 Investigations of the kinetics of radionuclides in the body as well as the development of metabolism models and dosimetric calculations
- 2.5 Dosimetric survey of patient exposure in X-ray diagnostics
- 2.6 Dosimetry in radiation therapy with open radioactive substances
- 2.7 Further development of rapid methods for the nuclide-specific determination of alpha- and beta-radiations

- 2.8 Further development of in-situ-spectrometry, taking the shielding by depth distribution of radionuclides in soil into consideration
- 2.9 Determination of Radon daughter products and equilibrium factors in the vicinity of repositories and other sources
- 2.10 Development of methods for performing the intended sampling from the containment of nuclear power plants after larger incidents or accidents

3 Radioecological data and models

- 3.1 Verification and validation of progressed migration- and flow models
- 3.2 Investigation of the influences of orography and cultivation on the migration of emissions (particularly at calm wind conditions)
- 3.3 Determination of the wind field to employ Lagrange-models for migration calculations at KFÜ (nuclear power plant remote control system)
- 3.4 Investigations of vertical migration, including the relationship between vertical migration and transfer factors
- 3.5 Deposition of radionuclides due to rain, snow, frost and fog
- 3.6 Determination of the rates of deposition of reactive gaseous nuclide combinations on soil and vegetation
- 3.7 Establishment of measurement units for the determination of meteorological data
- 3.8 Continued investigation of iodine deposition in soil over sufficiently long isotope-specific periods of time
- 3.9 Investigation of methods for inducing immobilisation and remobilisation of radionuclides in contaminated soils
- 3.10 Continued investigations of the re-emission of radionuclides due to diffusion or air movement or any other mechanical effect after their deposition on soil or vegetation, taking iodine and tritium into particular consideration
- 3.11 Migration of radon in soil and buildings
- 3.12 Investigation of deposition and dwelling time of radionuclides in urban areas (i.e. in buildings, traffic lanes and green areas) and the resulting radiation exposure of the population
- 3.13 Investigation of the deposition of radionuclides on fruit-trees and bushes and their translocation
- 3.14 Investigations of deposition and future behaviour of radionuclides in ecological forest systems
- 3.15 The dependence of dry deposition on the vegetative plant stage

- 3.16 Investigation of radiation exposure via the water pathway in relation to stagnant waters, in view of the long-term accumulation of radionuclides in waters and the exchange process between water and soil sedimentation
- 3.17 Development of a calculation basis for near coastal sites
- 3.18 Investigations of the parameterization of transfer factors, depending on various soil parameters
- 3.19 Investigation of the differences between long- and short-lived radionuclides with transfer processes in animals, with special consideration of storage compartments and the influence of stable isotopes
- 3.20 Transfer of radionuclides in the food chain with extensive cultivation
- 3.21 Radiation exposure of plants and animals in particularly exposed ecological systems
- 3.22 Continuous development of radioecological models for accidental events
- 3.23 Development of methods for calculating radiation exposures due to emissions from fusion reactors and associated nuclear facilities
- 3.24 Applicability of existing radioecological models to natural radionuclides
- 3.25 Examination of long-term behaviour of natural radionuclides in mine dumps, tailings ponds, mines and contaminated soil, including the effectivity of remedial action

4 Somatic and genetic effects of radiation exposure

- 4.1 Mutation induced by ionizing radiation
- 4.2 Repair of radiation damage in mammalian cells as a determinant of the effect from radiation on tissues, organisms and on man
- 4.3 Analysis of epidemiological data on cancer mortality and -incidence from the view of the cancerogenic radiation risk assessment, specifically at low doses
- 4.4 Carcinogenesis from ionizing radiation
- 4.5 Cancerogenic, teratogenic and mutagenic risk to offspring from irradiation before and during pregnancy
- 4.6 Standardization of investigative methods concerning epidemiological studies
- 4.7 Molecular-biological mechanisms of the inflammation inhibiting effect of ionizing radiation

5 Analysis of radiation risks

- 5.1 Total risk from radiological examinations
- 5.2 Determination of the cancerogenic and genetic risk as a side effect of therapeutic irradiation

5.3 Comparability of terminology systems and arithmetic methods developed for assessing the risk from ionizing radiation with risk analyses in respect to other toxic agents

6 Precautionary measures for incidents and accidents

6.1 Continued development of concepts for protection in emergencies

6.2 Measures to be taken for the nutritional maintenance after widespread regional contamination

7 Methods and facilities for the optimization of radiological protection

7.1 Techniques for person decontamination

7.2 Holdback facilities for radioactive substances

7.3 Diagnostic strategies for improved radiation protection in medicine

7.4 Continued development of quality assurance procedures in radiology

7.5 Optimization of training in radiological protection and continued education

7.6 Large-scale remediation of mine dumps and tailings ponds from uranium mining

7.7 Development of methods for the control of effluent air aerosol filters in nuclear industrial facilities

8 Radiological protection during treatment and removal of radioactive waste

8.1 Investigation of decontrol measurements of waste material from nuclear power facilities

8.2 Investigation of the deposition of low radioactive contaminated waste material

8.3 System study: Problems with melting down low contaminated scrap metal from a dismantled nuclear power facility

9 Biological indicators; diagnosis, pathogenesis and treatment of radiation damages

9.1 Objectives in biological dosimetry

9.2 Treatment of radiation damages

10 Radiation protection against non-ionizing radiation

10.1 Elucidation on the increased melanoma incidence from UV-irradiation of the skin

10.2 Biological effects from pulsed ultrasound

10.3 Biological effects in the near field of HF-radiation

10.4 Investigation of so far reported hypotheses on potential effect mechanisms and further elucidation of the nature of effects from ELF-fields on a cellular level

10.5 Possible health risks from MR-examinations

III Currently promoted projects and proposals for future research topics

1 Analysis of radiation exposure from natural and man-made sources

Research projects in the topical field "analysis of radiation exposure from natural and man-made sources" shall among others, include the exposure from all natural radiation sources in continuance of previous investigations. The range of deviation of natural radiation exposure is an important reference quantity for the determination of population dose limits.

In view of the industrially changed natural radiation exposure, the foundations for a possibly necessary extension of the validity range of the radiation protection regulation shall be established. This includes the determination of Radon exposure outdoors, in dwellings, in mines and in the vicinity of waste rock dumps and tailings ponds.

A further focal point is the inclusion of the remaining components of man-made radiation exposure sources, particularly in medicine and for aircraft personnel.

Currently promoted projects:

00593-1	Investigations on the radionuclide activity concentration in near soil air and its seasonal deviations
00603-1	Measurement surveys for determining the current radiation exposure in residential- and dwelling places
00697b-1	Measurements of Radon and its daughter products in residential places and outdoors and assessment of the resulting radiation exposure of the population
00946-1	Radioactive substances in human bone
00950-7	Radiation exposure of patients from medical measures
00951-1	Development and application of a model to calculate the Radon distribution in houses
00955-6	Investigations on the effect of Radon emission from the test mine Krunkelbach on workers and the environment
00975-7 4013-7	Radiation exposure of the patient from the nuclear-medical use of labelled antibodies
00977-7	Determination of radiation dose from the use of radioactive labelled monoclonal antibodies
00991-4	Determination of the radiation exposure to man after skin contact with radionuclides

01006-1	The geological influence of subsoil on the exposure from natural radiation in the Federal Republic of Germany
01008-1	Revision of the annual report on "Environmental Radioactivity and Radiation Exposure"
01009-7	Types and frequency of nuclear-medical examinations and the related radiation exposure of patients and the entire population
01016-1	Performance and evaluation of total body measurements subsequent to the reactor accident in Chernobyl
01018-1	Long-term control of children and adults in regard to incorporation due to Chernobyl
01020-1	Measurement of the course of incorporation of radioactive fission products in adults and children during the years 1986 - 1989
01024-1	Identification and quantification of radionuclide incorporation in the human body
01030-1	Compilation, documentation and radiological assessment of measurement data existing in the Federal Republic of Germany due to the reactor accident in Chernobyl
01062-1	Incorporation measurements of occupationally radiation exposed persons
01087-1	Occupational radiation exposure from Radon
01070-1 4015-1	Radioactivity in game
01091-1	Radiocesium in game
01093-1	Radionuclides in the deep sea
01110-6 4029-6	Risk from incorporation and measurement of persons occupationally exposed to radiopharmaceuticals emitting low energy gamma-radiation
01117-1	Analytical and measurement-technical determination of parameters for the radiological surveillance of incineration plants
01118-1	Geogenic factors of radiation exposure with special consideration of the Radon potential
01132-1	Radiation exposure due to the handling of residual material from coal incineration
4008/2-4	Radiological identification, investigation and evaluation of mining residues (residue register)
4038-3	Calculation of the external radiation exposure of persons evacuated in the Ukraine after the reactor accident at Chernobyl (external radiation exposure)

4039-3	Investigations of the internal radiation exposure of the Ukraine population with Iodine and Strontium after the reactor accident at Chernobyl (internal dosimetry)
--------	--

The following research topics are recommended for future support:

1.1 Radon in residential buildings in uranium mining regions

Substantiation:

A sensible decision on remedial actions for residential buildings with increased Radon content is possible only when the actually prevailing conditions are known. Identification of the Radon content is, simultaneously, the basic condition for a scientific determination of the epidemiological correlations.

1.2 Radiation exposure in mines

Substantiation:

The radiation exposure of mine workers with radioactive noble gases and their aerosol-bound decay products as well as the exposure due to radioactivity contained in rock is not yet fully known. Such data are equally necessary for industrial medical assessment and as source of epidemiological information on chronic occupational exposure to radiation. For the necessary determination of the concentrations of Radon and Radon daughter products in mine and surface air, the associated factor "dust" and the component "direct radiation" should likewise be determined.

This research topic is currently of great importance for the mining regions in Saxony and Thuringia. Only by a quantitative determination of the radiation exposure of mine workers will it be possible to establish dose-effect-relationships for radiation induced lung cancer.

1.3 Radiation exposure in medicine (patients)

Substantiation:

A declared aim in developing new techniques in radiology and nuclear medicine, apart from the improvement of diagnostic and therapeutic efficiency, is also the reduction of radiation exposures.

In particular it is recommended to establish a catalogue of radiation exposures due to commonly performed X-ray diagnostic and medical examinations and to consider the possibilities of their further reduction. There is a special need for research in areas such as data processing and continuous control of medically caused radiation exposures due to conventional and new diagnostic procedures as, for example, digital subtraction-angiography (DSA), digital luminescence-radiography (DLR), computer tomography (CT) or bone density measurements.

Surveys of patient radiation exposures are also an important basis for clarifying the risks related with the medical use of X-ray diagnostic methods.

1.4 Radiation exposure in medicine (staff)

Substantiation:

Newly introduced methods require the determination of values for the occupational exposure of the medical staff in X-ray- and nuclear medical diagnostics and therapy.

1.5 Radiation exposure of the population from medical facilities

Substantiation:

The population exposure from effluent air emitted by medical facilities (e.g. radiology departments in hospitals) should be determined. The results will answer the question whether filtering requirements or control measurements procedures are to be generally recommended for such air effluents.

1.6 Radiation exposure of flight personnel

Substantiation:

The radiation exposure of personnel in high altitude commercial aircrafts from cosmic radiation is of greater magnitude than that on the ground surface. A wide spectrum of ionizing particles must be considered when calculating body doses, assessing biological effects and developing dose measurement devices.

2 Measurement technology and dose determination

Different ionizing radiations are used in technology and medicine or occur as an accompanying phenomenon of nuclear technology. They include a wide spectrum in regard to radiation type, dose rate and energy range as well as to the types of radioactive substances. Universally applicable and maximum usable dose measurement devices and adequately accurate methods of dose assessment ascertain that a reliable dose determination with the least possible cost can be made at various exposure conditions.

Paragraphs 46, 61, 62 and 63 of the Radiation Protection Regulation require the measurement of activity released from a nuclear industrial facility, local dose measurement in the facility and measurement of activity in the body or personnel dose to occupationally radiation exposed individuals as well as the assessment of body doses, taking the exposure conditions into consideration. In order to more realistically control the adherence to limiting values and to the principles set forth in paragraph 28 of the Radiation Protection Regulation to apply in these areas at a justifiable cost for measurement devices, it is necessary to improve the existing dosimeter systems and to develop new measurement systems as well as to review and, if needed, to correct dosimetric models and data.

In current research projects existing dosimeters are modified and tested as to their use in special cases and their application possibilities examined. The development of methods for calculating body doses from external and internal radiation exposure of various age groups and at particular conditions is an important approach towards a quantification of the occupational and general radiation exposure. In some research projects the concentrations of radioactive substances in the environment are being measured. This is done in view of special nuclides by particular methods of determination in environmental areas such as air, water, soil as well as in the food chains up to man. For purposes of comparison, it is necessary to standardize measurement- and calculation methods.

Currently promoted projects:

00864-3	Computerized compilation of measurement guides for the control of radioactivity in the environment
00972a-2	Determination and sensitivity analysis of dose factors for external and internal radiation exposure with particular consideration of embryo, fetus, children and adolescents
00972b-2	Studies on the determination of radiation exposure from the uptake of radioactive substances in man
00981-2	Development and investigation of high energetic photon fields in radiation dosimetry
00986-2	Principles and criteria for the use of a proportional counter in neutron-person-dosimetry
01000-2	Neutron dosimetry in nuclear power plants with LWR
01002-2	Physical parameters for the definition of quality factors in radiation protection
01005-2	Testing of BeO-person-dosemeters
01014-2	Evaluation of an international test series on imaging systems in nuclear medicine
01015-2	Neutron equivalent dose rate meter according to the single-sphere albedo measuring method
01022-1	Determination of incorporated radioactivity by a whole body counter
01023-3	Study on new concepts in the control of environmental radioactivity
01028-2	Incident iodine monitor
01034-1	Incorporation measurements with a high resolution semiconductor detector
01036-2	Investigations of large area beta-radiations for the calibration of radiation protection dosemeters and contamination monitors
01040-2	Development, testing and use of rapid methods for determination of nuclide-specific atmospheric contamination
01041-2	In-vivo measurements of actinides
01042-2	Measurement and disposal of surface contaminations
01048-2	Calculation of organ shielding factors for pregnant women and fetuses as well as of dose-rate-factors for fetuses, children, adolescents and pregnant women
01057-3	Data-processing concept of the integrated measurement net for the control of environmental radioactivity according to the precautionary radiation protection law (StrVG)

01059-2	Technical optimization of TSEE-analysis equipment
01061-2	Field study – practical use of a new partial body measurement system
01063-3	Testing of airborne gamma spectrometry for radioactive fallout mapping
01067-3	Skeleton announcement on the integrated measuring and information system for the control of environmental radioactivity
01076-2	Testing of a phosphate glass dosimetry system
01080-2	Determination of the intestinal absorption (fi-values) of radionuclides from food and of specific influencing inhibitory substances
01083-2	Rapid determination of strontium-, plutonium- and technetium isotopes in air by laser mass spectrometry
01084-2	Examination of stochastic methods for determining detection limits in nuclear radiation measurements
01085-2	Analysis of radioactive strontium isotopes in aerosole by use of accelerator mass spectrometry
01094-2	Rapid methods for determining plutonium, americium and neptunium
01100-2	Investigation of calibration methods for neutron-person-dosemeters
01102-2	Step-converter examinations for Cr-39 detectors in neutron dosimetry
01106-2	Detection- and identification limits in spectrometric nuclear radiation measurements
01108-2	Development of proportional Geiger tubes
01112-4	Comparative studies for determining thyroid activity from the incorporation of iodine isotopes by partial and whole body counters
01113-2	Establishment of assessment criteria for measuring radon and its decay products in buildings
01114-2	Assistance in the surveillance of the project "Integrated Measurement- and Information System for the Control of Environmental Radioactivity"
01120-2	Application of proportional counters in neutron-person-dosimetry
01121-4	Determination of radiation dose in "non-storage organs" for thorotrast
01124-2	Measurement of potassium 40 and cesium 137 in infants
01126-2	Incorporation control of occupationally radiation exposed staff in nuclear medicine

01134-2	Establishment and investigation of defined radon fields for the calibration of radon dosimeters
4002-2	Revision of guidelines
4004-2	Frequency distribution and concentration of "non-accumulated" radon decay products and concentration of thoron and its decay products in indoor air (inclusive of investigations in Thuringia and Saxony)
4005-3	Issuance of expert judgement on the IMIS-IT-project
4009-2	Expansion of dosimetric concepts for radiation protection purposes
4019-2	Radon measurement within the scope of inter-German collaboration in the field of radiation protection
4020-2	Rapid determination of strontium-, plutonium- and technetium isotopes in air by laser mass spectrometry
4021-2	Analysis of radioactive strontium isotopes in aerosoles by use of accelerator mass spectrometry
4022-4	Tissue equivalent phantom materials
1046-4	

The following are research topics recommended for future support:

2.1 Realisation of new measuring quantities in radiation protection

- Development of principles for equipment calibration and calibration procedures
- Investigation of the energy- and direction dependence of available site and person dosimeters relative to the new measuring units
- Development of requirements for measuring equipment to measure the new measuring units; adaptation of test rules, DIN-(german industrial) standards and KTA-(nuclear industrial facilities) rules
- Adaptation of measuring equipment design and measuring methods
- Adaptation of calculation principles for determining body doses from site and personnel doses
- Conversion of tables for attenuation coefficients, shielding factors, etc.
- Conversion of tables for dose rate constants

Substantiation:

The incompleteness and inconsistency of measuring quantities used for the individual radiation- and exposure types were frequently the reason for uncertain or unreasonably high body dose assessments. By the introduction of new measuring quantities (ICRP 39, ICRP 43, DIN 6814, part 3), international developments have pointed towards a

basic improvement of the situation with site- and person dosimeters. The continued development of standard measurement methods, of requirements on measuring equipment, calibration techniques and practical measurement methods is needed.

2.2 Specific developments in the field of activity measurements

Substantiation:

Methods for measuring radioactive surface contaminations, in particular external and internal body surfaces in man, must be further developed to decrease the necessary measurement time and to improve the reliability of evidence in reference to quantities limited by statutory enactment.

Standardization and specification of activity determination by whole body measurements have gained in significance for widely contaminated areas.

For activity measurements in air and water, in vegetation samples, body fluids and excretions, the accuracy and consistency of measurement must be improved by the development and availability of special calibration test preparations. For alpha emitters, special measurement methods must be developed for the measurements of technically difficult samples. In spite of the extremely low probability of nuclear industrial accidents to occur, techniques must be developed by which high activities in air and water effluents can be accurately determined as precautionary measures.

2.3 Special developments in person dosimetry

Substantiation:

It is necessary to further develop measurement techniques for β -radiation, for neutrons and for low energy photons, to enlarge the range of measurements and to achieve a higher measurement consistency of a number of new dosimetric techniques. The uncertainties in environmental radiation measurements should be reduced because the latter serve as a reference base for the future operational control as investigative measurements taken prior to putting nuclear industrial facilities into operation.

2.4 Investigations of the kinetics of radionuclides in the body and the development of metabolic models and dosimetric calculations

Substantiation:

Improvement and completion of metabolic models for various incorporated radionuclides for purposes of dose calculation including the medical use of radionuclides as diagnostic and therapeutic agents. Consideration of age dependency and of chemical and biochemical parameters. Continuation of the dosimetric calculations and extension of the list of known radioactive substances. Influence of other involved toxic agents on radionuclide kinetics.

2.5 Dosimetric determination of patient exposure in X-ray diagnostics

Substantiation:

As an important approach towards the determination of organ doses in X-ray diagnostics, the measurements of entrance dose, e.g. by TLD, as well as the measurements of area dose products should be continuously developed.

2.6 Dosimetry in radiotherapy with open radioactive substances

Substantiation:

Efforts are necessary to raise the level of dosimetric accuracy in the radiotherapeutic use of open radioactive substances to that of tele- and brachytherapy.

2.7 Further development of rapid methods for the nuclide-specific determination of alpha- and beta-emitters

Substantiation:

In events with considerable radiological consequences, the measurement of gamma-radiation is presently possible for a rapid assessment of the situation. In most conceivable cases this information must, however, be complemented as quickly as possible by data on the content of alpha- and beta-emitters. This requires rapid methods for nuclide-specific determination which so far are available in only a limited extent.

2.8 Further development of in-situ-spectrometry, considering shielding due to the depth distribution of radionuclides in soil

Substantiation:

By in-situ-gamma-spectrometry it is possible to rapidly determine the nuclide-specific soil contamination in events with considerable radiological consequences. The evaluation methods which consider the depth distribution of radionuclides in soil must be improved so as to minimize the time-consuming measurement of soil profiles.

2.9 Determination of Radon daughter products and equilibrium factors in the vicinity of mine dumps and other sources

Substantiation:

Knowledge on the variable range of concentration of Radon daughter products or equilibrium factors in the vicinity of mine dumps and other sources must be improved in view of different dispersion conditions (meteorology, orography) so as to ascertain the assessment of the radiological situation.

2.10 Development of methods for the proposed sampling from the containment of nuclear power plants after larger incidents or accidents

Substantiation:

For the prediction of emissions and immissions after larger incidents or accidents it is necessary to know the radionuclide composition in the containment. Appropriate sampling techniques must be developed.

3 Radioecological data and models

The subject of the research projects is the dispersion of radioactive substances released into the environment with air and water. For this, it is necessary that specific concentrations are analysed in the individual ecological systems, in particular in view of the food chains. The results of such investigations should enable a realistic evaluation of the radiation exposure from the release of radioactive substances within the scope of radioecological models.

The immission concept in paragraph 45 of the radiation protection regulation requires that dose limits are to be observed in the vicinity of nuclear power plants. From the given release values, realistic immission values for the environment and thus for the radiation exposure of man can only be determined when the ecological behaviour of nuclides is well known. The results from studies examining the dispersion of radioactive substances in the environment are used to ascertain the adherence to dose limits in accordance with the radiation protection regulation within the framework of the authorization process.

Radioecological data are determined during the currently conducted research projects with the goal to verify or improve radioecological models. This includes atmospheric dispersion models which are likewise examined and experimentally tested. Further investigations are done for the purpose of establishing guidelines for the control of environmental radioactivity and for perfecting automatic control system.

Currently promoted projects:

00630-3	Radioecological studies at the lower Elbe river and the annexed estuary
00746-3	Radioecological investigations of the food chain air-soil-grapevine-wine
00781f-3	Radionuclide behaviour in sediment and sewage sludge in the Rhine and Weser rivers
00881-3	Mathematical-statistical testing of radioecological calculation methods
00913-3	Studies of the radioecology of iodine 129 with special consideration of the conversion of the iodine compounds under environmental conditions
00952-3	Calculation of radiation exposure in the vicinity of nuclear power facilities on the basis of actual on site weather data
00959-3	Accumulation of radionuclides in fish during normal operation and after incidents at nuclear power plants
00971-3	Comparison of three procedures to separate Kr 85 of the WAA (reprocessing plant) 350 with regard to radiation exposure
00979-3	The behaviour of chemicals used in nuclear fuel reprocessing in the ground with special consideration of ground water hazards
00984-3	The dispersion of man-made radionuclides in the North-Sea
00993-3	Experimental determination of long-term dispersion factors by simultaneous C 14 and Kr 85 measurements in the vicinity of the reprocessing plant Karlsruhe

00996-3	Wind tunnel studies to determine interfering influence on the dispersion of radioactive substances released from nuclear industrial facilities in the immediate building vicinity
01004-3	Studies on the realism of radioecology models
01011-3	Studies on the atmospheric dispersion of noxious substances after short-term emissions in uneven terrain
01012-3	Transport models and groundwater flow processes of radioactive substances in porous and cleft media
01017-3	Extension of the Lagrange-dispersion model and validation of the model in regard to its use in divided terrain
01033-3	Investigations of the transfer of Cs 137 in critical exposure pathways
01035-3	Comparison between the dynamics of Cesium and Potassium in soil
01037-1	Investigations of the transfer of Cs 137 and Sr 90 from food into mother's milk
01038-3	Determination of regional eating habits as a basis for the derivation of reference values
01043-3	Uptake and distribution of radioruthenium in plants for the exposure pathway air/plants
01047-3	Deposition of radionuclides via snowfall and fog and comparison with the deposition via rain and in dry weather
01051-3	Decrease of man-made radioactivity after deposition in urban environment
01055-3	Experimental verification of dynamic radioecological models after Chernobyl
01071-3	Development of a dynamic model for the calculation of radiation exposure via the water pathway in stagnant and flowing waters
01074-3	Investigations of the dispersion of radioactivity in the north-east Atlantic
01109-3	Concept of a register for occupational radiation exposures
01116-3	Investigations of the radioecology of Iodine 129 with special consideration of the conversion of iodine compounds under environmental conditions
01138-3	Transport of radioactive substances in saturated and unsaturated soil zones
4012-9	Assessment criteria and projects for remedial action on the uranium mining areas in the federal states Thuringia, Saxony and Saxony-Anhalt
4018-3	Influence of physical, physiochemical and biological processes on migration and plant availability of iodine 129 in three agriculturally important soil types

4025-3	Deposition of radionuclides via snowfall and fog and comparison with the deposition via rain and in dry weather
4036-3	Investigations of the influence from the supply of milkcows with stable iodine on the transfer of I 131 from feed into milk

The following research topics are recommended for future support:

- 3.1 Verification and validation of advanced dispersion and flow models
- 3.2 Investigation of the influence from orography and cultivation on the dispersion of emissions (particularly at low wind conditions)
- 3.3 Determination of the wind field for applying Lagrange-models for the calculation of dispersion in the KFÜ
- 3.4 Investigations of the vertical migration including the relationship between vertical migration and transfer factors
- 3.5 Deposition of radionuclides via rain, snow, hoar-frost and fog
- 3.6 Determination of deposition rates of reactive gaseous nuclide compounds on soil and vegetation
- 3.7 Establishment of measurement units for the determination of meteorological data
- 3.8 Continued investigation of iodine transfer in soil over sufficiently long and isotope-specific determined periods of time
- 3.9 Investigation of methods for inducing immobilisation and remobilisation of radionuclides in contaminated soils
- 3.10 Continued investigation of the re-emission of radionuclides – as based on diffusion or air motion or other mechanical effect – after their deposition on soil or vegetation with special consideration of iodine and tritium
- 3.11 Dispersion of radon in soil and buildings
- 3.12 Investigation of the deposition and retention of radionuclides in urban areas (i.e. on buildings, roads and lawns) and the resulting radiation exposure of the population
- 3.13 Investigation of the deposition of radionuclides on fruit-trees and bushes and their translocation
- 3.14 Investigation of the deposition and further behaviour of radionuclides in forest-ecology systems
- 3.15 Dependence of dry deposition on the vegetative plant stage
- 3.16 Investigation of radiation exposure via the water pathway in relation to stagnant waters and considering the long-term accumulation of radionuclides in waters as well as the exchange processes between water and soil deposit

- 3.17 Development of a calculation basis for near-coastal sites
- 3.18 Investigations of the parameterization of transfer factors, depending on different soil parameters
- 3.19 Investigation of the differences between long- and short-lived radionuclides in transfer processes in animals and with special consideration of storage compartments and the influence of stable isotopes
- 3.20 Transfer of radionuclides in the food chain with extensive cultivation
- 3.21 Radiation exposure of plants and animals in particularly exposed ecology systems
- 3.22 Continued development of radioecological models for incident case
- 3.23 Development of calculation methods for radiation exposure due to emissions from fusion reactors and associated facilities
- 3.24 Applicability of available radioecological models for natural radionuclides
- 3.25 Long-term behaviour of natural radionuclides in mine dumps, tailings ponds, mines and contaminated terrain, including effectivity control of remediation

General substantiation:

The above listed projects refer to radioecological calculation methods and measurements of radiological phenomena in ecology systems. Their study results in a necessary supplement to all so far available radioecological calculation materials. Not only additional dispersion pathways but also additional radionuclides (especially natural radionuclides) must be considered. The measurement methodology is discussed in paragraph 2.

4 Somatic and genetic effects of radiation exposure

The investigations of the principles involved in phenomena and mechanisms of biological radiation effects must be continued on account of their crucial significance for the evaluation and limitation of radiation risks, in particular at low doses and distribution of radiation exposure with time.

The determination of dose-effect-relationships is possible either by way of biological and medical examinations for various radiation types, doses and dose rates or on hand of epidemiological studies. Aside from the effects of ionizing radiation alone, the combined effects from noxious agents in the environment and those from ionizing radiation must be examined.

The radiation protection regulation recommends dose limits for occupationally exposed individuals and for the population. The results from such investigations are serving the purpose of re-examining and, if necessary, of supplementing these regulations in order to ensure the protection of man from the dangers of ionizing radiation.

Currently promoted projects:

00634-4	Long-term empirical-statistical assessments of health risk, in particular cancer risk, caused by radiation exposure of the population
00634/1-4	Long-term empirical-statistical assessment of the health risk and harm to the population caused by radiation exposure, in particular the assessment of cancer risk and the risk of malformations in newborns as well as infant mortality
00656a-4	Biological effects from low energy electrons
00698-4	Studies on pre-implanted mice embryos
00716a-4	Teratogenic radiation effects, phenomenas, dose-effect-relationships and risk areas
00716b-4	Diaplacentary passage and teratogenic effects from radioactive substances, compilation and evaluation of international literature
00718-4	Mutations induced in mammalian cells from low doses of ionizing radiation
00730-4	Methods for the assessment of risks to the population as a basis for the analysis and performance of epidemiological studies on radiation effects in the low dose range
00730/1-4	Statistical analysis and evaluation of results on thyroid cancer risk from radioiodine tests
00812-4	Studies on the assessment of late effects in man from artificial irradiation (thorotrast patients) – Follow-up study
00911-4	Effects from low radiation doses on the development of amphibians
00956-4	Dose-effect-relationships at low radiation doses via the Ames-test
00960-4	Reliability of studies on the determination of risk coefficients
00978-4	Examinations of the effect of incorporated radioactive and non-radioactive particles and their synergism on animals
00992-4	Examinations of the effects of incorporated radioactive and non-radioactive particles and their synergism on animals
00999-4	Oncogenic in vitro cell transformation due to ionizing radiation
01046-4	"Births 87" – exposures during pregnancy and early infant development; epidemiological study on the course of pregnancy subsequent to the reactor accident in Chernobyl
01075-4	Effects from low radiation doses on the metabolism of bone marrow cells, in particular on the control of protective mechanisms
01095-6	Epidemiology of radioiodine patients

01097-4	Epidemiological study of cancer during infancy occurring in the vicinity of nuclear power plants
01119-4	Examinations of the effect of hemopoietic growth factors on the radiosensitivity of hemopoiesis and the capacity of regeneration
01122-4	Investigation of the effect mechanism of ionizing radiation during early pregnancy in the mouse
01128-4	Teratogenic effects of ionizing and non-ionizing radiation phenomena, dose-effect-relationships and risk areas – model tests on mammals
04026-4 01096-4	Cellular repair processes
04033-6	Development of thyroid cancer after applications of ¹³¹ iodide in the course of radioiodine tests in children

Research topics proposed for future promotion:

4.1 Mutation induction from ionizing radiation

Substantiation:

Due to latest developments (primarily in the field of molecular biology), very extensive source material is available on analytical methods for examining genetic and somatic mutations.

This provides for

- a) a deeper insight into molecular repair processes and processes of mutation induction,
- b) the use of new mutation assays in mammalian cells or rodent-man-hybrid cells and
- c) the compilation of important findings on the question of a possible cancer disposition by genetic process (from the use of new methods).

4.2 Repair of radiation damage in mammalian cells as a determining factor of radiation effects on tissues, organisms and on man

Substantiation:

Further clarification of repair and false repair mechanisms of radiation damaged human and mammalian cells, e.g. the dependence of the repair kinetics on the cell cycle stage and on other biological parameters, is of essential significance for radiation protection, particularly at low doses and different dose distribution over time. Cell repair processes of damaging effects from radiation are factors which essentially influence dose limit values as to their degree and differentiation over time.

4.3 Analysis of epidemiological data on cancer mortality and -incidence for an assessment of the cancerogenic radiation risk, in particular at low doses

Substantiation:

An analysis of epidemiological data is indispensable for assessing the risk from radiation for man. In carrying on the basic studies on the evaluation of late effects of the atomic bomb victims of Hiroshima and Nagasaki the following topics are of significance:

- a) Lung cancer risk for uranium miners
- b) Leukaemia- and cancer risk for the population in connection with uranium mining
- c) Leukaemia- and cancer risk for occupationally exposed persons
- d) Leukaemia- and cancer incidence in the vicinity of nuclear industrial facilities
- e) Analysis of the occurrence of leukaemia in clusters.

4.4 Carcinogenesis from ionizing radiation

- a) Molecular biology of neoplasmas
- b) Oncogenic activation or oncogenic suppressor-deactivation

Substantiation:

By the inclusion of molecular biological and experimental genetic investigative methods it is intended to receive information on the oncogenic activation or deactivation mechanisms and on their significance for the induction and promotion of cancer. The ability to classify a tumour by the inducing agent would be of essential significance for risk assessment and a basis on which to identify specifically work-related diseases in occupational medicine.

4.5 Carcinogenic, teratogenic and mutagenic risks to offspring from irradiation before and during pregnancy**Substantiation:**

Extension of the quantitative and qualitative basis for the assessment of radiation exposures before and during pregnancy. The emphasis is on disorder in the neural development.

4.6 Standardization of epidemiological investigative methods**Substantiation:**

For summarizing the results from several studies (meta-analysis) as well as for assessing studies of alternative design, a standardization of epidemiological investigative methods is needed.

4.7 Molecular biological mechanisms of the antiphlogistic and stimulating effect of ionizing radiation

Substantiation:

For a scientific assessment of the antiphlogistic effect of ionizing radiation applied in balneology and for the assessment of such uses in view of radiation protection, it is indispensable to clarify the underlying biological molecular mechanisms. In view of scientific assessment and of radiation protection it is necessary to examine in what extent the results concerning the stimulating effects of ionizing radiation found in some individual biological systems, e.g. plants, could be transferred to man.

5 Analysis of radiation risks

Introduction:

The quantitative compilation of radiation risks in relation to the various occupational and man-made exposures of individuals and of occupational- or population groups is one of the continuous tasks in radiation protection research and an indispensable basis for the development and comparison of optimizing methods.

Currently promoted projects:

00870-1	Questions concerning radiation protection in the production, use and removal of natural-radioactive materials
0967-1	Radiation risk of the population from radionuclides in the deep sea
01044-7	Benefit and risk from radioiodine treatment of patients suffering from hyperthyroidism
01066-1	Lung cancer risk from radon in the Federal Republic of Germany
4006-1	Lung cancer risk from radon in Germany, case study Thuringia and Saxony
4033-1	Radiation Protection of man and the environment – 25 years Professional Society for Radiation Protection

Research topics proposed for future promotion:

5.1 Total risk from radiological examinations

Substantiation:

For a quantitative risk assessment of radiological examinations, such factors as age distribution of the exposed individuals or actual frequency of examination require special consideration.

5.2 Determination of the carcinogenic and genetic risk as a secondary effect of radiotherapy

Substantiation

Due to the increased remission rates in radiotherapy, the quantitative determination of carcinogenic and genetic secondary effects is gaining in significance.

5.3 Comparability of terminology systems and calculating methods developed for assessing the risk from ionizing radiation, with risk analyses of other toxic agents

Substantiation:

It was shown that models developed for ionizing radiation basically apply also to other toxic agents for which no intrinsic development exist but where a risk assessment would be reasonable. This clarification is also indispensable for the assessment of combined risks.

Proposals for the analysis of radiation risks from non-ionizing radiation are not listed here; they are, however, contained in paragraph 10.

6 Prevention of incidents and accidents

It is the goal of the research project to quickly determine the extent of imminent radiation exposures of the population and the staff of nuclear industrial facilities in accident situations; to further develop suitable methods, techniques, procedures and equipment in consideration of effectivity, practicability, planning and optimization of emergency protection procedures; and thus by proper planning provide an optimum of protection against radiation injuries from nuclear industrial accidents.

The results from investigations, studies and expert assessments are either directly used for the decisions by BMU, in accordance with its respective authority for controlling legality and practicability as per article 85 GG (basic constitutional law) in reference to the atomic law and the radiation protection regulation, or are used for progressive analyses aimed at the further development of radiation protection. In particular assessed are investigations in connection with articles 36 to 38 of the radiation protection regulation and with the "framework of recommendations for protection in emergency situations" to actualize the criteria of emergency protection procedures.

In addition, special measurement possibilities are tested within the scope of currently promoted research projects and the effectivity of emergency protection procedures is examined as well as the efficiency of specific radiation protection procedures.

Currently promoted projects:

00980-5	Determination and demonstration of the extent and benefit of emergency protection procedures for different types of accidents in nuclear power plants
00997-5	Investigations of the impact of new results from risk analyses on emergency protection planning in the vicinity of nuclear industrial facilities
01013-5	Application range and limits of Gauß-models for calculating the dispersion of accident-related airborne radionuclides
01019-5	Investigations of the decontamination of urban surfaces (Part B)
01021-5	Investigations of the decontamination of urban surfaces (Part A)
01025-5	Assessment of possible radiation exposure after a single emission from rapidly available data

01026-5	Investigations of the dynamic behaviour of radionuclides after incidents for the development of emergency protection procedures
01027-5	Compilation of medial facilities concerning medial attention after radiation accidents
01032-5	Development and practical use of rapid methods for the detection of accident-related environmental contamination
01054-5	Computer-supported decision aids in nuclear industrial emergencies with application possibilities tested in exercises and training
01056-5	Investigation of the resuspension of plutonium in the biosphere
01065-5	Evaluation of the environmental burden after higher emissions, part II (development of the system OLDES into a nuclear facility remote control system (KFÜ)-element)
01069-5	Development and establishment of an automated station for the control of aerosol activity
01072-5	Guide for expert advisors to persons in control of catastrophic protection in the event of a nuclear industrial emergency
01073-5	Establishment of an expert real-time data processing system for assessing and limiting radiological effects in the Federal Republic of Germany from accidents in nuclear industrial facilities with large-scale consequences
01077-5	Checking modifications of ABNG (Basic Calculations for Exposure by Radioactive Releases with Waste Air or into surface Waters) and SBG (Basic Calculations for Incidents in Nuclear Installations) for implementation as a calculation method for AVV (General Administrative Provision Concerning Section 45 of the Radiation Protection Regulations) in accordance with paragraph 45 of the radiation protection regulation
01082-5	Emission control of radioactive substances released from the effluent air stack during incidents or accidents occurring in foreign nuclear power plants
01089-5	Medical guide- and information system after radiation accidents
01090-5	Concept of a „Kontrollbereichsüberwachung" (control area surveillance) by considering the relevance of radiological contaminations
01105-5	Studies on the adaptation of new results from risk analyses for emergency protection planning in the vicinity of nuclear industrial facilities
01115-3	Calculation of radioepidemiological tables for the Federal Republic of Germany
01125-5	Preparations for the damage control in accidental and incidental situations
2002-5	Radiological relevance of contaminations

4023-5 Program system for assessing and limiting radiological consequences with widespread radionuclide contamination (PARK)

Research topics proposed for future promotion

6.1 Further development of emergency protection concepts

Substantiation:

In the discussion of emergency protection concepts and strategies, new modern communication techniques must now be considered more than before. Concerted actions must be taken should incidents occur.

6.2 Procedures to safeguard the food supply after widespread contamination

Substantiation:

The experiences in consequence of the reactor accident in Chernobyl emphasize the importance of this research topic.

7 Methods and facilities for optimizing radiation protection

Within the scope of a research project, precautionary measures, techniques and equipment must be developed that result in a reduction of radiation exposure and thus in an improved radiation protection. In medicine, these are dose-reducing methods and devices but also quality assurance procedures. In the nuclear industrial area this includes equipment, shielding, enclosures, detention devices, transport and storage methods, all of which contribute to dose reduction, as well as special decontamination procedures. Lastly, an effective radiation protection must be achieved by optimal training in the above named areas of radiation protection.

By use of the research results, it is intended to initiate measures for the optimization of radiation protection within the framework of BMU-supervision measures in accordance with article 85 GG.

The current research projects are concerned with the extent of the effectivity of radioactive substances used in medicine and with quality assurance procedures. Also, in the nuclear industrial area, methods for decontamination, detention and enclosure as well as the sealing density of transport containers are further developed for the optimization of radiation protection; respective regulations are being developed.

Currently promoted projects:

00685-7	Development of guidelines in radiation protection technology
00887-7	Effectiveness of the use of radiation in pediatrics
00878-7	Radiation protection regulations for the technical use of sealed radioactive substances; handling of site-transferable equipment for gamma-radiography
00921-7	Investigations of the occurrence and separation of iodine compounds in effluent air emitted from nuclear power plants

00923-6	Investigations of radiation protection against emissions from the nuclear fuel circuit at the place of work
00943-7	Investigations of sealing systems and sealed enclosures for the transport and storage of radioactive substances
00954-6	Improvement of the radiation protection of individuals with a work permit in accordance with paragraph 20 of the radiation protection regulation (StrlSchV) by investigating the radiation exposure at the respective work place
00974-6	Compilation and evaluation of significant data for operational radiation protection in nuclear industrial facilities
00995-7	Examinations of the physical aspects of quality assurance in brachytherapy
01001-6	Investigations on the transport of radioactive substances
01010-6	Radiation exposure from the use of residual substances from fuel element factories
01045-6	Studies on the possible recycling of nuclear power plant scrap into the nuclear industrial circuit by cast container production
01045-6	Quality control of technetium-99m-generators
01053-7	Further development and testing of a method to demonstrate and measure the blood circulation of myocardium and brain
01079-7	Optimization of radiation protection against uranium-hexa-fluoride containers 48y
01081-7	Investigation of the safety reserves of sealing systems used in the transport and storage of radioactive substances
01086-7	Optimization of the radiation protection of uranium mine workers by examining and reducing the radiation exposure
01088-7	Development of a detail-specific concept and cooperation for establishing a computer-aided method for the control of radioactivity in the environment
01092-7	The organisation of radiation protection in German nuclear power plants
01099-7	The organisation of radiation protection in German nuclear power plants – Instrumentation of radiation protection reports
01101-6	Investigations of radiation-specific aspects concerning the transport of radioactive substances
01103-6	Radiological work protection in nuclear power plants with BWR and LWR during the years 1987 and 1986
01107-7	Performance and evaluation of suitable methods for the remedial measures of houses with above average radon burden

01111-7	Simulated calculations of the emission behaviour of containers used in transporting radioactive substances by special consideration of inherent safety criteria
01127-7	Development of a method to demonstrate a viable myocardium and to determine the use related exposure to radiation
01129-6	Compilation and evaluation of data on operational radiation protection
4000-7	Decision-aiding background material for recommendations and procedures in accordance with the precautionary radiation protection law
4003-7	Optimization of radiation protection in nuclear medicine for patients and staff in regard to the preparation of radiopharmaceuticals with generator nuclides
4024-7	Effectiveness of radiation for diagnostic use in pediatrics

Research topics proposed for future promotion:

7.1 Methods for person decontamination

Substantiation:

The development of more rapid and effective techniques for person decontamination has come to a standstill during the past years. The store of methods for the removal of radionuclide substances attached to the skin or incorporated is in need of supplementation. The proposals of the SSK-recommendation for person decontamination should be used in the development of new concepts.

7.2 Detention facilities for radioactive substances

Substantiation:

There is a need for new cost efficient methods, in particular for covering the demand in the new federal states.

7.3 Diagnostic strategies for an improved radiation protection in medicine

Substantiation:

Strategies for reducing the radiation exposure of the patient and thus of the population are, for instance, the development of dose reducing imaging techniques, the development of calculation methods for combining various imaging techniques and an analysis of the connection between radiation exposure and the strength of results from imaging.

7.4 Further development of quality assurance procedures in radiology

- a) Quality assurance in X-ray diagnostics
- b) Quality assurance in nuclear medicine
- c) Quality assurance in digital data- and image recording

Substantiation:

Quality assurance in diagnostic radiology is an already known method for reducing the radiation exposure of the patient. However, other promising techniques, in particular computer-aided procedures, measurements on phantoms and organisational improvements, are still in the process of development and need to be supported by research efforts.

7.5 Optimization of further education and training in radiation protection**Substantiation:**

The value of well organized radiation protection training as a countermeasure against human failure is more and more evident. A systematic scrutiny of the efficiency of the training goal catalogue is needed and should be aiming, among others, at shorter periods of training.

7.6 Large-scale remedial measures of mine dumps and tailings ponds from uranium mining**Substantiation:**

The identification of possible dangers to the population due to radioactive emissions from dumps and the determination of contaminations by measurement techniques are practical problems as well as research problems in former uranium mining regions. The high costs involved with each conceivable process add special weight to efforts for developing practicable techniques.

7.7 Development of methods for the control of waste air aerosol filters in nuclear industrial facilities**Substantiation:**

Concerning this problem, an investigative study should determine in which facilities and in which intervals of time quantitative on-site filter tests should be performed.

8 Radiation protection in the management and removal of radioactive waste

Unresolved questions in the management and removal of radioactive waste should be clarified by respective research projects. Beginning with the accumulation, management, conditioning and control until the final deposition of radioactive waste material, the individual areas of waste management and removal should be improved by organisational and technical measures in respect to radiation protection. The results from such research projects should support administrative radiation protection measures for handling radioactive waste material, especially for temporary and final deposition. Within the scope of currently conducted research projects, the exposures from radioactive waste material is determined by actual measurements and on models.

Currently supported projects:

00988-8	Determination of limits for the removal of low radioactive contaminated waste
01031-8	Investigation of the non-injurious use of metals other than iron

01078-8	Investigation of the non-injurious use of scrap metal, structural debris and building parts
01104-8	Modification and development of new radioecological models for calculating the radiation exposure from low radioactive contaminated waste
01130-8	Possible method-mechanical solutions concerning the radioactive residual substance release when dismantling shutdown facility structures
04001-6	Studies into the derivation of release criteria for the conventional removal of radioactive waste
04028-8	Transport of waste to the repository Morsleben: assessment of transport safety

Research topics proposed for future promotion:

- 8.1 Investigation of measurements concerning the exemption of waste from nuclear technology

Substantiation:

For the exemption of waste from nuclear facilities, it is currently required to perform area-covering contamination measurements. These are connected with considerable cost. Therefore, it appears as reasonable to conduct a study to determine whether this expense is justified in every case. Furthermore, in connection with this study, measurement-mechanical questions should be clarified. The investigative results could serve as a basis for respective guidelines.

- 8.2 Investigation on the deposition of low radioactive contaminated waste

Substantiation:

Because of the expected large amounts of low radioactive contaminated waste, in particular of concrete debris, from the future shutdown of nuclear industrial facilities, a closer examination of the radiation protection aspects of such amounts of low radioactive contaminated waste is necessary. This includes also the applicability of available methods for detecting the eventual dispersion of radionuclides in soil strata close to the surface and, if needed, the development of respective calculation- and examining methods.

- 8.3 System study: Problems concerning the melt-down of low contaminated scrap metal from a dismantled nuclear industrial facility

Substantiation:

By means of this system study it should be examined which kind of radiation protection problems might occur with the possible decision of a nuclear power facility operator to allow on his own responsibility the melt-down of accumulating scrap waste on the facility property. The melt-down, in particular that of metallic scrap, is of considerable advantage for the measurement concerning the exemption of the material. On the other hand, problems such as the possible accumulation of higher contaminated waste material, e.g. slags and filters, must be considered.

9 Biological indicators; diagnosis, pathogenesis and therapy of radiation injuries

Biological indicator systems are important aids for determining radiation exposures, if data sources from physical dosimetry are not sufficient. Research projects should test and develop the possibilities of biological indicators up to an applicable stage.

The results from the research project should effect an improvement in the control of occupationally exposed persons with increased radiation doses and thus fulfil the requirements of § 63, para. 2 of the radiation protection regulation in regard to the assessment of body doses. Within the scope of current and proposed research projects, the various biological indicator systems are tested and examined as to their possibilities for practical use. In addition, investigations of the development, recognition and treatment of radiation injuries should be performed to protect those exposed to radiation. The possibilities for a reduction of radiation injuries by an improved knowledge about diagnosis, pathogenesis and therapy are, at the same time, topics for further research projects immediately connected with those concerning the measures against increased exposures.

Currently promoted projects:

00651-9	Biological indicators for effects from radiation
00910-2	Testing and optimization of a mutation monitor system for man
00965-9	Chromosome analyses on chronically radiation exposed persons
00983-9	Determination and assessment of radiation exposure by means of chromosome aberrations
00985-9	Determination of radiation exposure after accidents by biochemical examinations and chemoluminescence measurements
00990-9	Immunological indicators for the determination of radiation exposures
01029-9	Investigations of possibilities to influence the recovery of body resistance after radiation injury by therapeutic measures
01039-9	Investigations of the influence of chemical agents on chromosome dosimetry

Research topics proposed for future promotion:

9.1 Objectives in biological dosimetry

Substantiation:

The practical use of biological dosimetry has been widely accepted in recent years (in particular due to chromosome analysis). Still existing methodical imperfections and differences appear to be not insurmountable. Particularly promising, among others, are the following improvements:

- a) automation (computer-aided use) of biological indicator systems,

- b) development of new biological indicator systems to determine the effects from low doses.

In order to avoid misinterpretations, a quantification is needed of the deviation of measurement values in and between individuals as well as of the biological influences on measurement results.

9.2 Treatment of radiation injuries

Substantiation:

Study and use of therapeutic experiences on victims of radiation accidents.
Development of improved treatment methods for acute cases of radiation disease.

10 Radiation protection in the field of non-ionizing radiation

The field of non-ionizing radiation is comprised of a heterogenous spectrum of electromagnetic fields and mechanic waves. These become more and more important in an environment that is increasingly influenced by electronics, so that research on interaction mechanisms and possible health risks for man is gaining in significance. However, the influence of "natural" non-ionizing radiation, i.e. sunlight, must likewise no longer be underestimated due to man-made changes in the environment (for example the ozone hole), so that also in this field sector of ionizing radiation the demand for research is on the increase.

Due to the increasing use of non-ionizing radiation and on account of the accordingly increased significance of population protection, the Commission on Radiological Protection (SSK) has established the committee S8 "Non-ionizing Radiation". Between 1986 and 1991 there were no projects supported.

The following research topics are proposed for future promotion:

10.1 Clarification of the increasing melanoma incidence from UV-irradiation of the skin

Substantiation:

The increase of man-made as well as natural UV-irradiation of the human skin during the past years (sun studios, the lacking protective ozone layer) requires a thorough discussion of the connection between the development of melanoma and the radiation dose or wave length. By means of a melanoma-register, epidemiological studies in this field should be initiated.

10.2 Biological effects from pulsed ultrasonic

Substantiation:

The causes for the occurrence of cavitations in cell suspensions from the use of ultrasonic for diagnostic purposes as well as the non-occurrence of cavitations in solidly connected cells (organs) have not as yet been clarified. Since the exposure of living tissue to ultrasonic is mainly the cause of mechanical and thermic interaction, it is primarily the teratogenic effect from ultrasonic on embryonic tissue that needs to be examined.

10.3 Biological effects in the near field of high frequency radiation

Substantiation:

While the dosimetric concept of the absorption of high frequency electromagnetic fields by man and animal is well developed in the far field range of aerial transmitters, there is a considerable lack of knowledge in the near field range of aerial transmitters. The dose concepts developed for the far field do not apply here. It is, for instance, known that in the near field range, low capacity transmitters (e.g. mobile radio equipment) may exceed by many degrees the limits developed for far field conditions.

Of relevance for possible biological consequences is the high frequency rate or energy absorbed in tissue. The field literature contains statements on mathematical assessments. However, they need to be supplemented by measurements. Required is the development of measurement methods of suitable local resolution and the construction of tissue-equivalent phantoms. Measurements of the rate of high frequency absorbed in tissue in the near field range of high frequency emitters in current use, and of those in the stage of development, are an indispensable prerequisite for radiation-hygienic assessments and those of worst-case situations.

Tests on biological cell suspensions have shown that the permeability of cell membranes can be changed by electric impulses. Assessments demonstrate that the inhomogeneous absorption of electromagnetic energy appears to have similar effects on human membranes at high pulse rates, even if the chronologically determined density rates are insignificant and below the discussed limits. From low frequency modulated high frequency radiation, some authors have seen changes in membrane permeability. The significance of these observations for health protection needs to be clarified.

The fundamental effect mechanisms need to be clarified at conditions of either no or hardly any possibility of high frequency heating ("window-effects").

10.4 Examination of available hypotheses on potential effect mechanisms and further clarification of the form of effectiveness of ELF-fields on a cellular basis

Substantiation:

Electric and magnetic fields in the very low frequency range, e.g. the mains frequency, occur in many areas of everyday life. Known are the so-called irritation effects below high tension lines, while findings on biological effects of magnetic fields in the living environment are still under discussion. This shows the need for research from an epidemiological viewpoint as well as from that of the underlying biological mechanisms.

10.5 Possible health risks from MR-examinations

Substantiation:

The steadily spreading diagnostic use of nuclear magnetic resonance in vivo requires a continued assessment of the health risk from the use of such techniques.

In particular, it must be examined whether static magnetic fields of more than 2 Tesla and the use of specific high frequency pulse sequences may affect and/or injure the human organism.

The possible influence of high magnetic fields on pregnant staff members or pregnant patients should be examined.