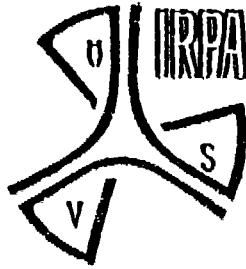


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AUSTRIAN ASSOCIATION FOR
RADIATION PROTECTION

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XI. REGIONAL CONGRESS OF IRPA

AUSTRIAN - HUNGARIAN - YUGOSLAVIAN RADIATION PROTECTION MEETING

RECENT DEVELOPMENTS AND NEW
TRENDS IN RADIATION PROTECTION

Bitte ehestens retournieren.
Bitte nach Bearbeitung
an OFZS - SEIBERSDORF-
HAUPTBIBLIOTHEK

Vienna, Austria
20 - 24 September, 1983

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Invited I

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RADIATION

Session
NON IONIZING

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MEASUREMENT

Session
BIOLOGY

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DOSIMETRY

Session
ENVIRONMENTAL

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INVITED LECTURE

THE NEW IAEAS BASIC SAFETY STANDARDS AND THEIR
IMPLICATIONS FOR OPTIMIZING RADIATION PROTECTION

Abel J. GONZÁLEZ
Head, Radiological Safety Section
International Atomic Energy Agency

A new revision of the Basic Safety Standards for Radiation Protection has been recently published by the International Atomic Energy Agency (IAEA) as the 1982 edition of the IAEA Safety Series No. 9. The Standards, which are jointly sponsored by the International Labour Organization, the Nuclear Energy Agency of OECD, the World Health Organization and the IAEA, incorporate the system of dose limitation recommended by the International Commission of Radiological Protection (ICRP). A key component of the system is that radiation exposures should be kept as low as reasonably achievable, social and economical factors being taken into account. This has been identified with the requirement that radiation protection should be optimized. The present paper summarizes the main features of this relevant requirement and briefly discusses some debatable aspects in its practical implementation.

Although the Standards provide some practical guidance for implementing the optimization requirement, further guidance may be needed for those designing radiation protection. Recognizing that any radiation exposure may be assumed to involve some degree of risk, the Standards recommend a quantitative analysis as a guideline for competent authorities when formulating specific radiation protection requirements. The aim of the analysis should be to assess how far exposures can be reduced before further reduction would not justify the incremental cost required to accomplish it. As the Standards make clear,

this can be effected by a differential cost-benefit analysis. The Standards imply that individual dose limits should not be used as a design objective but, rather, as a constraint to an optimization process.

The practical guidance given by the Standards for the purpose of optimization is limited and some problems may arise when they are implemented. Several such problems and their implications are discussed in this paper. For instance, the different ways in which factors related to radiation protection can change with different design strategies, and the different methods of taking this into account are presented. The different time distribution of efforts and resulting benefits in radiation protection decisions and their implications are also discussed.

The IAEA is aware of these difficulties and is in the process of strengthening its working directed at producing practical guidance for implementing the Basic Safety Standards. The IAEA's new radiation protection programme includes many activities directly related to this work. These are also summarized in the paper.

SESSION I

GENERAL ASPECTS OF RADIATION PROTECTION

Co-chairmen:

Aiginger (A)

Andrasi (H)

Srdoc (YU)

EMERGENCY PLANNING AND PREPAREDNESS FOR NUCLEAR FACILITIES:
AN OVERVIEW OF ACTIVITIES OF THE INTERNATIONAL ATOMIC
ENERGY AGENCY

H.E. COLLINS, B.W. EMMERSON
Division of Nuclear Safety
International Atomic Energy Agency

Since January 1981, the International Atomic Energy Agency has pursued the development and implementation of an expanded programme in emergency planning and preparedness supportive of nuclear facilities. The programme consists of four main parts:

- (1) the development of additional technical guidance needed to complement existing published technical guidance;
- (2) the implementation of a training programme;
- (3) providing Special Assistance Missions to requesting Member States to assist in the development of emergency plans including evaluating exercises to test these plans;
- (4) the upgrading of the Agency's capability to respond, along with its Member States, to a request for assistance in the event of a serious nuclear accident.

In the area of technical guidance, the Agency will address:

- (1) policy for the setting of intervention levels;
- (2) accident release monitoring;
- (3) deposition monitoring and data handling; and
- (4) on-site habitability to maintain control during the course of an accident.

Training programmes will emphasize the advent of advanced state-of-the-art "Computerized Aids to Accident Assessment" to assist in analyzing accidents, assessing potential consequences and identifying appropriate remedial actions for decision-making. Linked to training, Special Assistance Missions will continue to emphasize the practical implementation of Agency technical guidance and preparation and testing of emergency response plans.

In 1983, following authorization by the Board of Governors, the Agency commenced implementing recommendations of a Group of Experts convened in 1982. These encompass activities aimed at improving the international ability to render assistance to a country which has experienced a serious nuclear accident at one of its facilities.

RECENT RECOMMENDATIONS ON RADIOLOGICAL PROTECTION STANDARDS
IN ISRAEL

Y.G. GONEN, Advisory Committee for Nuclear Safety
E. STERN, Licensing Division, Israel AEC

The regulation of occupational and health hazards in Israel and the role of the different organizations/ functions in the regulatory system is described, with emphasis on the regulation of radiological protection. The Advisory Committee for Nuclear Safety (ACNS) has leading position in the development of radiological protection standards.

Recently the ACNS's working group on standards, in collaboration with the Licensing Division of the Israeli AEC, recommended the adoption of the ICRP's recommendations given in it's publications No. 26 and 30 as basis for the Israeli radiological protection standards. The implementation of these recommendations depends on further rulings and advice, left by the ICRP to the jurisdiction of the competent national authorities. The working group is engaged in the preparation of this advice.

To date, the group dealt with the following topics:

- the requirements for justification
- the α -values to be used in conjunction with optimization
- exemptions
- derived levels for air, water and surface contamination
- investigation levels
- emergency action levels.

The recommendations on these subjects are presented and discussed in the paper.

DOSIMETRY - PROTECTION OR EXHIBIT
THE TRENDS IN HANDLING THE REGULATIONS OF RADIATION
PROTECTION

Erich L. HUBER

Working Inspector (Social Ministry of Austria)

For radiation protection personnel has to be controlled by law with physical methods. The dose controlled personnel is often under the impression that the dosimetry is not only for protection of health but also for the exhibit of an incorrect behaviour in the radiation area. It is shown that persons can be found out with the results of dosimetry who did not follow up correct behaviour without receiving a dose contrary to regulations. In contrast to this maximal permissible doses are infringed without that controlled persons has been in any restricted area. Under this circumstances licensees and persons of responsibilities are often confronted with evidences from incorrect behaviour of the personnel or of themselves in the radiation area. The results of inspections indicate that the results of the dosimetry alone is hardly a handsome exhibit for a violation of regulations. Just the incontestable clarification about the source of unallowed radiation will be sufficient to start a trial. However assumption for this is the knowledge and the practice of the inspectors to make the right conclusions. Nevertheless it is surely in the interest of the licensees and the responsibilities to interpret the results of dosimetry correctly and the control organs primarily will be their partner and not by all means cause for a trial.

MICRODOSIMETRY OF GAMMA AND NEUTRON RADIATION.
STATE-OF-THE-ART ANF RECENT EXPERIMENTAL DATA

1)

Dušan SRDOČ¹ 2)

Radiological Research Laboratory, Department of Radiology,
Cancer Center/Institute of Cancer Research, Columbia
University, College of Physicians and Surgeons, New York

A wide range of neutrons and photon energies has been used to obtain energy deposition spectra in small tissue volumes ranging from 100 nm to 8 μ m in diameter. The experimental data were obtained by means of a Rossi-type wall-less proportional counter filled with tissue-equivalent gas. The counter was irradiated with mono-energetic neutrons from the Tandem Van de Graaf accelerator at the Radiobiological Radiation Facility of the Brookhaven National Laboratory. Neutron beams varying in energy from 0.22 to 14 MeV in discrete steps and two gamma emitters (^{137}Cs and ^{60}Co) represented a wide range of radiation sources used to produce basic data in form of $d(y)$ vs y spectra for subsequent use in microdosimetry, radiobiology and radiation protection.

1 This investigation was supported by grant CA 12536 to the Radiological Research Laboratory/Department of Radiology, and grant CA 13696 to the Cancer Center/Institute of Cancer Research awarded by the NCI, DHEW and by contract DE-ACO2-78EVO4733 from the Department of Energy.

2 On leave from Ruder Bošković Institute, Zagreb, Yugoslavia.

A selection of microdosimetric spectra of low, medium and high energy neutrons is presented and discussed, as well as gamma ray spectra at very small site sizes. The mean values \bar{Y}_D and \bar{Y}_F for all measured spectra are given in keV/ μm . The present state-of-the-art in experimental technique and some basic limitations of the experimental method are presented. The implications of microdosimetry data on radiation protection standards is briefly discussed.

HEALTH EFFECTS OF AIR POLLUTION IN JAPAN AND COMPARISON
OF HAZARD INDICES OF EFFLUENTS FROM FOSSIL FUEL AND
NUCLEAR PLANTS

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Air Quality Standards and the dose-response relationship between prevalence rates of chronic bronchitis and sulphur dioxide are introduced. Based on this standards, various efforts have been made to reduce the concentrations of sulphur dioxide in the atmosphere. Consequently, the sulphur dioxide concentrations decreased. However, the atmospheric concentrations of nitrogen dioxide tended to increase gradually. It was therefore considered important to study the health effects of nitrogen dioxide. In six different areas in Japan with varying atmospheric concentrations of nitrogen dioxide, an extensive epidemiological survey was conducted with over 10,000 school-children 6 to 15 years old during the period 1979 to 1981. The prevalence rate of asthma was estimated to be 4.7 % for males and 2.1 % for females in the high NO₂ concentration area, and 1.9 % for females in the low NO₂ concentration area. For asthma-like symptoms, 12.2 % for males and 11.9 % for females was observed at the high NO₂ concentration area, and 7.1 % for males and 5.9 % for females in the low NO₂ concentration area. The natural radioactivity from fossil-fuel power plants is also discussed. From the

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comparison of hazard indices of effluents from fossil-fuel and nuclear power plants, the hazard indices of air pollution by SO₂ and NO₂ may be considered most significant. In decision-making on environmental protection and safety, it should be carefully considered whether a reduction of one type of risk might increase another type of risk.

AN OUTLOOK ON DEVELOPMENT AND TREND OF MICROPROCESSOR
BASED RADIOLOGICAL INSTRUMENTATION

Aleksandar M. KOTUROVIĆ, Radomir B. VUKANOVIĆ
Institute of Nuclear Sciences "Boris Kidrič", Beograd,
Yugoslavia

Microprocessor, as an electronic component, combined with memories has a great software versatility and is able to handle a large quantity of data. When it is used in measurement instrumentation new qualities may appear, and here are analysed possible consequences when microprocessor is introduced in radiological instrumentation.

The role of a microprocessor strongly depends on the purpose of the instrument. Due to that reason we divide all radiological instruments into three classes: general purpose instruments, special instrumentation and measuring systems. For every of these classes the place and tasks of a microprocessor is discussed in detail. Some solutions are reviewed, peculiar features due to microprocessor are underlined, but solutions where the microprocessor gives a new quality in the measuring method or results were preferred. At the same time interesting possibilities are pointed out and new facilities which might appear are discussed.

Particular aspects of microprocessor application in radiological instrumentation are discussed: the influence on measuring methods, accuracy, measuring possibilities, the new type of data, and new user's psychology. Consequently, the idea arises that the radiological instrumentation might be characterised in future by software support rather than by built in electronic components.

SSOR

SIX YEARS OF RADIATION PROTECTION EXPERIENCE AT THE SAFEGUARDS ANALYTICAL LABORATORY

Robert OUVRARD, Reinhart HARTMANN
IAEA Vienna

ograd,

For implementing its responsibilities in international safeguards, the IAEA is operating, at Seibersdorf (Austria) an analytical laboratory, made available by the Austrian Government.

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This facility is staffed by the Agency with scientists and technicians from various Member States. Built under the project management of the Forschungszentrum Seibersdorf, on design criteria defined by the Agency, this laboratory has been doted with a very comprehensive health physics system. Since January 1976, the laboratory had been operating under a limited license, granted until 1982. Now that it has been transferred to the sole responsibility of the Agency, the number of analyzed samples has increased and the laboratory has reached its full capacity. During this time, the radiation protection organization and the monitoring procedures have been tested and improved.

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Results of these six-years operation show that they are well adapted and that the exposure of radiation workers are being kept at a very low level.

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APPLICATION OF NEW KNOWLEDGE ON THE EVALUATION OF THE
DOSES AFTER A SEVERE REACTOR ACCIDENT

Konrad MÜCK

Österreichisches Forschungszentrum Seibersdorf, Austria

At least after the TMI accident the too conservative approach in estimating the dose in case of severe accidents in power reactors became evident. Since then new research efforts have been carried out the results of which show considerably lower estimates for the released activities and the maximum dose to be expected in the environment in case of such extreme accidents.

Applying these new research results estimates of the dose in case of a MCA at a 12 MW pool type research reactor with a containment with controlled leakage were made. Only the deposition of iodine isotopes in the reactor containment was taken into account, while the effects of the closed atmosphere of the containment on aerosols such as coagulation and sedimentation were completely ignored.

Results show considerably lower release values and resulting doses, in particular for the inhalation dose in comparison to previous conservative estimates. The whole body dose at the point of highest concentration for example is in the range of annual natural background dose re-evaluation of the contents and the necessity of off-site emergency plans for reactors of this size and containment therefore is advisable.

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EVALUATION OF RADIATION RISK RESULTING FROM DIAGNOSTIC PROCEDURES THAT INVOLVE RADIONUCLIDES

Miroslav TOMAŠEVIĆ

Clinical Centre of Medical Faculty, Beograd
Institute of Occupational and Radiobiological Health

During 1981 in SR Serbia there were performed 72043 diagnostic procedures that involved application of radionuclides. From this quantity it has been selected 71819 of procedures for evaluation of radiation risk.

The thyroid has been the most frequently investigated organ. The investigation for thyroid function has been done in 31.46 % of cases (¹³¹I-sodium iodine) and scintigraphy by application of ¹³¹I-sodium iodine in 21.80 % and in 0.26 % of cases by application of ^{99m}Tc-Pertechnetate.

The most frequently applied radionuclides were ¹³¹I (sodium iodine and Hippuran - 76.36 %) and ^{99m}Tc. Application of ^{99m}Tc has been increased not earlier than the last few years (19.56 %). The other radionuclides have been applied in considerable less extent.

Using of an extended dose concept of absorbed fractions for evaluation of internal absorbed doses as well the model for evaluation of radiation risk, there have been evaluated the number of malignancy which could occur in observed population because of application of radionuclides in diagnostic purposes.

The evaluated number of malignancy resulting from thyroid investigation was found to be 5.8 (0.32 in men and 5.46 in women) and from the investigations of all other organs it was found to be in total 0.33 (0.15 in men and 0.18 in women).

BROAD-BEAM ATTENUATION IN BARYT CONCRETE AND IN ORDINARY
PLATE GLASS FOR X-RAYS FROM 50 TO 300 kVp

Dj. RISTIĆ, P. MARKOVIĆ

"Boris Kidrič" Institute of Nuclear Sciences, Vinča
Radiation Protection Department, Belgrade, Yugoslavia

In this paper results of the measurements and corresponding determination of the attenuation data for baryt concrete and ordinary plate glass are given for a broad beam 50 - 300 kVp X-rays. A special experimental arrangement and procedure of the experiment, to meet the IEC recommendation for these measurements, are discussed.

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ACCIDENTAL IRRADIATION BY ^{192}Ir OF 296 GBq (8 Ci) INTENSITY

B. MARKOVIĆ, D. PANOV, D. PETROVIĆ, M. JEREMIĆ, S. DODIĆ
Clinical Center of Medical Faculty, Institute of
Occupational and Radiological Health "Dr Dragomir Karajović"
Beograd, Yugoslavia

A case of accidental irradiation of persons by Iridium 192 source of activity of 296 GBq used at gamma radiography have been described in this paper.

On that occasion 8 persons were exposed to higher exposure.

Chromosome aberrations were examined in the peripheral blood lymphocytes.

The highest frequency of chromosome aberrations was found in the worker (LM) who was exposed to the highest dose (exposure). The number of aberrant cells was 67 and the total number of chromosome aberrations 119 (acentrics 11, ring 5 and 103 the others) while the rest persons had lower frequency of chromosome aberrations.

In this paper it is discussed the assessment of whole body exposure on the basis of chromosome aberration examinations.

EDUCATION OF VETERINARY SPECIALISTS FOR RADIATION CONTROL
OF ANIMAL PRODUCTION

Branislav PETROVIĆ, Gordana DJURIĆ
Faculty of Veterinary Medicine, University of Beograd,
Department of veterinary radiology, Yugoslavia

The paper describes the tasks and field of activity of veterinary specialists for radiation control of animals and animal production. The education process of veterinary specialists for the work on this field is also presented.

Curriculums in the field of radiation hygiene of the animal production at veterinary faculties in our country comprise this matter as a separated one term subject. At undergraduate level teaching is accompanied by appropriate practical exercises. In this way a good basis for post-graduate improvement of students through master degrees of specialization is provided.

An important role in the education of veterinary specialists in the field of radiation protection and radiation control of animal production play special seminars and courses for innovation and mastering of new working methods. Practical work and exercises in various field are so designed as to enable students to master completely the foreseen matter.

Such a developed system for education of veterinary personnel furnished a personnel basis for development of radiation hygienic monitoring system of animal products.

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RADIATION AND ENVIRONMENTAL PROTECTION TRAINING COURSES
AT THE RADIATION PROTECTION INSTITUTE OF THE
AUSTRIAN RESEARCH CENTER SEIBERSDORF

E. SCHWAB, A. MALASEK, H. SORANTIN
Austrian Research Center Seibersdorf

Training programmes for radiation protection were carried out for health physicists and radiation protection officers in the medical and technical field.

Training courses for physicians and technicians in the medical field were held in cooperation with local authorities, medical schools and hospitals.

At the university of Leoben a course was organized for students including lectures and practical applications.

In addition, two seminars were arranged to inform health physivists about present trends in radiation protection.

In cooperation with our government and various emergency organisations such as fire brigade, ambulance, red cross. civil defence, various programmes and tests were executed to evaluate general knowledge and preparedness for an emergency.

Last not least, training programmes were organized in cooperation with colleges, local governments, hospitals, emergency organizations for radiation protection, protection against dangerous materials and transport of dangerous goods.

Not June!

SESSION II

NON IONIZING RADIATION

Co-chairmen:

Hefner (A)

Ninković (YU)

Predmerszky (H)

RADIATION PROTECTION PROBLEMS BY NONIONIZING
ELECTROMAGNETIC RADIATION IN AUSTRIA

K.E. DUFTSCHMID

Austrian Research Center Seibersdorf

In recent years worldwide increasing industrialization and rapidly expanding application of numerous equipment and techniques producing electromagnetic nonionizing radiation (NIR) has led to a significant man-made electromagnetic pollution of the environment. In many countries and international organizations such as WHO or IRPA/INIRC concern has been raised on potential hazards to workers and the general public and legislative measures are being taken to limit human exposure.

In Austria the Federal Ministry of Health & Environmental Protection initiated an extensive programme to identify the major sources of electromagnetic NIR in this country and to study their biological effects and appropriate techniques of measurement and control. The aim of the project, performed in cooperation with several university institutes and experts, is to develop a sound basis for future legislation.

The types of electromagnetic radiation covered in this study include static and low frequency electric and magnetic fields with particular reference to 50 Hz electric power lines, induction heating etc. The adjacent part of the spectrum to higher frequencies being a topic of major concern includes radiofrequency (RF) and microwave fields mainly due to radio and TV broadcasting, telecommunication partly via satellites and radar. Further important sources of this part of the spectrum are the use of RF heating for plastic sealing, drying and defrosting, and cooking in microwave ovens. A particular source of extremely expanding application are lasers.

The paper describes the situation in Austria in view of radiation protection problems with the use of electromagnetic NIR and the present status of information obtained as a basis for proposed legislative action.

SAFETY ASPECTS AND CRITERIA FOR PREVENTION OF HEALTH
HAZARDS FROM OUTDOOR LASER-APPLICATIONS

Vratislav H. HAVLOVIC

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Medical Faculty, University of Vienna, Austria

Outdoor laser-applications include the use of laser-devices for scientific, industrial and professional purposes in the open air as e.g. aligning instruments in the building industry, automatic guidance of road building equipment, laser rangefinders, open communication links, laser radar (LIDAR), some remote sensing instruments, high-power laser-satellite trackers and so forth. A special case of outdoor laser-application concerns artistic displays on walls, buildings, clouds etc. While the indoor laser-applications can be relatively easily held under control, the outdoor applications can cause serious eye hazards to personnel in aircraft or in the ground.

First of all the ocular exposure conditions will be discussed which are valid for intrabeam viewing (corneal irradiance and corneal radiant exposure). The beam irradiance or radiant exposure as a function of range will determine, whether hazardous exposure conditions exist in the operational or target area from the laser-beam. Precautionary controls can be determined and a decision can be made as to whether personnel should be restricted from the operational area or be required to wear laser protective eyewear. Additionally reflections (diffuse or specular) of the laser beam can result in exposure to personnel outside of the controlled areas of the immediate beam path and/or the target. Special measures has to be applied for airborne laser-applications; in this case restrictive minimum altitudes or slant ranges of operation and controlled beam paths and buffer zones around the operational or target area can be established as required.

Some examples of hazard limitation resulting from the outdoor laser-application from author's experience will be discussed. Further a safety analysis of the operation of an Austrian high-power laser-satellite tracking station located in the neighbourhood of a controlled area of an airport will be presented.

CRITERIA AND PROPOSED RULES FOR PREVENTION OF
HEALTH HAZARDS FROM UV-RADIATION IN AUSTRIA

A. HEFNER, Austrian Research Center Seibersdorf
N. VANA, Atom Institute of Austrian Universities
V. HAVLOVIC, Federal Ministry of Health and Environmental
Protection, Austria

Due to the wide-spread use of equipment generating UV-radiation in the last years in households, medicine and industry and based on the well-known biological effects reported in most of the reports, it was necessary to establish also for Austria expert working groups.

This paper describes the work in the field of IV-radiation done by members of one of these expert groups, mostly in establishing of criterias and rules for prevention of health hazards from UV-radiation. Namely the first part of the work deals with application of rules, definitions, UV-sources, UV-equipment, UV-radiation etc , while the second part gives also an outlook for the future work.

EXPOSURE OF PERSONNEL TO MICROWAVE DURING MEDICAL DIATHERMY

L. BALLAY, L. BAGDY, M. CSERMELY, T. PREDMERSZKY, L.D. SZABÓ
OSSKI, Budapest, Hungary

Microwave diathermy has been used for many years in the treatment of different kind of arthritis. More recently, diathermy has been used experimentally in the treatment of cancer. Around the diathermy devices employed for therapeutic purposes, to the intended exposure there is to be found some uncontrolled exposure of the personnel and patient from reflections, scatter and leakage too.

This survey was conducted to quantify the exposure levels in the proximity of the applicators and on the "personal's location". In addition several other physical parameters concerning the machine and the procedure were recorded. The measurements were made at diathermy devices most frequently used in Hungary and at the actual treatments rooms in different locations. Measurements were carried out with a Narda Model 8606 meters with an isotropic 8623/B probe.

The proposed Hungarian exposure standards include two basic limits of levels: the permissible exposure level is $100 \mu\text{W}/\text{cm}^2$ and the hazard exposure limit is $10 \text{mW}/\text{cm}^2$. From the results of our investigation it would appear that the magnitude of fields to which the personnel could be exposed is between these two levels mentioned above.

According to the ALARA principle this survey indicates a need for reduction of unnecessary radiation in the vicinity of diathermy equipments.

SESSION III

MEASUREMENT AND TECHNIQUES

Co-chairmen:

Koturović (YU)

Szörenyi (H)

Vana (A)

RECENT DEVELOPMENTS AND TRENDS IN RADIATION PROTECTION
INSTRUMENTATION

R. MAUSHART

Laboratorium Prof.Dr.Berthold, Germany

A survey is given on the influence of modern technology on radiation protection instruments. The recent developments are reviewed critically with regard to their advantages and benefits for applied radiation protection.

The main topics treated are:

- Why and how far are new instruments better than old ones? - the technological changes of the past years.
- Radiation detectors, - the crucial link in the chain of reliability of measurements.
- With microprocessors and computers, we can do almost everything, - but should we?
- Improvements in the human/instrument interface lead to more ease of operation.
- What shall we do with all those figures? - Storage and registration of measured values.
- All this progress in technology, does it really mean progress in radiation protection, too?

EXPERIENCES ON THE VERIFICATION OF PROTECTION LEVEL
DOSEMETERS IN HUNGARY

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The reliability of technical data specified by the manufacturer and the period of validity of the verification are very important aspects in the metrological practice in the field of radiation protection measurements. Experiences obtained with verifications made in OMH have proved that in many cases it is reasonable to check the values specified for the parameters of various models and to make regularly the periodic verifications.

In the past years, due to the introduction of SI units and to the increasing number of protection level dosimeters it was necessary to make some technical and organizational amendments in the practice of verification.

This paper outlines the Hungarian practice of verification of secondary standards and field instruments used in radiation protection dosimetry and sums up our experiences obtained in the last fifteen years in this field.

Moreover, the estimation of the measuring uncertainty as well as organizational aspects of the verification of dosimeters are discussed.

NEW TYPE OF TL DOSIMETERS FOR PERSONNEL BETA DOSIMETRY

Mirjana PROKIĆ, Poul CHRISTENSEN

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Beograd, Yugoslavia

The paper presents dosimetric characteristics of special graphite-mixed magnesium borate thermoluminescent dosimeter for beta-ray dosimetry, developed at Boris Kidric Institute Vinca. Sintered graphite-mixed $MgB_4O_7:Dy,C$ Tl dosimeters are attractive for beta-ray dosimetry because this material combines low transparency with near tissue-equivalence and high sensitivity.

Released skin-dose equivalent sintered magnesium borate TL-dosimeters give the possibility for skin dose assessment from low-energy beta emitters which is required by ICRP recommendations.

It is also given the results from practical use of graphite mixed magnesium borate TLD a various laboratories at Risø National Laboratory, Roskilde, Denmark.

POSSIBLE USE OF LiF DOSEMETERS IN MIXED NEUTRON-GAMMA FIELDS

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University, Debrecen, Hungary
H.J. PROBST, M. HEINZELMANN, IKP, ASS-ST KFA Jülich, Germany

LiF is a frequently used thermoluminescent material of the gamma dosimetry, but it was claimed to be unsuitable for mixed neutron-gamma fields, because it is sensitive only to thermal neutrons. We have tried to establish the possibilities and conditions of its applicability in accelerator laboratories, where the fast neutron production may be considerable.

We found, that the shape of the glow-curve strongly differs for gamma and for neutron radiation, and this way it is possible to separate the gamma and the neutron components. One can change the ratio of the gamma/neutron sensitivity of the TLD-100 by changing the read-up temperature range. Its neutron sensitivity is restricted to the thermal component. Around neutron generators and cyclotrons generally the fast neutrons take the dominant part of the neutron fluence (40 % or more) and consequently supply the dominant part of the neutron dose (near 95 %). Knowing (or estimating) the ratio of the thermal to fast neutron fluence, one can calculate the neutron dose from the TLD-100 response. It can be recommended to determine (or to estimate) the neutron dose in such a way for accidental dosimetry, first of all in those laboratories where this task is unsolved.

A POSSIBLE SECONDARY STANDARD FOR LETHAL DOSE
MEASUREMENTS IN RADIOLOGICAL RESEARCH AND ACCIDENT
DOSIMETRY

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A chemical system of the composition by volume of 10 % chlorobenzene, 10 % ethanol, 80 % 2,2,4-dimethylpentane and up to $3 \times 10^{-5} M$ thymolsulphonthalein indicator has favourable characteristics as a dosimetric system. The basic mechanism of radiolytical HCl formation is described. The dosimetric properties of the chemical system as well as the dose response of the commercial personal dosimeter DL-M4(M3) based on the same system was investigated in the gamma ray field of a ^{60}Co source in a dose range from 0 to 10 Gy and compared to standard dosimeters (ion chambers Fricke dosimeter). The radiolytically produced colour change is evaluated by spectrophotometry, or in case of the DL-M4(M3) by visual colorimetry or by spectrophotometry. The systematic error, the reproducibility of the experimental results and the accuracy of the method is discussed in detail. A series of experiments was carried out with DL-M4(M3) in a mixed neutron and gamma ray fields of various energy spectra. It was found that the response of the dosimeter to neutron tissue dose for different neutron energy spectra is approximately equal to the response to the same tissue dose of gamma radiation. The advantages and disadvantages of the system and of the dosimeter DL-M4 for calibration and standardization of radiation fields in accident dosimetry, research, radiation therapy and other fields of radiation application are discussed.

EXAMINATION OF FALLOUT SHELTERS

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**G. SCHUSTER, Federal Ministry of Construction and Technology
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A method to evaluate the over all integrity of shielding material against radiation was developed at the Austrian Research Center. It allows to find inhomogeneties in the shielding walls by using an irradiation source.

THEORETICAL ESTIMATE OF THE FAST NEUTRON SENSITIVITIES
OF DIFFERENT CELLULOSE NITRATES

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Ivanka MIRIĆ, Boris Kidrič Institute for Nuclear Sciences
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This paper deals with the method of theoretical estimate of the neutron sensitivities of different types of domestic cellulose nitrates as well as of the Kodak LR 115, type 2.

Neutron interactions producing heavy charged particles in the cellulose nitrate layer have been considered in the calculation, as well as the effective thickness of the layer, defined by the range of the charged particles and the etching conditions.

In the calculations some criteria were adopted, concerning the efficiency of the cellulose nitrate and isotropy of distribution.

By applying the accepted criteria the neutron sensitivity of the domestic NC-650, NC-1800 and NC-900 detectors as well as of the Kodak LR-115, type 2 have been calculated for neutron energies from 2,5 MeV to 15,0 MeV.

It has been shown that the theoretical results agree with the experimental data, especially in the energy region from 6,5 MeV to 15 MeV.

CALCULATION OF THE ATTENUATION OF NARROW X-RAY BEAMS
GENERATED BY PULSATING POTENTIAL X-RAY GENERATORS

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The calculation of the attenuation of heterogeneous X-ray beams is rather complicated but it can be performed with the aid of a computer. The average X-ray spectrum from a pulsating potential X-ray tube can also be calculated and this calculation can be more easily performed than the measurement of the spectrum since the spectrum depends upon the waveforms, i.e. the load.

Combining the two known methods and completed with considering the attenuation effect of any medium, we have derived a new formula for the calculation of the attenuation and the absorbed dose from narrow X-ray beams generated by any pulsating potential generator.

We have elaborated a computer program for the calculations. We present some examples, for dose absorbed in air compared with measurement results. The formula is valid for narrow beams, i.e. one-dimensional thus it does not involve the dose originated from scattered radiation. This deficiency can be eliminated by empirical approximations or extending the method to three dimensions.

The importance of the given method can be the following:

- 1/ It makes possible the qualification of X-ray generators in respect to dose performance and formulation of a new definition for the ripple correction factor of X-ray generators.
- 2/ It makes possible the calculation of the input exposure at the skin of the patient, depending upon the waveforms.

- 3/ It makes possible the calculation of the so-called beam quality parameters/half value layer, effective energy etc./ and their evaluation from the point of view of practical applicability.
- 4/ Supposing the elimination effect for scattered radiation of a Bucky-grid, it makes possible the calculation of the input dose and the spectrum of the direct beam attenuated by the patient at the beam detecting device. It can be matched with the spectral sensitivity of the detector, hereby the input signal value of the image transmission system can be determined. The comparison of different detectors and spectra can give guidance for the development of detectors corresponding best to the patient exposure - image quality optimization.

MEASUREMENT OF THE TOTAL SPECIFIC ALPHA ACTIVITY WITH
SILICON DETECTORS

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32,33.000 YU

The method of measuring the total alpha activity in the sources of saturation thicknesses is described in this paper. Plant samples and water are treated. Two procedures have been applied for preparation of thick sources: drying and grinding the plant samples into fine powder and the wet-ashing procedure by H_2O_2/Fe^{2+} .

The sources were measured with a counting device based on silicon detector optimized for measurement of alpha radiation in the presence of beta and gamma radiation. For discrimination level of 1 MeV, selectivity for detecting alpha radiation relative to beta radiation of ^{90}Sr - ^{90}Y was 10^4 in the case of thin sources.

The efficiency of detection of alpha radiation for thick sources defined as the ratio between count rates and specific activity was $3 \cdot 10^{-6} \text{ imp.s}^{-1} \cdot \text{Bq}^{-1} \cdot \text{kg}$.

USE OF N-I-P STRUCTURED SILICON DETECTOR FOR
GAMMA RADIATION MEASUREMENT

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6703800-16

While silicon detectors have come into general use in measuring alpha and beta radiation, the measurement of gamma radiation is still done mainly by GM tubes especially in portable devices. This is due to the relatively small sensitivity of the silicon detectors and their high dependence on the gamma energy as well.

VIDEOTON Development Institute has been engaged in manufacturing silicon detectors for radiation protection purposes for more than 10 years. The sensitivity of 5 - 50 mm³ detectors is equivalent to that of small size GM tubes. Moreover, silicon detectors have a lot of advantageous properties in comparison with GM tubes, namely, higher stability, endless operating life time, ability to operate reliably in extremely high dose rate /above 100 Gy/h /, and they don't need high operating voltage. It is possible to make the application of silicon detectors easier by using hybrid integrated circuits which have been developed for their electronics.

This paper gives information on the characteristics of silicon detectors, their advantageous und disadvantageous features as well. It also demonstrates methods applied in order to reduce the temperature dependence of the noise level and energy dependence of sensitivity. Finally, the measuring results of radiation protection probes built of hybrid circuits will be given.

A POCKET GAMMA RAY MONITOR WITH SEMICONDUCTOR DETECTOR
AND NUMERICAL DISPLAY

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A small size, very low power consumption gamma ray monitor Si(Li) room-temperature semi-conductor detector has been developed. The detector can be used directly with solid state circuitry. Compared to GM tubes it requires much lower bias voltages (4.5 V in this application). In this case, no high voltage step-up circuitry is needed and power-consumption is less than in the usual GM tube devices. Besides that, because of the short dead time of semi-conductor detector, a measuring range is considerably wider than with GM tubes.

The realized pocket gamma ray monitor combines the possibilities of simple signal processing system and data indication with suitable characteristics of applied detector. It is equipped with light and sound alarm indicators, and the alarm level can be selected and changed simply and accurately. It has good operating characteristics and the operating range is determined by the applied PBX 1400 semi-conductor detector manufactured by Hungarian firm VIDEOTON-REMIX. The measurement of dose rates below $1 \mu\text{C.kg}^{-1}.\text{s}^{-1}$ is possible. The relative sensitivity, of the realized monitor, on temperatur changes in the range of -10°C to $+40^{\circ}\text{C}$ is less than 6 %. For supply voltage shange of 4.7 V to 3.3 V the relative sensitivity on supply voltage variation lies between +0.5 % and -4 %. With supply voltage of 4.5 V the total power consumption is less than 10 mW.

Taking into account attained results and advantages which offer semiconductor detectors as well as their rapid development, it can be expected that those detectors will be more and more used in radiation protection instrumentation, especially in portable and pocket size types.

AUTOMATIC SMEAR SAMPLE COUNTER CONTROLLED BY A POCKET
CALCULATOR TYPE HP41

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For a responsible Health Physicist it is very important to have an exact knowledge as to the state of surface contamination in his laboratory. One way to get a general view of the condition in the lab is to take smears at various points. Usually the way that smears are taken und measured is laid down in regulations by the authorities.

The measurement of the smears is a very time-consuming and boring work. Therefore there is a tendency for staff to try to reduce the number of smears which also reduces the change of detecting contamination at an early stage. Additionally 99% of the measured smear show only background. This leads into the temptation not to measure or to do improper measurements.

To solve these problems, half of fully automatic counting equipment should be used. Usually institutes with a high number of smears are using such automatic counting equipment. The equipment available on the market is all multi-purpose equipment and very expensive. Too expensive for measuring only a small number of smears and too expensive for developing countries and our institute.

Thus, as the result of an idea originating from Dr.DUDLY of the IAEA, we decided to built a cheap, fully automatic smear sample counter. We bought a very common and cheap slide projector as sample changer, used our existing rate-meter for counting and a programmable calculator type HP41CV with printer for control calculation and printout of the results. The various components were assembled together by our Electronics Workshop. The result was a cheap, fully automatic smear sample counter which is described in the presentation.

APPLICATION OF Si DETECTORS, PHOTO-DIODES AND GM COUNTERS
FOR EXPOSURE RATES MEASUREMENT

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The paper presents the results of the measurements of the following characteristics of Si detectors, Si photo diodes and GM counters:

counter response vs. energy, counter response vs. temperature, angular dependence of the response, and the measuring range.

These results show that these detectors could be applied for exposure rate measurements.

INVESTIGATIONS OF A NEW THERMOLUMINESCENT BULB DOSIMETER

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5 3073 100 100

A bulb dosimeter was developed by utilizing highly sensitive $\text{CaSO}_4:\text{Dy}$ or $\text{CaSO}_4:\text{Tm}$ thermoluminescent crystal. The crystal granules of about 0.5 mm in diameter are glued to the thin heating with tray a heat resistant paste.

For readout the required power consumption does not exceed 20 Ws. The glass bulb is free from potassium, thus the background due to self irradiation from ^{40}K is immeasurably low. The bulb dosimeter shows a good resistance to mechanical shaking and shock.

For gamma radiation the minimum detectable dose is 1 μGy . The dose response is linear up to 10 Gy. A room temperature fading is negligible /below 2%/month /. Dependence of fading on the ambient temperature will be discussed in detail.

Owing to the above properties, the new bulb dosimeter proves to be particularly useful for space dosimetry, for personal dosimetry and for sensitive monitoring of the environment.

CHARACTERISTICS OF SOME TLDs FOR LOW DOSE MEASUREMENT

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The TL characteristics of some TLD chips and discs (table 1) used for environmental and personal dosimetry were compared. The aim of the investigations was to choose TL dosimeters which can be easily handled for routine measurements and are available in both countries.

Table 1: Some data on the investigated TL dosimeters

TLD	Origin	Dimensions	Main peak
CaF ₂ :Dy	Institute Jozef Stefan Ljubljana, Yugoslavia	5 mm dia x 0.7 mm	260°C
MgB ₄ O ₇ :Dy	Institute Boris Kidric Beograd, Yugoslavia	5.5 mm x 1 mm	210°C
CaSO ₄ :Dy	Institute Boris Kidric Beograd, Yugoslavia	6 mm dia x 1 mm	260°C
LiF:Mg,Ti	Institute of Nuclear Physics, Krakow, Poland	4.5 mm dia x 0.6 mm	250°C
⁷ LiF-teflon	Pitman Instruments Weybridge, England	12.7 mm x 0.4 mm	220°C

⁶⁰Co and ²²⁶Ra sources were used for calibration and the TOLEDO 634 and NHZ-203 /KFKI/ readers were used for the TL-evaluation. The linearity was studied in the dose range up to 5 mGq. The sensitivity, reproducibility, fading and the light induced fading, light sensitivity, lowest detectable dose and the individual sensitivity of the TLDs were investigated in order to compare their suitability for low dose measurements.

SELF EXTINCTION OF LUMINESCENCE SIGNAL IN LiF
THERMOLUMINESCENCE DOSIMETERS

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LiF-thermoluminescence dosimeters are now being widely used in various fields of personnel and biomedical dosimetry. Particularly in fast neutron dosimetry the secondary recoil protons from the surrounding hydrogenous material possess a limited range in the TLD-chips. The same phenomenon may occur in the case of heavy charged particle, alpha or proton dosimetry. When the TLD-chip is heated the luminescence light emitted from the irradiated layer is partially absorbed in the rest of the chip. thus a correction factor should be necessary when thick TLD-chips or powdered TL-material are used.

In this report the experimental value of the extinction coefficient of LiF-dosimeters (TLD-100 of Harshaw Chemical Co.) is presented. Groups of TLD-100 dosimeters (3.2 x 3.2 x 0.4 mm³) with four TLD-chips were irradiated with ⁶⁰Co-gamma rays up to a dose level of about 1 Gy at a dose rate of 2.3 Gy/h. The irradiated chips were covered with different numbers of TLD-chips (6 x 6 x 0.9 mm³) and evaluated with DAT-1 TL-reader, developed at our institute at a heating rate of 0.46 °C/s. The extinction curve was derived from the main TL-peak height and fitted by an exponential function of type: $I = I_0 \exp(-\mu x)$. The value of the extinction coefficient was determined to be $0.51 \pm 4.5 \% \text{ mm}^{-1}$.

DOSIMETRIC PROPERTIES OF A LABORMADE CaSO₄-TL-DOSIMETER

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C. 607/16

17,

CaSO₄:Dy is one of the most sensitive TL-dosimeters. It can be labormade easily and is, therefore, cheap and always available. Dominant properties are the high Z and a fading of up to 60 % in the first four hours after exposure. The optimized labormade material is doped with 0.1 % Dy. The Dy-content is determined by neutron activation analysis. After a preheating of 3 minutes at 85°C emerges a stable glow peak at 210°C. This treatment stabilizes the fading at 5% for the first six weeks. Though this procedure reduces the sensitivity the lower limit of detection was ~500 μR. The energy dependence between 10 and 50 keV was determined for different wrappings with a Bragg-monochromator. The maximum of the sensitivity normalized to ⁶⁰Co-radiation was 14.4 at 35 keV for PMMA ("Plexiglas") and 12 at 40 keV for gelatine wrapping.

RELATIVE STANDARD DEVIATION OF THERMOLUMINESCENCE
DOSIMETRY - COMPARISON OF THE EXPERIMENTS WITH THEORY

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The authors have pointed out in a theoretical paper that the variance of a TL reading, σ_R^2 as a function of absorbed dose, D , has the form of $\sigma_R^2 = A^2 + B^2 D + C^2 D^2$. In this expression A^2 is the contribution of the nonradiation background, $B^2 D$ represents the Poissonian, $C^2 D^2$ the Gaussian part of the variance. The three constants can be determined experimentally, and therefore a standard deviation may be assigned to any single measurement.

In the present contribution LiF powders of different origin, $\text{CaSO}_4:\text{Dy}$ and $\text{CoSO}_4:\text{Tu}$ powders were used for the experimental verification of the above expression. The expected variance was compared with the measurements performed in the $(1 - 1000)D_{\text{LDL}}$ range. D_{LDL} is defined as threefold of the standard deviation of the background. The agreement of theoretical and measured values is good.

The Poissonian part of the variance is especially important at the $(20 - 40)D_{\text{LDL}}$ dose range for some TL-measurements (e.g. low-sensitivity reader combined with small background variance and individual calibration). This is illustrated by using some data from the literature.

THE AUTOMATED/COMPUTERIZED TLD-MONITORING SYSTEM
IN BORIS KIDRIČ INSTITUTE - VINČA

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32 33 000 YU

The paper describes system of microcomputer controlled thermoluminescence personnel dosimetry monitoring in Institute of nuclear sciences, Vinca.

Results showed that automated and computerized TLD system resulted in higher degree of accuracy and have the advantage in comparison with classical manner of data processing.

The peculiarity of the described automated monitoring system is the fact that the dosimetric control is performed with the new type of near tissue-equivalent, high sensitive, own produced TL dosimeters. The four year experience showed highly satisfying results.

ROUTINE USE AND CALIBRATION PROCEDURE FOR THE AUTOMATICALLY
OPERATED SINGLE TLD-CRYSTAL READER HARSHAW 2000D

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+ Institute for Medical Physics, University of Innsbruck,
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For routine measurements of the finger-dose of occupational-
la exposed persons the automatically operated single
crystal TLD reader HARSHAW 2000D is used. The main problem
is the calibration of the TLD-chips (TLD 100 and TLD 200,
LiF and CaF₂ crystals manufactured by HARSHAW). In order
to reduce the handling i.e. the mechanical stress of the
material and to make sure that the TLD's are properly
identified, the following procedure is used: the dosimeters
are transferred to the read-out disc of the 2000D (being
manually identified and the name of the user recorded);
after a short thermal treatment the normal read-out cycle
is performed, having the dose of each dosimeter printed
on a recorder as well as on line fed to the computer via
V 24 interface (simultaneously the glow curve is plotted).
Afterwards the whole disc with the dosimeters unchanged
in their order is irradiated in a modified STUDEVIK 6525 B
reference dose irradiator, capable of receiving the read-
out disc of the HARSHAW 2000 D. Normally the dosimeters are
irradiated to 200, 400, 800 and 1600 mrad with accuracy of
at least 10 %. Again the calibration doses are fed via
interface to the computer and the calibration factor is
calculated separately for each crystal by using a least
square fitting through the (normally) four calibration
points. Finally the corrected dose of the first read-out
is printed together with the user's name and the time of
surveillance.

The flow-diagram of the FORTRAN-program is shown as well as calibration curves for different dosimeter materials and glow curves.

That way it is possible to read out different dosimeter materials in any order up to a dose of about 2 rad with sufficient accuracy for routine use.

Finally the results of the routine measurements of the finger-doses of occupationally exposed persons are shown as a function of the different types of surveyed occupation.

SESSION IV

W

BIOLOGY AND MEDICINE

Co-chairmen:

Irlweck (A)

Kargačín (YU)

Sztanyik (H)

DO BIOPOSITIVE EFFECTS OF IONIZING RADIATION EXIST?

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In official documents (UNSCEAR, BEIR) only harmful effects of radiations are envisaged, and doses are to be kept down as far as possible. The same philosophy is adopted in all legislations. In contradiction, it is claimed by officials of radioactive spas and some doctors that irradiation may be beneficial. An example is the "Healing Gallery" (Heilstollen) at Badgastein-Böckstein with its radon-rich atmosphere. It is here proposed that claims for biopositive effects have no foundation in scientific fact (1,2,3,4).

Clearly spas, radioactive or otherwise, may be helpful. But it has never been demonstrated that any radioactive substance, e.g. radon, is a "healing factor", as claimed. Scientific proof of benefits would be difficult with humans. But in the enormous literature on spas no conclusive results with animals exist either. Effects of doses in the relevant range were reported, e.g. concentrations changes in body fluids. But are changes, i.e. deviations from the normal values, beneficial? From the standpoint of general radiation biology benefits are implausible. The persistent conflict between radiation biology and commercial propaganda is a scientific scandal.

A different question is posed by alleged stimulation of crop plants. Often increases in yield and accelerations of development were claimed. But while stimulation, if it exists as a reproducible effect, is welcome to the farmer, it need not be beneficial for the plant.

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DNA REPAIR PROCESSES IN PERSONS CHRONICALLY EXPOSED
TO LOW LEVELS OF RADIATION

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It is now generally agreed that DNA repair is an important requisite for the abolition of damage induced within the genetic material by a variety of chemical and physical agents. It is of special importance for persons occupationally exposed to ionizing radiation or living in areas of high background radiation.

The present studies were conferred on a group of persons regularly descending to the radioactive gallery of Badgastein and employees of the Austrian Research Center Seibersdorf exposed to very low levels of ionizing radiation. The ability to repair DNA lesions was tested in these probands by the response to unscheduled DNA syntheses following in vitro UV exposure of peripheral lymphocytes and by sister chromatid exchange induction after Mitomycin C treatment. After chronic exposure to low levels of ionizing radiation an increased amount of DNA repair could be demonstrated both by an enhancement of unscheduled DNA synthesis and a reduction of Mitomycin C induced sister chromatid exchanges. The results could not be correlated with changes within the lymphocytic cell population. No differences in the B/T cell ratios were found after different levels of radiation exposure.

BIOLOGICAL DOSIMETRY.RECENT ADVANCES AND TRENDS FOR THE FUTURE

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Biological dosimetry is one of the methods for assessing dose to exposed individuals. Its principal use is in cases of overexposure, either as a complement to physical dosimetry or as a substitute in cases in which overexposed persons or persons suspected to have been overexposed did not wear a dosimeter. Chromosomal Aberration Analyses (C.A.A.) is, among others, the method of choice, and has been studied extensively in the past for genetic risk assessment and for dose assessment as well. There is a trend as present to concentrate research, for the application of C.A.A. in radiological protection in the area of exposure related to abnormal conditions, in a dose range between 0.25 to several Sievert (25 to 500 rem).

Other methods have been and are being investigated in biological dosimetry, but have not yet been perfected for immediate routine use. Some of them are particularly interesting and may prove very useful in the future, in particular some biochemical methods like cell membrane probes, and some physical methods like the assessment of neutron activation products in tissues, and thermography of body areas severely affected by radiation. The IAEA is active in the field of biological dosimetry with some Coordinated Research Programmes and with the publication of manuals covering the basic principles and the practical implications of the Biological Dosimetry methods.

AVAILABILITY AND PROBLEMS OF BIOLOGICAL INDICATORS
FOR RADIATION INJURY

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One of the important tasks of radiation protection is to develop and apply biological and medical laboratory techniques which indicate any overexposure of a person especially in cases of radiation accidents. Although several methods are available, none of them satisfies the requirements as yet (1). The commonly used biological indicator is the chromosome aberration analysis, the application of which seems to have limitations either, being influenced by various conditions of irradiations. These will be reviewed and own data presented.

Another approach in our laboratory is based on the radiation-induced cell membrane alterations. A technique has been worked out (2, 3), the experimental data will be presented and discussed.

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Int.J.Radiat.Biol. 40, 175-186, 187-194.

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STOCHASTIC LUNG DOSE MODELLING -
A JOINT AUSTRIAN-HUNGARIAN PROJECT

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Models currently applied in radiation protection are so-called deterministic models, i.e. all model parameters are represented by mean values. Since these models do not consider parameter variabilities inherent in all biological and environmental systems, they should be replaced by stochastic models. In such models all parameters are regarded as random variables, each of them described by a probability density distribution and inserted into the system's equation in a random manner.

Large inter- as well as intra-subject variabilities have been observed in all morphological and physiological parameters involved in lung dosimetry. A case in point is the anatomical structure of the lung which is highly asymmetric with randomly varying linear dimensions, branching angles and number of airways. Morphometric data on the human lung were analyzed to define probability distributions of airway diameters and lengths and to study correlations among these parameters. Experimental results of deposition studies with cylindrical glass tubes, varying flow rate, particle size, linear dimensions and branching angles confirmed the applicability of published theoretical deposition equations for straight tubes and provided additional information on deposition at branching sites. The random walk of aerosol particles during inhalation and exhalation in such a random airway structure was then simulated by

Monte Carlo methods yielding probability distributions for the deposition fractions in various lung regions.

With this information on random variations of deposition probabilities and geometric dimensions and additional information of the same kind on clearance velocities and basal cell depths, lung dose distributions could be derived instead of single mean values. All parameters in this stochastic compartment model are described by truncated lognormal frequency distributions yielding basal cell dose distributions, which can be approximated in most cases by lognormal distributions. These basal cell dose distributions are of primary significance for the definition of upper limits in radiation protection regulations and for the correct interpretation of epidemiological data on lung cancer incidence.

**LUNG CANCER RISK AS A RESULTS OF ENERGY CONSERVATION
AND WASTE RECYCLING**

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Technical and societal developments indicate that future exposures to the natural radiation environment (NRE) are likely to increase for two main reasons:

1. Energy conservation efforts demand the reduction of ventilation rates and the increased use of air-recirculation. This will cause an increase of both, atmospheric radon and radon daughter levels indoors as well as the dose determining equilibrium factor between radon and its daughters.
2. Concern about the environmental impact of large amounts of industrial waste products from e.g. power production, mining- and phosphate industry, stimulates the recycling of these waste materials as raw materials for the construction industry. Due to technological enrichment processes some of these new materials show a high content of Ra-226, leading to increased radon exhalation into the atmosphere of dwellings.

In the paper an extensive risk-benefit-cost analysis will be presented. National and international efforts for dose limitations and the definition of action levels are reviewed, indicating the widespread lack of coherence of the presently used recommendations and regulations. The optional reduction of this anticipated exposure from the technologically enhanced NRE is associated with varying financial burdens to the society. Therefore different remedial actions will be discussed for several defined types of NRE

exposure, assuming varying causes for the increased exposure (reduced ventilation conditions, increased radionuclide content of fuel and construction material). The cost-effectiveness analysis shows that for all hypothetically assumed types of NRE exposure causing increased lung cancer risk for the general public, there is a considerable net financial gain for the society in undertaking remedial actions in order to reduce this elevated exposure.

COMPOSITE TREATMENT FOR REDUCING RADIONUCLIDE RETENTION
IN RATS

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In cases of human contamination with mixed fission products and transuranic elements use of several antidotes is recommended as a therapeutic treatment (IAEA, 1978). There is however a possibility that by the simultaneous use of antidotes the efficiency of each therapeutic means would change because of their mutual interference.

The purpose of present work was to evaluate the efficiency of antidotal composite treatment - consisting of a "mixture" of calcium alginate, ferrihexacyanoferrate(II) and potassium iodine (shown to be highly efficient in reducing radioactive strontium, caesium and iodine retention), administered in diet and/or $\text{Na}_3(\text{CaDTPA})$ (antidote for transuranic elements) administered intraperitoneally on the absorption and the removal of radioactive cerium, strontium, caesium and iodine in seven-week-old female rats. The animals were on respective treatment for three days. The retention of ^{141}Ce , ^{85}Sr , ^{137}Cs and ^{131}I was determined in the whole body, carcass, gut, liver, kidney and respective critical organs (femur, muscle, thyroid) six days after their oral or intraperitoneal administration.

In animals which received the "mixture" or $\text{Na}_3(\text{CaDTPA})$ alone the radionuclide retention was practically the same as in rats which were given the composite treatment ("mixture" + $\text{Na}_3(\text{CaDTPA})$). This indicates that the efficiency of specific antidotes was practically unaffected by the simultaneous use of four different antidotes. The antidotal

treatment reduced the whole body retention of orally administered radionuclides 10 times for ^{141}Ce , 5 times for ^{85}Sr , 50 times for ^{137}Cs and 10 times for ^{131}I and after intraperitoneal administration 10, 1, 2 and 10 times respectively. It is concluded that such composite treatment presents a therapy of choice in cases of internal contamination with several radionuclides.

LEUKAEMIA MORBIDITY IN BAVARIA.
AN EPIDEMIOLOGICAL STUDY INCLUDING LOW-LEVEL RADIATION
FROM NATURAL AND ARTIFICIAL SOURCES

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As a contribution to the discussion as to whether there is any positive relation between the operation of Nuclear Power Plants and the increase of leukaemia incidence, the Federal Health Office is carrying out a study on leukaemia morbidity in Bavaria. The aim of this study is to prepare a map of leukaemia in Bavaria and to find out whether there are regional differences in morbidity or not and, if so, whether these differences enable for the identification of the environmental factors influencing morbidity, especially for outdoor and indoor low-level radiation from natural and artificial sources.

Considering the fact that there is no cancer register for Bavaria, we are preparing a total survey of leukaemia incidence in cooperation with more than 330 hospitals.

At present we are not able to present final results of our study because we are still collecting data. However the amount of cases collected up to now is large enough to allow a first view on the regional distribution. So preliminary results of this study will be presented with emphasis on the following aspects:

- analysis of leukaemia incidence in the vicinity of nuclear technical facilities;
- analysis of leukaemia incidence in communities exposed to

relatively high doses from natural radiation, differentiated for outdoor and indoor exposure.

Last remarks will be made on the question whether there is any chance to identify radiation exposure as a risk factor viewing the variety of other intervening risk factors.

THE EFFECT OF MILK DIET ENRICHED WITH LACTOSE AND/OR
IRON ON STRONTIUM-85 TRANSFER AND RETENTION IN
RAT'S ILEUM

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The aim of this study was to see how milk diet, pure or enriched with lactose and/or iron, influences strontium-85 transfer and retention in the rat's small intestine.

Five-week-old female albino rats were divided into seven groups according to the diet they were fed during a three-day period. The groups were:

- (1) standard laboratory food (SF) + drinking water (control)
- (2) SF + 15 % lactose in drinking water
- (3) pasteurized cow's milk (CM)
- (4) CM + 6 % lactose
- (5) CM + 15 % lactose
- (6) CM + 10 mg Fe/100 ml
- (7) CM + 15 % lactose + 10 mg Fe/100 ml.

On the fourth day all animals were killed by decapitation and exanguination. A 4 cm long ileal segment was cut out and the everted sac prepared according to the method of Wilson and Wiseman. It was injected with 0.6 ml of the modified Krebs-Ringer solution, tied at both ends and incubated in 2.5 ml of the same medium for 45 min. Strontium-85 was added as chloride only to the outside solution as an essentially carrier-free form. The medium was equilibrated with oxygen. After incubation at 37°C the activity of strontium-85 was determined in an aliquot inside and outside the ileal sac and in the intestinal wall. The results

were expressed as S/M ratios for strontium-85 transileal transport and as per cent of initial mucosal solution activity for its intestinal retention.

The effect of the experimental diets used was not the same with regard to radiostrontium transfer and retention in the intestinal wall. Compared to the controls (group 1), all diets enhanced the transfer of strontium-85 from the mucosal to the serosal side from 14 to 38 per cent, whereas the impaired the intestinal uptake from 6 to 23 per cent. The lactose effect was dose dependent only on strontium-85 transfer.

HAPTOGLOBIN (Hp) AND PROFESSIONAL IRRADIATION

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The acute phase reactant proteins (haptoglobin is one of them) are mainly glycoproteins that alter their plasma concentration in response to stimuli produced by many forms of tissue injury, acute and chronic inflammation, connective tissue disorders and cancer.

The subject of this paper is to find out whether Hp responses to the ionizing radiation in the controlled occupational exposure.

Haptoglobin has been examined on M-PARTIGEN HAPTOGLOBIN immunodiffusion plates of the Behring Institute with the workers employed in the heavy water experimental reactor RA with normal power of 6.5 MW using 2 % enriched uranium fuel. In the last 8 years maximum exposure doses were less than 20 mSv/a. Control group consisted of the workers who had never been exposed to the ionizing radiation in their worktime. Average age in both groups was 50 ± 4 years, and duration of the worklife was 24.4 ± 2 years with reactor workers and 23.8 ± 2 years with controls.

Hp has been analysed during preventive periodical survey. It means in conditions in which the illnesses that need medical treatment were excluded.

With the reactor workers Hp increased in the sera in 40 %, and 11 % in the controls. Such a significant difference in the population at the similar fisiological conditions, lead to conclusions that the ionizing radiation was the provoking factor which increased Hp level in the sera even in controlled occupational conditions.

The question is now, whether the alteration of the Hp means injury or it is an aberrant modification of various protective mechanisms.

It might be helpful in monitoring population exposed to ionizing radiation and organised repeated medical controls with those that have enhanced level in Hp. The aim of that is to find out the first sign in the radiation injury and to act in time.

W

HEMORRHAGIC MANIFESTATIONS IN SEMI-LATHALLY RADIATED
EXPERIMENTAL GOATS

Z. MILOŠEVIĆ, I. SELAK, Z. MARKOVIĆ, R. KLJAJIĆ, E. HORŠIĆ
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This paper deals with the hemorrhagic manifestations during the acute radiation syndrome in the experimental animals (goats) which could be seen on the linear accelerator by X-radiation energy of 4 MeV.

The hemorrhages have been followed by the adequate changes of the blood picture.

There have found pathological-anatomic macroscopically visible hemorrhages, while microscopically there have been found morphological equivalents of disseminated intravascular coagulation (DIC).

EFFECTS OF STIMULATORS HAEMATOPOIESIS AT TOTAL
SINGLE AND FRACTIONAL IRRADIATION IN EXPERIMENTAL
CONDITIONS

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Beograd, Yugoslavia (282 000)

The experimental study includes the investigation of reactivity of some physiological radiosensitive systems and pharmacotherapeutical effects of stimulators on the haematopoietic tissue at conditions whole body gamma irradiation. Albino rats were exposed either to a single dose of 6 Gy or to fractional irradiation (3 x 2 Gy) applied in the course of one week. The effects of the applied drugs on the postirradiational haematologic reaction and reparatories, have been observed in dependence on ordinary time in some phases of acute radiation illness.

It has been shown that ordinary time of antiradiation means in relation to some phases of the acute radiation illness are from the greatest importance for the next postirradiation period, having in view that illness becomes worse or better.

In this study have been discussed the possibilities of application of the drugs in prevention and therapy of radiation injuries, as well as the optimal time and ordinary way.

RADIATION DOSE RECEIVED BY THE PERSONNEL OF
GYNECOLOGICAL AND NUCLEAR MEDICINE DEPARTMENTS

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Different measurement methods, including GM-tube and ionization chamber dose-rate monitors, as well as lithium-fluoride thermoluminescent detectors were compared. Correction factors were established for the GM-tube devices.

By using TL detectors local doses at the head, chest, palm, fingers, finger tips and gonads were measured for fifteen typical operations performed at nuclear medicine and gynecological departments.

Typical dose values are presented for medical doctors, assistants, nurses and other personnel. All the doses, averaged for a year period were found to be below the maximum permissible values.

**IN VIVO DETERMINATION OF THYROID-MASS IN
NORMAL INDIVIDUALS**

49613

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Data in the literature concerning the normal thyroid mass of the population have so far given diverging results. From the viewpoint of nuclear medical radiation loading and environmental protection it was deemed necessary to determine the average value of thyroid mass, in Hungary.

In the first part of our work we supervised the in vivo methods and their evaluation for the estimation of thyroid mass presented in the literature, as the possibility arose that the reason of the different results may be attributed to the variety of methods. Methods were compared with each other and with model-experiments. On the basis of these results an empirical formula was introduced and applying thyroid scanning the probable mass of the gland could be determined accurately with the aid of this formula.

Based on the scintigraphic pictures of 200 euthyroid subjects, who were sent to the department for the evaluation of their thyroid function, the distribution parameters of the normal thyroid mass could be assessed and in the knowledge of this dosimetrical conclusions have been drawn, too.

W

EARLY ESTIMATION OF THE ABSORBED DOSE IN X-IRRADIATED RATS
BY MONITORING OF SIMPLE INDICATORS OF HAEMOTOLOGIC AND
DIGESTIVE SYSTEM REACTIVITY

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Zivan DEANOVIĆ
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Haematologic and gastrointestinal systems are among the most radiosensitive organ systems in mammals, because of their intensive cell renewal. Both manifest early (up to 3rd day) postirradiational non-stochastic changes and they were extensively investigated up till now. The dose ranges of their most pronounced reactivity to irradiation, in terms of dose-response, are quite different (or complementary if considered on the other way).

We made apragmatic evaluation of the suitability of two early non-stochastic effects monitoring, in order to get biodosimetric information. For this purpose we chose two simple but relevant parameters reflecting postirradiation reactivity of haematologic and digestive system in rat: leucocyte (or more specifically lymphocyte) count and body weight.

Simultaneous following of both parameters enabled us to cover wide dose range of early and reproducible response to absorbed X-irradiation dose (0.2 - 13 Gy).

SESSION V

DOSIMETRY

Co-chairmen:

Duftschiid (A)

Medveczky (H)

Prokić Mirjana (YU)

A NEW MODEL OF ELECTRON INTERACTION WITH MATTER TO BE
USED FOR CALCULATION OF DETECTOR'S RESPONSE FUNCTION

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Classical models of electron interaction with matter which are being applied in Monte Carlo calculations, have a limited application in spectrometric calculations. These classical models give correct results for the average values of different integral interaction characteristics, such as in the exposure dose, but they lead to the large error for detector's response function calculation. In this paper is presented an improved model which takes into account bremsstrahlung, corrected energy loss distribution along the elementary path as well as algorithm of the calculation.

A NEW MONTE CARLO TRANSPORT CODE FOR BETA DOSIMETRYÁkos PETŐ, László KOBLINGER[†]

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Hungary

BETRA is a new three-dimensional Monte Carlo transport code developed for β -dosimetric purposes. It is capable of handling electrons with energies from 10 keV to 3 MeV. The code allows the use of arbitrary source spectra and geometries. The volume in which transport takes place may consist of several different compartments with different materials. The number of materials is limited only by computer capacity. In order to avoid coupled β - γ transport, Bremsstrahlung is neglected. Secondary electrons are produced according to the Møller cross section, and followed until their energy drops below a previously given lower limit.

A special free path length sampling technique is used to save computer time. Multiple scattering is simulated using precomputed data on the basis of the Goudsmit-Saunderson theory and Coveyou's sampling method. The performance of the code is illustrated with results obtained for the energy dependence of LiF TLD chips, cold pressed LiF β -dosemeters and a special three element β - γ -sandwich dosemeter.

SOME EXPERIENCES IN INCIDENTAL INTERNAL CONTAMINATION
MONITORING AND DOSE ASSESSMENT

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The whole body counter of the Central Research Institute for Physics, Budapest, is used as one of the main device for routine and special monitoring of internal contamination of workers employed in the institute and in few other institutions. During routine and special monitoring, contaminations of ^{46}Sc , ^{57}Co , ^{123}Te , ^{137}Cs , ^{192}Ir and ^{203}Hg were found and the whole body activities were followed in time. The levels of contamination were not very high from the point of view of occupational exposure, but high enough to determine some individual parameters like whole body retention function, or long term biological half live. The estimated doses based on individual parameters have been compared with those derived from Annual Limit on Intakes using Reference Man data accepted in ICRP no.30 recommendations. In the light of the results, for high level contamination the necessity of the individual dose assessment for the given case is underlined. The preparedness for internal dose assessment at the whole body counter laboratory of the Institute will be presented and briefly discussed.

NEUTRON DOSE DISTRIBUTION IN A WATER BOTTLE PHANTOM
IRRADIATED WITH 14 MeV NEUTRONS

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Neutron dose distribution in a water bottle phantom was calculated by using the Monte Carlo method, which included elastic, inelastic scattering, as well as nuclear reactions on oxygen.

The calculated fast neutron fluence and spectra were verified by measuring activation of S and Mg pellets in different depths of the corresponding bottle phantom filled with water and irradiated homogeneously with 14.9 MeV neutrons.

Thermal and intermediate energy neutron doses were determined by measuring the Cd-ratio with Au- and Cu-foils.

Theoretical data agreed with the experimental ones within the limits of 15 %.

PRESENT STATE OF NEUTRON DETECTION IN ATOMKI

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Among the results obtained in the Institute of Nuclear Research of the Hungarian Academy of Sciences in the field of the technique and application of solid state nuclear track detectors (SSNTD), some are important for health physics (e.g. recoil tracks induced by fast neutrons in plastics (1966), empirical formula for monitoring neutrons with LR 115 type cellulose nitrate (1974, 1977)).

In this paper neutron sensitivities of three SSNTD (LR 115 II, LR 115 strappable type, Melinex O) are given. The detectors without any external radiator were irradiated with neutrons of the spectrum of moderated fission. The relative sensitivities of these detectors were obtained to be 5.48 : 11 : 3.16.

The counting characteristics of spark counter evaluation on detectors of LR 115 strippable type irradiated with 14 MeV neutrons were also studied.

The sensitivity of a dosimeter containing a polycarbonate detector and fissile radiator foils (U, Th) were also examined.

RELATION BETWEEN THE LOCAL AND CHEST DOSIMETER READINGS

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Workers engaged in the radioisotope production are generally exposed to a highly inhomogeneous radiation field. In order to reveal possible correlations between chest and local doses, the personal dose distribution was measured. Workers dealing with ^{131}I , $^{99\text{m}}\text{Tc}$ and ^{192}Ir radioisotopes were included in the investigations.

The head, chest, back, gonads, hands and fingers were monitored with Harshaw type LiF and $\text{CaSO}_4:\text{Dy}$ thermoluminescent detectors.

During the operations with ^{131}I and $^{99\text{m}}\text{Tc}$ the local and chest doses were found to be similar, while in the case of iridium production gonad doses exceeded chest values by a factor of 6.

INCORPORATION MONITORING AND EVALUATION OF RESULTS OF THE
NUCLEAR RESEARCH CENTRE ROSSENDORF/GDR

J. Fietz

Nuclear Research Centre Rossendorf, GDR

The Department of Radiation Protection at the Nuclear Research Centre Rossendorf in the German Democratic Republic controls all people working with radioactive material or having the possibility of incorporation with the aid of a whole body counter, iodine monitor, excretion analysis.

Programs for these surveys, results of control measurements will be presented and discussed. Future views will be given on the development of our laboratory to determine incorporation control.

RADIATION DAMAGE IN APATITE

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The calcium apatites are an important group of synthetic and natural compounds with widespread applications, i.e. one potential application being in the frame of high level nuclear waste disposal. Experimental knowledge about radiation induced damage in this material, however, is still in its infancy.

Hence, we have studied fission induced radiation damage in natural calcium fluorophosphate by absorption spectroscopy and light microscopy. Extending previous studies from this laboratory we have investigated (1) the annealing behaviour of the etchable defect zone and (2) we have measured the total absorption and the characteristic absorption difference as a function of the radiation damage intensity, as a function of annealing time and temperature, the sample thickness and orientation. It was found that the annealing kinetics can be described by a sum of exponential decay functions. From an analysis of the temperature dependence of the annealing law it can be concluded that the etchability of the etchable defect zone is due to extended defects, i.e. systems of dislocation loops. Moreover, one of the dominant annealing mechanism for the absorbing defects appears to be diffusion of H(II) centers to the surface with a measured diffusion coefficient in the order of $10^{-9} \text{ cm}^2/\text{s}$. Further experiments revealed that it is not possible to reproduce some of the absorption structures by first annealing the fossil tracks and then producing freshly induced tracks by subsequent neutron irradiation.

Work partially supported by Österr. Forschungsfonds,
Projekt 4580, and Reaktorzentrum Seibersdorf.

SESSION VI

ENVIRONMENTAL

Co-chairmen:

Djurić (YU)

Koblinger (H)

Sorantin (A)

THE AUSTRIAN SURVEILLANCE SYSTEM FOR ENVIRONMENTAL
RADIOACTIVITY

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The Austrian surveillance system for environmental radio-activity started already in 1957 with air control and has developed into a system which includes nowadays the control of air, precipitation, surface water, food etc.

During the last years more and more nuclei specific measuring methods have been introduced. The methods include now high-resolution gamma spectroscopy, liquid scintillation counting and alpha spectroscopy.

The current status of the surveillance system and results of the measurements are presented.

RADIOECOLOGY OF VARDAR RIVER

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In attempt to make an approach in determining the bio-geochemical and radioecological characteristics of the river Vardar, in the near of which (location Krivolak) a Nuclear Power Plant is planned to be constructed, activation analysis as well as determination of ^{18}O , ^2H , ^3H , ^{14}C , U, Th, ^{226}Ra , ^{40}K , ^{137}Cs , ^{90}Sr and total beta activity on different samples from the investigated area have been performed. An assessment of internal exposure of the local population, as a result of possible radioactive release into the Vardar river under certain circumstances and assumption was also made.

NATURAL RADIOACTIVITY OF SOME METALS AND CERAMICS

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Austrian Research Center Seibersdorf, Austria

The natural radioactivity of commonly used metals as aluminium, iron, steel and lead as well as noble metals as silver, gold and platinum or special metals as rhenium was determined.

Also ceramic materials as porcelain and its components and dental powders were analyzed.

The results are discussed in view of dose commitment for the population.

SETTING RELEASE LIMITS OF RADIOACTIVE MATERIALS INTO
THE ENVIRONMENT

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The release of radioactive material from nuclear installations during normal operations should be set and design features and operating procedures elaborated so that two conditions are met:

1. the authorized doses to individual members of the public shall not be exceeded, and
2. the collective dose from each release shall be kept as low as is reasonably achievable, economic and social factors being taken into account.

This process is referred to an optimization of protection resulting from the release and the general methodology has been described in other lectures.

In this lecture the intention is to briefly discuss the implementation of the requirements 1 and 2 mentioned above and the general monitoring program required.

CONTENTS OF ^{137}Cs AND ^{90}Sr IN THE SAMPLES FROM THE
SURROUNDINGS OF THE NUCLEAR PLANT

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In the paper are discussed the results of two year measurements of the total beta radioactivities of fallouts. The data on the content of ^{137}Cs on monthly composite samples, collected in the surroundings of the nuclear reactor in Vinča, have been presented.

In relation with this, i.e. the predominant cause of the change of biospherical radioactivity, the authors also discuss the contents of ^{137}Cs and ^{90}Sr in human food and cattle fodder, and in the ground surrounding of the plant.

COLLECTIVE DOSE FROM THE USE OF DANUBE WATER IN AUSTRIA
AND HUNGARY - I

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This paper concernes itself with the basic definition and for what reasons this quantity has to be assessed. The procedure of pathway related assessment is shown, where considerations already applied for the Danube river are used. Some considerations deal with the avaiiability of data and their validity for the present purpose. Eventually the results obtained in a six year program carried out since 1977 are discussed, taking into account the present use of Danube water in Austria.

COLLECTIVE DOSE OF THE POPULATION IN AUSTRIA AND
HUNGARY FROM THE USE OF THE RIVER DANUBE - II

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M. TSCHURLOVITS, Atominstitute of Austrian Universities,
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Almost half of the Hungarian population is provided with drinking water from the Danube river. Drinking water supply of more than two million citizens in the capital, Budapest, depends entirely on the Danube. Therefore, cleanliness of the river water is of vital importance for Hungary.

Since 1977, an intense monitoring programme has been performed within the framework of the IAEA's co-ordinated research programme on the "Radioecology of the River Danube" to measure the concentrations of various natural and man-made radionuclides in the Hungarian reach of the river. In addition, information has been collected concerning the annual consumption of drinking water, fish, vegetable irrigated with river water, milk and meat of animals watered from the river or fed with contaminated fodder. In the knowledge of these data and the number of citizens involved in consumption of the products mentioned, it is possible to calculate individual and collective doses received by the population of Hungary due to the utilization of the Danube. Results of these calculations will be presented in the paper.

It is the intention of the authors to show that nearly identical individual doses of radiation may result in quite different collective doses in the two neighbouring countries, because of the significant differences in habits of their populations and in utilization of the river.

GM-COUNTERS FOR CONTINUOUS ENVIRONMENTAL MONITORING
AT THE PAKS NUCLEAR POWER STATION

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In case of normal operation of the Paks Nuclear Power Station the increase of dose rate due to radioactive releases to the atmosphere is expected to be only some per cent of the natural background. That is why estimating the minimum detectable dose rate increase is of great importance for the calculation of individual and collective doses. The results of in situ background measurements performed by the GM detectors of the environmental monitoring system are discussed. The measurements were performed hourly in the period of September to December 1982, at 7 stations, by pairs of GM detectors, one detector in each pair has a low sensitivity below 200 keV due to an absorbing cover. The periodic variation of background radiation is studied in relation to changes in weather parameters viz. the effects of inversion and precipitation on the terrestrial radiation as well as the effects of changes in atmospheric pressure on the cosmic background. Correlation between the signals of individual stations is studied and a background correction method is developed.

Applying this latter method, 2 - 3 nGy/h dose rate increase can be detected at 95 per cent significance level.

EFFECTS OF DECONTAMINATION TREATMENT OF NORMAL SKIN
AND EXCORIATION ON CONTAMINATED WITH RADIONUCLIDES

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These investigations concern the penetration of radiostrontium, radioiodine and radiocaesium through normal skin and excoriation under influence of some physical and chemical factors which could determine permeability variations. In the experimental study of internal contamination induced by percutaneous way and through excoriation, the influence of cleansing procedures and means for decontamination on the absorption and prevention of locally and total irradiation were observed. Efficiency of decontamination treatment has been evaluated on the basis of penetrated quantities of radionuclides and residual radioactivity in the decontaminated regions.

The results obtained show that the absorption through normal skin was to 2 % of the applied quantities of radionuclides and efficiency of decontamination was to 99 %. The highest decontamination efficiency of the excoriation was obtained, when about 70 % of radiostrontium was removed in early performed decontamination (after 10 minutes). For excoriation contaminated by radioiodine, efficiency of decontamination after 10 minutes was about 35 %, but for radiocaesium to 45 %.

On the basis of the obtained experimental data, the importance of the observed factors for arise of internal contamination and the risk of some fission products, as well as the aspects of decreasing of local and total irradiation, have been discussed.

APPLICATION OF A SCREEN DIFFUSION BATTERY TO
MEASUREMENTS OF ULTRAFINE AMBIENT RADIOAEROSOL

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The work included the setting up a system to separate ambient aerosol in the size range from 0.01 to 0.2 μm for measuring radioactivity by different detections. The task was to ensure

- the radioactive measurement of each penetrated aerosol fraction just after sampling, or during sampling
- the maximum feasible aerosol flow through the samples to get detectable activity,
- the adjustment of measured data for subtraction method resulting activity/size distribution.

For these aims a screen diffusion battery and a conductor switching valve were used after modification providing the continuous stage cycling mode and the necessary air flow rate through also the port outlets. Furthermore, a calculation method was introduced to adjust, or drop out the defective data set caused by some technical shortcomings of diffusional sampling and tubing: wall losses, fault in seals, and that of nuclear detection.

The radioactivity of penetrated aerosol fractions was measured both by simultaneous alpha and beta scintillation after sampling and by CR-39 track detection during sampling. Correlation of activities measured by different ways, and activity/size distribution are discussed.

DETERMINATION OF ARTIFICIAL RADIONUCLIDES IN SOME
SURFACE WATERS IN SOUTHERN AND EASTERN AUSTRIA

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Kontroll- und Meßstelle des Bundesministeriums für
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Within the scope of the Austrian Surveillance System for Environmental Radioactivity measuring units of the Federal Ministry for Health and Environmental Protection have found artificial radionuclides in some surface waters of Southern and Eastern Austria. The origin of these substances lies in medical applications.

Sampling routines, sample preparation methods and measurement results are presented.

RADIATION BURDEN OF POULTRY BY RADIONUCLIDE ^{40}K

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The paper presents data about the ^{40}K activity level, i.e. the concentration of K, in different feeds that are used in the intensive poultry production. Also, radiation burden to which poultry is exposed by ^{40}K is estimated.

The ^{40}K activity level to which broilers and laying hens are exposed during intensive husbandry depends on the kind of feed. Broilers receive least ^{40}K activity of they are fed on oats. The laying hens are two times more burdened by ^{40}K activity than broilers, regardless of the type of feed. In their lifetimes broilers take up ten times less ^{40}K than laying hens.

These results rise the question whether ^{40}K has a radiobiological effect on the poultry organism, having in mind the level of activity of this radionuclide to which poultry is exposed.

CONTRIBUTION TO THE RADIOLOGICAL CHARACTERIZATION OF
THE BOKOKOTOR'S BAY

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To our knowledge radiological investigations of the BokoKotor Bay have not been carried out so far. Our investigations of this bay on the jagged South Adriatic coast, important for its geomorphological and geographical position, included in the first phase determination of the total beta radioactivity, total potassium and ^{40}K in the samples of sea water, sediments and biota collected from 6 experimental points in the bay. Contents of ^{137}Cs and ^{90}Sr have further been determined in the most characteristical samples.

In the present paper are discussed some more important facts based on the obtained experimental data.

TRITIUM CONCENTRATIONS IN THE NATURAL WATERS OF
BELGRADE REGION

M. HADŽIŠEHOVIĆ, M. ZUPANČIĆ, R. VUKANOVIĆ, R. STEPIC
Boris Kidrič Institute of Nuclear Sciences - Vinča,
Beograd, Yugoslavia

The tritium concentrations from the monthly samples of Danube and Sava river waters, precipitations and some alluvial underground water in the Belgrade region for the period 1978 - 1982 are presented.

Measurements are performed in order to establish the hydrological characteristics of the Belgrade water supply region.

The concentration of ^3H in the precipitations gradually decreases and similar behaviour in the river waters is noticed. Towards the end of the presented period the concentrations of ^3H in the Danube water become relatively higher than in the Sava water. The measurements of ^3H concentrations in the alluvial underground water shows that ^3H from the river and the precipitation migrates differently in the different alluvial layers. In some layers the concentrations are higher than in the river water due to slower flow of the water in the alluvium.

INVESTIGATION ON THE PREOPERATIONAL LEVEL OF RADIATION
FIELD IN THE VICINITY OF PAKS NUCLEAR POWER STATION

István NÉMETH, Péter ZOMBORI, László KOBLINGER,
Andor ANDRÁSI

Central Research Institute for Physics Budapest
Endre GERMÁN, László KEMENES
Paks Nuclear Power Station, Paks, Hungary

Measuring and calculating methods of the preoperational in situ field dose rate determination applied in the environment of the Paks Nuclear Power Station in 1979-82 are discussed in this report.

The in situ measurements were performed by a NaI/Tl/scintillation spectrometer and a GM detector at 24 points in the environment of the Power Station. During the sophisticated calibration procedure the energy and direction dependence of the detector responses were also taken into account. The dose rates were also determined by the FOKER-CAMP computer code for natural radionuclides with an assumed source distribution.

On the basis of the good agreement of the measured and calculated values the sensitivity of the measuring system was assessed for some given distributed radionuclides released from the Power Station. The reliability of the methods used were confirmed by international intercomparison measurements. For the development of the gamma-spectrometric method a Ge/Li/spectrometer was calibrated and applied for field dose rate measurements.

RADIOACTIVITY OF FISHES IN THE HUNGARIAN REACH OF THE DANUBE

Endre KURTÁCS

Frédéric Joliot Curie National Research Institute for Radiobiology and Radiohygiene, Budapest, Hungary

In connection with the National Nuclear Power Plant Programme, author studied the ^{90}Sr and ^{137}Cs activity concentration in various Danube fish species /bream, carp, perch pike, nose carp, breamflat, ide/. Between 1979 and 1982 ground-level investigations were performed in the area of Paks. Samples taken from the surroundings of the operating Paks Nuclear Power Plant will regularly be measured in 1983.

After the radiochemical separation of ^{90}Sr from fish bone and ^{137}Cs content from muscles, activity concentration data obtained from the measurement of beta-activity refer to mBq/kg wet-weight.

The results of ground-level measurement do not show any significant difference as for sampling sites, seasons and species of fishes.

Elaboration and evaluation of samples taken during the first half of 1983 will be completed by July. The paper contains two tables.

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FISSION-NUCLIDE CONCENTRATIONS OF AMBIENT AEROSOL
SEPARATED BY SIZE

T. CSEPREGI, L. KOVÁCS, I. MASCHEK

Frédéric Joliot Curie National Research Institute for
Radiobiology and Radiohygiene, Budapest

K. SZTERJOPULOS, University of Sciences, Budapest, Hungary

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Examinations were carried on the radionuclides in aerosol deposited on filters of an air-conditioning plant with high air flow rate. For nuclide concentration of ambient air qualitative and quantitative analyses were made by gamma spectrometry.

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Methods have been developed for sample preparation, size fractionation by sedimentation technique and measurement of air flow. The collected aerosol particles was separated into five size fractions from 1 to 5 μm and the aerosol fractions were analysed. The mass/size distribution of the particles processed by sedimentation has been compared with that of the ambient aerosol separated by a slot impactor Hungarian type. Because the aggregation caused by the resuspensation technique would be assumed, electronmicrophotos were made on processed and unprocessed aerosols. On the basis of them the particle aggregation may be negligible. Otherwise, the derivation of concentration needs to know the exact air volume. For this aim the technical parameters of the aerodynamic system have also been measured in two different ways.

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The paper reports on the size dependence of fission products originating from the present global late fallout for a two years monitoring period. The results are compared with the daily beta activity concentration of aerosol samples taken by an other sampling unit.

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ESTIMATION OF THE NATURAL GAMMA-RAY, COSMIC RAY AND
RADON DAUGHTERS DOSE TO THE POPULATION OF VIENNA

Erich TSCHIRF, Mathilde DANZER

Atominstute of Austrian Universities, Vienna, Austria

A survey was carried out in the last years to evaluate the natural external radiation dose (indoors and outdoors) to the population of Austria. To obtain also an estimate of the inhalation dose in the city of Vienna (pop. 1.5 mill.), a series of radon daughter measurements inside private buildings was performed in 1982.

The most important results of these studies are:

Average dose rates outdoors (city of Vienna):

External terrestrial radiation 50 mR/a

Cosmic radiation 31 mR (equivalent)/a

Average dose rates indoors (city of Vienna):

Extern gamma radiation 75.9 mR/a

Cosmic radiation 31 mR (equivalent)/a

Measurements of the concentration of radon daughters in the air of 56 Viennese apartments under standard ventilation conditions resulted in a mean radioactivity level of 6.1 mWL (0.8 mWL - 44.1 mWL). Assuming normal ventilation rates during the year and a mean occupancy factor 0.8 for houses we estimate the annual radon daughter exposure to be 0.18 WLM/a.

A mean effective dose equivalent to the population of Vienna of

$$H_E = 1.8 \text{ mSv/a}$$

can be estimated.

AND

WL IN A BUILDING WITH ENHANCED NATURAL RADIOACTIVITY

a, Austria

Jadranka KOVAČ, Alica BAUMAN
Institute for Medical Research and Occupational Health,
Zagreb, Yugoslavia

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During the measurements of radon in buildings, in one old building the WL was measured. The measurements were repeated every ten days, in two different rooms distant 25 m for a period of 100 days. The average WL in room 1 was 0.346 and in room 2 0.135. Since people were working for 8 hrs daily without being aware which cannot be classified as occupationally exposed persons remedial measures must be undertaken.

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ON THE APPLICATION OF MONTE CARLO CALCULATIONS IN
ENVIRONMENTAL MODELLING -
APPLICABILITY AND LIMITATIONS

W. HOFMANN, University of Salzburg, Institute for
Biophysics, Salzburg, Austria

M. TSCHURLOVITS, Atominstitute of Austrian Universities,
Vienna, Austria

Monte Carlo calculations are becoming increasingly applied in environmental modelling. When multi compartments are used, the transfer parameters may vary substantially and the use of a mean value is not sufficient. Therefore, distributions of parameters have to be introduced into the calculations. If these distributions have to be proved by actual measurements, the question how many data are necessary for a reasonable assessment arise.

This paper concerns itself with the establishment of a parameter indication the goodness of data.

INVESTIGATIONS ON THE RADIOECOLOGICAL BEHAVIOR OF TRITIUM

L.A. KÖNIG

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Sicherheit/Radioökologie, Karlsruhe, Germany

According to a rough estimate the total tritium inventory of the Karlsruhe Nuclear Research Center amounts to about 20 PBq. Of the tritium present nearly 1 % is discharged as DTO or HTO via the exhaust air and the liquid effluents. The discharges via both paths take approximately the same order of magnitude.

The tritium discharges via the exhaust air cause clearly increased concentrations in the humidity of the air in the vicinity of the emitters. Thus the tritium concentrations in precipitations, soil, ground water, and plants are augmented.

The decontaminated liquid effluents released from the Nuclear Research Center are carried in a 2.9 km long pipe duct into a branch of the Altrhein serving as the main canal. Mixed with surface water, the liquid effluents flow through the main canal over a distance of 23.6 km before they reach the River Rhine. Via the ground water, the tritium in these effluents contaminates the neighboring surface waters as well as the independent drinking water supplies of some farms, and consequently, also the agricultural products.

The special situation in the environment of the Karlsruhe Nuclear Research Center provides the chance to perform a radioecological research program under natural conditions. A survey is presented of the results existing hitherto.

RADIOACTIVITY IN SURFACE AIR AND FALLOUT AROUND A
COAL-FIRED POWER PLANT

Alica BAUMAN, Jadranka KOVAČ
Institute for Medical Research and Occupational Health,
Zagreb, Yugoslavia

The radioactivity of surface air was measured around a coal fired power plant. The total alpha activity was considerably higher than background values. ^{210}Pb was also higher by a factor of 10. The same applies to uranium concentrations. The alpha activity and ^{226}Ra of fallout measured at two locations in opposite direction from the coal fired power plant exceeded the standard values by 30 - 40 times.

SOIL PROPERTIES INVESTIGATION IN SLOVENIA,
RELATED TO SOIL TO PLANT RADIONUCLIDE AND STABLE ELEMENT
TRANSFER FACTORS

M. MIHAILOVIĆ, A. JERŠIČ, B. SMODIŠ, Z. SMERKOL,
D. BRAJNIK, K. JUŽNIČ
Institut Jožef Stefan, Univerza E.Mardelja, Ljubljana,
Yugoslavia

To evaluate the dose from ingestion of terrestrial foods contaminated by radionuclides routinely released to the atmosphere and hydrosphere from light water reactors, the models are used which require the data on nuclide or elementspecific transfer factors. It has been shown that transfer factors for a particular plant may vary by orders of magnitude depending on soil type, meteorological conditions and agricultural practice.

The investigation have been made in Slovenia of various soil types, their properties, their radionuclide and microelement content determined. Some plant and associated soil transfer factors have been determined, for ^{90}Sr , ^{137}Cs and several stable elements.

LONG-TERM GROUNDWATER PROTECTION RELATED TO THE NUCLEAR ENERGY USE

Ljiljana R. KNEŽEVIĆ, Zivorad VUKOVIĆ
Boris Kidrič Institute of Nuclear Sciences - Vinča,
Beograd, Yugoslavia

In this paper problems of the groundwater pollution, due to use of the nuclear energy are discussed. The illite type of the soil characteristics related to the sorption and migration of the radionuclides were investigated. Using experimental results the transport parameters of radionuclides through vertical soil layer down to level of groundwater were estimated.

NUCLEAR

A SIMPLE METHOD FOR ASSESSING OF TRITIUM CONTENT IN REACTOR COOLING WATER

J.J. RAIČEVIĆ, M.M. NINKOVIĆ
Boris Kidrič Institute of Nuclear Sciences - Vinča,
Beograd, Yugoslavia

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It's well known that a principal radioactive product in the cooling system of heavy water reactor is tritium. The estimation of concentration of tritium as function of the power and working time of reactor is a very difficult especially at research nuclear reactor, because of unusual order of work. This study is dealing with setting of model and computer cod for determination concentration of tritium in experimental reactor's cooling system. The computer cod had been developed, was intended for application on the personal computer primary. The program have been tested on the basis of experimental data about concentration of tritium, which have been obtained from the cooling system of heavy water reactor RA at Vinča.

MONITORING OF AIRBORNE RADIOACTIVITY AT AUSTRIAN
AND HUNGARIAN NUCLEAR TRAINING REACTORS

- E. VIRÁGH, Radiation Protection Group in Nuclear
Training Reactor of Technical University Budapest,
Hungary
- E. TSCHIRF, Health Physics Group in Atom Institute of
Austrian Universities, Vienna, Austria

Taking into account that both nuclear reactors are
situated in the inner town of capital the monitoring
of released airborne radioactivity is one of the most
important routine work of radiation protection.

In the lecture the following topics will be discussed:

1. Basic physical aspects /developing of ^{16}N , ^{41}Ar , ^{14}C
and radioactive fission products
2. Basic radiation safety criteria in Austria and in
Hungary
3. Survey of applied measuring and monitoring techniques
for airborne radioactivity
4. Critical review of experiences.

AIRBORNE RADIOACTIVE RELEASE MONITORING AT THE
PAKS NUCLEAR POWER PLANT

J. RONÁKY, G. RÓSA

Paks Nuclear Power Plant, Radiation Protection Dept.
Paks, Hungary

In the pressurized water reactors the greatest part of radioactive releases in normal operation are the airborne radioactive effluents goint through the ventilation stack.

The airborne radioactive release monitoring system of the Paks Nuclear Power Plant is built up from the continuously operating measuring systems in the ventilation stack in one hand, and laboratory measurements in the other hand. The authorities have their own independent measuring program.

The detection limits of the monitoring system supplied with the plant for the main three effluent components /inert gases, aerosols, iodines/ lie between 1 - 10 % of the release limits imposed by the regulatory body.

For the monitoring of releases at the working levels /3 or 4 orders of magnitude below the limits/ sensitive Hungarian made instrumentation is used. These instruments were developed especially for this purpose in the Central Research Institute for Physics of the Hungarian Academy of Sciences and at the Training Reactor of the Budapest Technical University.

The first results of effluent monitoring in the startup period are presented and the environmental effects are estimated.

PROBLEMS IN ESTABLISHING MODELS FOR PREDICTION OF ENVIRONMENTAL MIGRATION OF RADIONUCLIDES IN THE AQUATIC PATHWAY

Manfred TSCHURLOVITS, Günter PROHASKA
Atominstute of the Austrian Universities, Vienna,
Austria

Environmental models are established to predict a given quantity (e.g. the activity concentration) being released from a given source, and some assumptions have to be made.

Different types of models are available for these purposes, ranging from simple chain models to complex models. However, the use of a complex model does not guarantee that the result is better in both accuracy and precision. This is due to the often very poor accuracy of the input parameters.

Regarding a running water system, models are checked in order to prove not only their applicability, but also the availability of input parameters.

THE ANNUAL DOSES RECEIVED FROM SEAFISH CONSUMPTION
BY YUGOSLAV POPULATION

Emilija HORŠIĆ, Zdravko MILOŠEVIĆ, Ranko KLJAJIĆ

Faculty of Veterinary Medicine, Sarajevo, Yugoslavia

Alica BAUMAN, Institute for Medical Research and Occu-
pational Health, Zagreb, Yugoslavia

After the investigations of the radioactivity level found in sea water and sea water fishes along the Adriatic coast, the annual doses were calculated received by the population from fish consumption.

Two groups were considered, fishermen and local population. The doses for the most common fish species such as merlucius vulgaris, scomber scomber, clupea pilichardus, fresh and canned and dicentractus labractus were calculated. For natural radioactivity Ra-226 and U-238 were evaluated for fission products Sr-90 and Cs-137.

A SIMPLE FIELD METHOD FOR MEASURING RADON DAUGHTER-
AND THORON DAUGHTER WORKING LEVELS IN AIR OF
DWELLING ROOMS

Árpád TÓTH

Hospital Clinic of Baranya County, Pécs, Hungary

The need for a simple but accurate working level field measuring method arises because the radiological inhalation risk assessment of the population is based mainly on the working level of the radon- and thoron-daughters in room air. On the other hand, air sampling in private houses endeavours to avoid the problem of disturbing the inhabitants for longer than is absolutely necessary.

Using the stationary model-room parameters and equations of Porstendörfer et al. /1978/ and Wicke /1979/, for a mean air exchange rate of 1 h^{-1} the probable activity concentration ratios of radon- and thoron daughters were calculated. Bearing on these figures, for 10 minute long air sampling and an air sampling rate of 1 l/min, the conversion factors from alpha disintegrations /measurable in different long decay intervals after sampling has ceased/ to working levels were determined.

The radon daughter working level was corrected for thoron daughters, occurring in room air.

Formulae for radon daughter- and thoron daughter working levels and for estimation of limits of quantitative detection of working levels, as well as results of preliminary WL_R - and WL_T -measurements in dwellings are given.

The method described is a modification of the procedure of Blanchard-Holaday /1960/, Strandén /1980/ and Nazaroff /1980/.

THE RADIOACTIVE CONTAMINATION AROUND A CYCLOTRON

I. URAY, Institute of Nuclear Research of the Hungarian
Academy of Sciences, Debrecen, Hungary
H.J. PROBST, Institute for Nuclear Physics, KFA Jülich,
Germany

Although cyclotrons are known mainly as closed radiation sources, a considerable radioactive contamination may appear in their surrounding. At the isochronous cyclotron in Jülich the different forms of the radioactive contamination were studied, occurring at different places, on the surface of the structural elements, around the accelerator and target system, and in the connected radiochemical laboratory. The isotopic composition and the activity of the collected samples was determined by using Ge(Li)- and Si(Li) spectrometers. Different contamination monitors were tested with this radioactive sources. Whether they are sensitive enough to correspond to the requirements of the international recommendations and the national regulations concerning the limits of the radioactive contamination.

It was found that around the cyclotron often appears surface contamination of varying isotope composition with a surface activity above 0.37 kBq/cm^2 . The sensitivity of the contamination monitors is generally between 30 - 300 Bq, depending on the decay mode of the investigated isotope(s). The counting rate of the monitors might strongly decrease by the incomplete geometry or by the possible absorbent layers. The calibration of the contamination monitors for practical purposes is generally difficult and may be only approximately valid, so to determine by them the condition of "free from contaminants" - satisfying the requirements for an uncontrolled area - is practically impossible.

SOME IMPORTANT CHARACTERISTICS OF CONCRETE CONTAINERS
IN RADIOACTIVE WASTE PACKAGE

Ilija B. PLEČAŠ

Boris Kidrič Institute of Nuclear Sciences - Vinča,
Beograd, Yugoslavia

Low and intermediate level radioactive waste represents 90 % of total radioactive waste. It is conditioned into special concrete containers. Since these concrete containers are to protect safely the radioactive waste for around 300 years, the selection of materials and precise control of their physical and mechanical characteristics is very important.

In this work, results obtained with some Yugoslave concrete compositions are described.

MATHEMATICAL MODELLING OF RADIONUCLIDES REMOVAL
FROM THE WATER BY THE METHOD OF COPRECIPITATION

Slavica LAZIĆ, Zivorad VUKOVIĆ
Boris Kidric Institute of Nuclear Sciences - Vinca,
Beograd, Yugoslavia

A coprecipitation process in an apparatus under conditions of continuous water purification is analysed. Process is described by the set of balance equations defining a change of radionuclides and carrier mass in the volume of liquid and solid phase within the system.

The productivity of the apparatus, concentration degree and coefficient of distribution are defined as parameters to be optimized.

The mathematical model was applied to the case of radioactive ^{85}Sr removal from the water by the coprecipitation with BaCO_3 .

Laboratory water treatment process consisted of three basic operations:

precipitation, flocculation and separation.

For the mixing of reagents pipe mixer with injection nozzles was used. Flocculation and separation process occurred in the fluidized sludge blanket clarifier. Experimental results showed that mass transfer of carrier and radionuclide was completed very fast ($t < 1$ min) and radioactivity removal of about 99 % was achieved.

Parameters of the mathematical model were experimentally determined and basic outlet characteristics of the process were calculated.

Outlet characteristics of the process were represented graphically as a function of the inlet suspension flow.

The results enabled optimal choice of working regime in the apparatus.

DOSE LEVEL MEASUREMENTS DURING STARTUP OF THE
FIRST UNITS OF THE PAKS NUCLEAR POWER PLANT

S. FEHÉR, M.F. NAGY, E. VIRÁGH, Technical University of
Budapest, Training Nuclear Reactor
J. RÓNAKY, G. RÓSA, Paks Nuclear Power Plant, Radiation
Protection Department, Paks, Hungary

An important part of measurements during startup of the Nuclear Power Plant was concerned to determination of "dose-map" in the controlled area. In investigation program was performed for obtaining gamma and neutron dose levels and the calculations with data were carried out by using a computer code PAVDAP. In this lecture we summarized our work as follows:

- a) experiences with the gamma and neutron dosimetric equipments (including calibration processes)
- b) the "DAP" concept ("DAP" means Dosimetric Base Point)
- c) the PAVDAP computer code
- d) detailed analysis of results.

The results presented indicate that shielding walls satisfy the design criteria and the dose level values fairly agree with the signs of the stationary installed radiation monitoring system ("SEIVAL").

CHARACTERISTICS OF MIXED NEUTRON-GAMMA RADIATION
FIELD AROUND CYCLOTRONS

I. URAY, Institute of Nuclear Research of the
Hungarian Academy of Sciences, Debrecen, Hungary
P. MANNGÅRD, Åbo Akademi, Turku, Finland
H.J. PROBST, M. HEINZELMANN, IKP, ASS-ST, KFA Jülich,
Germany

The knowledge of the strongly varying neutron-gamma radiation field around the cyclotrons is necessary for the construction and control of the shielding, for the estimation of the induced radioactivity and also for the personal and accidental dosimetry. The radiation protection calculations, based on primary data can not take all the real circumstances into account. It is compensated usually by rigorous "safety factors", resulting often in an overestimation of the danger. On the other hand the data set from the daily routine supervision is naturally incomplete, resulting in an underestimation of the danger. The realistic estimation of the radiation conditions needs also a wide range of informations and experience about the most important effects influencing the neutron-gamma field.

The investigations of these factors were made at the MGC cyclotron of the Åbo Akademi and at the JULIC isochronous cyclotron of KFA Jülich, at realistic working conditions. The measurements were carried out in a wide energy range and with different bombarding particles, during both shorter and longer operating periods of the cyclotrons, partly near to the cyclotron or to the target system and partly at a longer distance from them, both inside and outside the shielding. Activation detectors, REM counters and solid state track detectors were used for the neutron measurements, while the gamma radiation was investigated by using different types of thermoluminescent detectors.

FISSION-NUCLIDE CONCENTRATIONS OF AMBIENT AEROSOL
SEPARATED BY SIZE

T. CSEPREGI, L. KOVACS, I. MASCHEK

Frédéric Joliot Curie National Research Institute for
Radiobiology and Radiohygiene, Budapest

K. SZTERJOPULOS, University of Sciences, Budapest,
Hungary

Examinations were carried on the radionuclides in aerosol deposited on filters of an air-conditioning plant with high air flow rate. For nuclide concentration of ambient air qualitative and quantitative analyses were made by gamma spectrometry.

Methods have been developed for sample preparation, size fractionation by sedimentation technique and measurement of air flow. The collected aerosol particles were separated into five size fractions from 1 to 5 μm and the aerosol fractions were analysed. The mass/size distribution of the particles processed by sedimentation has been compared with that of ambient aerosol separated by a slot impactor Hungarian type. Because of aggregation caused by the resuspension technique would be assumed, electromicrophotos were made on processed and unprocessed aerosols. On the basis of them the particle aggregation may be negligible. Otherwise, the derivation of concentration needs to know the exact air volume. For this aim the technical parameters of the aerodynamic system have also been measured in two different ways.

The paper reports on the size dependence of fission products originating from the present global late fallout for a two years monitoring period. The results are compared with the daily beta activity concentration of aerosol samples taken by an other sampling unit.

AIR-GROUND CORRECTION FACTOR FOR GAMMA RADIOACTIVE CLOUDS

P. JACOB, H.G. PARETZKE

Gesellschaft für Strahlen- und Umweltforschung
Neuherberg, Germany

A Monte Carlo study has been done to calculate the spectral energy fluence above the ground due to an isotropical gamma emitter at a height h above the ground. The kerma was calculated for 10 source energies in the range 0.01 - 10 MeV. The results are compared with the kerma due to gamma emitters in infinite air. The greatest deviations are found for the case that the source is near the ground. In the calculation the lowest height was 0.05 mfp. The presence of the ground was two effects (i) for great lateral distances (in the calculation around 5 mfp) and source energies in the range 80 - 150 keV it reduces the kerma by a factor 3; (ii) near the source and for source energies in the range 80 - 500 keV it enhances the kerma by 10 %. The air-ground correction factor is analytically approximated so that it may be easily used in programs that calculate the dose due to gamma emitting clouds.

COMPARISON OF AEROSOL MONITORING DEVICES USING
MICROPROCESSORS TO BANDFILTER SYSTEMS

Konrad MÜCK

Austrian Research Center Seibersdorf, Austria

With the introduction of microprocessors new concepts have become feasible in the measurement and data processing of radioactive aerosols. A comparison of continuous aerosol monitoring versus bandfilter systems is presented. Detection limits and time response in particular with regard to working place monitoring are discussed.

ENRICHMENT OF STABLE AND RADIOACTIVE ISOTOPES
IN FISH MEAT

K. HÜBEL, D. LASCHKA

Bayrische Landesanstalt für Wasserforschung, München,
Germany

The radiation load resulting from aquatic food chain contributes substantially to radiation exposure of human by radioactive substance into face water. The uptake of activity through fish consumption can be expressed by a simple mathematical equation. A prerequisite for a realistic appraisal of radiation exposure, however, is a good knowledge of the concentration factors of the individual radionuclides in fish meat.

The uptake of radionuclides by fish and the resulting accumulation in fish bodies is influenced by many factors. These include the chemical properties and the physical-chemical speciation of a radionuclide, the simultaneous presence of stable isotopes or chemically similar non isotopic carriers, the content of suspended matter, the concentration of organic matter in the water body, water temperature, and others. Effort are being made to understand the accumulation processes of radionuclides in fish meat by means of mathematical models, which hopefully enables us to estimate the prospective radioactive contamination of fish in the vicinity of a projected nuclear power plant.

A concentration factor indicates the ratio of the activity concentration in fish meat and water. If the radioisotope has the same chemical speciation as the stable element, it will be taken up and excreted by fish to the same extend. This results in the fact that the concentration

factor of an element and its radioisotopes is the same (assuming that possible isotopic effects can be excluded).

In this context, the question arises, whether the concentration factors of stable elements and their radioisotopes in the same area can be compared. Only if the data reservoirs of the radioisotopes and the sample elements are the same, can the concentration factors of the radionuclides be estimated reliably from the measured concentrations of their stable isotopes or their non isotopic carriers in water by means of a mathematical equation.

CASE STUDY OF RADON DAUGHTERS PRODUCT CONCENTRATIONS
IN A DWELLING

W.F. PASSCHIER

Interuniversitair Reactor Instituut, Delft, The Netherlands

Measurements of the air-tightness of a house, the air-pressure distribution around the house as a function of the wind-speed and wind-direction, and of the radon sources inside the house provide the necessary parameters for a model of the distribution of the radon- and radon-decay-product concentrations within the house. The presentation reports on such measurements and compares the model results with the actual radon concentrations in the house. This approach is suitable for the testing of theoretical calculations of radon exposure of the population due to the radioactivity in building materials.

Herausgeber und Verleger: Österreichischer Verband
für Strahlenschutz
Lenaugasse 10, A-1080 Wien

Nach dem Pressegesetz verantwortlich:
Univ.Prof.Dr.E.TSCHIRF, Dr. A.HEFNER

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